MADRID-BOSTON PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

CESCC	Canadian Endangered Species Conservation Council
CWS	Canadian Wildlife Service
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DNA	Deoxyribonucleic acid
DEM	Digital Elevation Model
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
ELC	Ecological Land Classification
EM	Ecosystem Mapping
GIS	Geographic Information System
GN DOE	Government of Nunavut Department of the Environment
GPS	Global Positioning System
KIA	Kitikmeot Inuit Association
HSR	Habitat Suitability Rating: final rating assigned to an ecosystem unit with all assumptions and adjustments taken into account
Life Requisite	Specific activities of an animal that are critical for sustaining and perpetuating the species and that depend on particular habitat attributes or conditions. Life requisites include feeding, cover, breeding, migration, hibernation, etc.
LSA	Local Study Area
MBCA	Migratory Birds Convention Act
NIRB	Nunavut Impact Review Board
NU	Nunavut
NWT	Northwest Territories
PRISM	Program for Regional and International Shorebird Monitoring
RISC	BC Resources Information Standards Committee
RSA	Regional Study Area

SARA	*Species at Risk Act*
SOP	Standard Operating Procedure
Species Account	A summary of geographic distribution, life requisites, seasonal use of habitats, limiting factors, and habitat attributes for an animal species within a geographic range
Species Diversity	A measure of biodiversity that takes into account the number of species present, as well as the relative abundance of each species. Species diversity indices are mathematical estimators of diversity based on sample data (i.e., Fisher's-alpha and Simpson's Diversity Index).
Species Richness	The simplest measure of biodiversity. It is a count of the number of different species in a given area or sample
Suitability	Ability of the habitat in its current condition to provide life requisites of an animal
the Program	The Wildlife Mitigation and Monitoring Plan Compliance Monitoring Program (WMMP Compliance Monitoring Program). Refers to the current WMMP, the monitoring that occurs, and the associated report for any given year.
The Project	The Hope Bay Project
VECs	Valued Ecosystem Components
WHR	Wildlife Habitat Rating: preliminary rating assigned to an ecosystem unit
WKSS	West Kitikmeot / Slave Study
WKRLUP	West Kitikmeot Region Land Use Plan
WMMP	Wildlife Mitigation and Monitoring Plan. The WMMP is the official document that outlines the program to be conducted to mitigate and monitor wildlife for the Doris Gold Mine Project.
Zone of Influence (ZOI)	The area over which an effect of a Project may occur and may be measured compared to natural populations prior to and at a greater distance from the Project. This area is typically given a circle around a Project and is measured by its radius.

9. Terrestrial Wildlife and Wildlife Habitat

This section provides an overview of terrestrial wildlife populations and available wildlife habitat in the areas surrounding the Madrid-Boston (Phase 2) Project. The assessment evaluates the potential effects of the Phase 2 Project on wildlife VECs, and then evaluates the potential effects of the Hope Bay Project (Permitted Project plus Phase 2) and cumulative effects on wildlife VECs.

The Hope Bay Project is located in the Hope Bay greenstone belt, a north-south belt of gold deposits extending south from Roberts Bay in Melville Sound. The Hope Bay Project is made up of the Permitted Project and Phase 2, which is the object of this draft Environmental Impact Statement (EIS).

The Permitted Project includes:

1. the Doris Project – currently completing construction and entering operations and includes the Roberts Bay laydown, the Doris site located approximately 4 km south of Roberts Bay and including an accommodation area, underground mine and Tailings Impoundment Area (TIA);
2. the Hope Bay Regional Exploration Project – drilling to explore for resources;
3. the Boston Advanced Exploration Project – a bulk sample at the Boston site, approximately 60 km south of Roberts Bay; and
4. the Madrid Advanced Exploration Project – a bulk sample at the Madrid site, approximately 10 km south of the Doris site (application currently in review).

Phase 2 will include:

1. continued use of the Doris site, with accommodation, milling and TIA located there;
2. expansion of the Roberts Bay laydown with a cargo dock and additional fuel storage;
3. expansion of the TIA;
4. continued operation of the Madrid site;
5. construction and operation of a 53 km all-weather road from Madrid, south to Boston; and
6. construction and operation of the Boston underground mining site.

Section 9.4.1 includes an overview of Phase 2 and the Hope Bay Project. A comprehensive description of Phase 2 activities is included in Section 3, the Project Description.

9.1 INCORPORATION OF TRADITIONAL KNOWLEDGE

9.1.1 Incorporation of Traditional Knowledge for Existing Environment and Baseline Information

Traditional Knowledge (TK) and cultural significance of wildlife was considered throughout the design and implementation of the wildlife and wildlife habitat baseline program. The wildlife and wildlife habitat baseline programs focused on species of cultural importance to Inuit as well as the characterization of habitat that supports those species.

Results from the *Naonaiyaotit Traditional Knowledge Project* (NTKP) report (Banci and Spicker 2016) were integrated into the Existing Environment and Baseline Information sections of the draft Environmental Impact Statement (EIS) and discussed in relation to scientific knowledge presented in peer reviewed journals and studies as well as baseline studies conducted for Phase 2. Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into habitat suitability models and mapped as high-quality habitat.

Habitat for wildlife species identified from TK, particularly caribou, were included in the setting and used in the effects assessment (Section 9.8), including wintering habitat for Dolphin and Union (Island) caribou and summering areas for Beverly/Ahiak caribou. Movement corridors described in TK were also included in the baseline and effects assessment, including overland movement areas, such as the Kent Peninsula and the Kent Peninsula isthmus, sea-ice crossing areas in Dolphin and Union Straight, Elu Inlet, and Melville sound and fresh water crossing locations on the Nunavut mainland.

Descriptions of good quality habitat from TK for caribou, muskox, grizzly bear, wolf, and wolverine were included in the Habitat Suitability Models for each species to evaluate habitat loss. Specific locations of higher quality habitat or areas where these species were harvested were also included in the setting and in the effects assessment.

During baseline data collection, TK was further incorporated through the involvement of Inuit personnel in field programs, with input sought from Elders and experienced land users on program optimization. This TK input assisted in identifying areas best suited to detections of caribou, carnivores and den sites, and influenced the placement of wildlife monitoring cameras and Deoxyribonucleic acid (DNA) tripods, as well as how survey effort was focused. TK was also used as baseline information to support the human and environmental risk assessments (Volume 6, Section 5; Human Health and Environmental Risk Assessment) which in turn support the wildlife effects determination (Volume 6, Section 5).

9.1.2 Incorporation of Traditional Knowledge for Terrestrial Wildlife Selection

Results from the NTKP report (Banci and Spicker 2016) were reviewed for scope and refine the potential Wildlife and Wildlife Habitat Valued Ecosystem Component (VEC) list (see Volume 2, Section 4).

The NTKP report provides maps of distribution of valued animal species, environmental components, and traditional land use activities. The wildlife species and habitat features identified in the NTKP report were considered as potential VECs for the wildlife and wildlife habitat assessments. Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families rely on them as a main or supplemental food source food source (Rescan 2013a). Other terrestrial wildlife species that are highly regarded by Inuit include grizzly bears, muskox, furbearers, raptors, and migratory birds (Banci and Spicker 2016).

Traditional knowledge was combined with data from public consultation, baseline surveys, and published species distributions to determine which valued components would potentially interact with Phase 2, and therefore be evaluated as a candidate VEC. As a result of this process, and in consideration of the Phase 2 Project Specific Guidelines for the Phase 2 Project, caribou, muskox, grizzly bear, furbearers (wolverine), raptors, waterbirds, and upland birds were selected as VECs for the EIS (Volume 2, Section 4; Effects Assessment Methodology).

9.1.3 Incorporation of Traditional Knowledge for Spatial and Temporal Boundaries

The NTKP report was used to guide the boundaries of the Local Study Area (LSA) and Regional Study Area (RSA) used for the EIS. Baseline wildlife field studies and habitat suitability modeling were completed in the delineated Local and Regional study areas to encompass potential Hope Bay Project effects on wildlife resulting from construction, operation and closure of the Hope Bay Project.

Current Inuit use of the land for hunting and travel (identified in V. Banci and R. Spicker 2012; Banci and Spicker 2016), overlaps the LSA and RSA (Volume 6, Section 4 Land Use), and was also considered in the delineation of the study area boundaries. The wildlife RSA encompasses an area large enough to characterize potential effects to species which may come into contact with the Hope Bay Project or Project-related activities.

9.1.4 Incorporation of Traditional Knowledge for Project Effects Assessment

Traditional Knowledge was used to identify potential effects of the Phase 2 Project on wildlife VECs by examining where and when Phase 2 Project components may interact with wildlife VECs or wildlife VEC habitat identified by TK. These included habitats used for winter and summer forage and important habitat areas such as eskers, fresh water crossings, streams, wetlands, ocean ice crossings, and other features.

In addition to TK gathered by the KIA (Banci and Spicker 2016), TMAC held three workshops with Elders and harvesters in September 2016, and April and August 207 in Cambridge Bay to discuss habitat use, potential effects of Phase 2 on caribou and to propose mitigation and management to minimize these effects. The Elders and harvesters identified 18 potential effects, which were rated by their likelihood to occur (unlikely, possible and expected) and their likely impact on caribou (low, medium, high). These potential effects were then evaluated in the effects assessment (Section 9.8.1, Table 9.8-1). Elders and harvesters also reviewed the existing Doris site, the mitigations used at Doris for caribou and the planned mitigation for the Phase 2 Project to evaluate the effectiveness of mitigation the likely effects of the Doris and Phase 2 projects on caribou.

TK collected by the KIA (Banci and Spicker 2016) and land user information gathered through the caribou workshop were then used to evaluate potential effects on caribou, particularly for habitat loss, disturbance to caribou, disruption of movement, direct mortality and the potential effects of chemicals and pollution in the environment (assessed as potential changes to environmental media quality) (Section 9.8).

TK and land user information were also incorporated into the assessment of effects for other wildlife VECs, primarily to evaluate habitat loss, disruption of movement and response of wildlife species to disturbances for muskox, grizzly bear, wolverine and birds.

Traditional movement patterns, particularly of caribou, along with satellite collar information and land user information were also used to define the study area and potential cumulative effects for caribou, including habitat loss and disturbance over the seasonal and annual ranges for this VEC.

9.1.5 Incorporation of Traditional Knowledge for Mitigation and Adaptive Management

Traditional Knowledge collected by the KIA (Banci and Spicker 2016) was used to identify mitigation and adaptive management for wildlife VECs by examining where and when Phase 2 Project components may interact with wildlife VECs or wildlife VEC habitat identified by TK.

In addition to TK gathered by the KIA (Banci and Spicker 2016), TMAC held a workshop with Elders and harvesters in September, 2016, in Cambridge Bay to discuss habitat use, potential effects of Phase 2 Project on caribou and to propose mitigation and management to minimize these effects. The Elders and harvesters identified proposed mitigation and adaptive management measures for Phase 2 and Hope Bay Project. A complete list of the potential effects identified by Elders and harvesters, their proposed mitigation and TMACs commitments to mitigation and adaptive management are listed in Section 9.8.2, Table 9.8-2.

The majority of these proposed mitigation and adaptive management measures focused on reducing noise and dust so that caribou would not be disturbed by Phase 2, including measures to reduce noise disturbance from helicopters, fixed wing aircraft, blasting, processing, rock hauling, and vehicles on roads. Disturbance from dust was addressed through dust control on roads. TMAC committed to mitigation and adaptive management measures to address each of these proposed mitigations (Table 9.8-2).

The second major area of proposed mitigation was reducing potential disruption of movement for caribou by aircraft, Phase 2 sites, and the Phase 2 roads. The proposed mitigations included crossing ramps on roads at identified movement corridors for caribou, speed limits, giving wildlife the right of way on roads, avoiding caribou (and other wildlife) during migration, monitoring for caribou during migration and adaptively managing Phase 2 activities to reduce disturbance during migration. TMAC committed to mitigation and adaptive management measures to address each of these proposed mitigations (Table 9.8-2).

Elders and harvesters also reviewed the existing Doris site, the mitigations used at Doris for caribou and the planned mitigation for the Phase 2 Project to evaluate the effectiveness of mitigation the likely effects of the Doris and Phase 2 projects on caribou.

Elders and harvesters also proposed potential effects, mitigation and management for grizzly bears and wolverine, and these measures are discussed in Sections 9.10 and 9.14. Mitigation measures for these species included having appropriate plans in place to deal with grizzly bears and wolverines that may be attracted to the Phase 2 site.

9.2 EXISTING ENVIRONMENT AND BASELINE INFORMATION

9.2.1 Regional Overview and Past Activities

The Phase 2 Project is located approximately 153 km southwest of Cambridge Bay, Nunavut, on the southern shore of Melville Sound in the West Kitikmeot region of Nunavut. The Phase 2 Project is located within the Hope Bay greenstone belt, a predominantly north-south oriented band of mineralized geology approximately 80 km long and 20 km wide. The northern portion of the Hope Bay Belt (the Belt) boarders the ocean and is characterized by cliffs and rocky dykes interspersed with lakes, rivers, wetlands, and uplands. Further inland cliffs and rocky outcrops become less common and the topography is characterized by rolling tundra.

The Belt's vegetation is characterized by shrub tundra vegetation such as dwarf birch (*Betula nana*), willow (*Salix* spp.), Labrador tea (*Ledum decumbens*), avens (*Dryas* spp.), and blueberries (*Vaccinium* spp.). The region provides habitat to a number of wildlife species, including migratory caribou and wolves, and resident muskox, grizzly bear, wolverine, foxes, and a variety of other smaller mammal species. The distribution of moose distribution has also been expanding northward in recent years. Migratory bird species including upland birds, waterbirds, and raptors also use the region during migration and breeding seasons. Resident birds such as ptarmigan, ravens, and gyrfalcon, and other

species identified by Inuit TK such as rough-legged hawk, snowy owl, and snow bunting, may also overwinter in the region (Banci and Spicker 2016).

9.2.2 Proximity to Designated Environmental Areas

There are currently no existing or proposed parks or conservation areas on or adjacent to the Hope Bay Project site. The nearest conservation area is the Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS) approximately 50 km east of the Project. A part of the QMGMBS is also designated as an Important Bird Area (IBA; IBA 2012a), and is identified as a key terrestrial habitat site for migratory birds by the Canadian Wildlife Service (CWS; Latour et al. 2008). The QMGMBS supports over one million breeding waterbirds every year (IBA 2012a), and is used by caribou during the calving, post-calving, and summer seasons.

The Thelon Wildlife Sanctuary is located roughly 300 km to the south of the Project, and was created in the 1920s to protect caribou and muskox populations (Taylor 2006). It is an important area for caribou during late summer and fall, as well as other Arctic wildlife. The 2016 Draft Nunavut Land Use Plan designated wildlife conservation areas including key migratory bird habitat sites and caribou habitat. The Bathurst/Elu Inlet key migratory bird habitat site covers marine areas within Melville Sound, Elu Inlet, and upper Bathurst Inlet; interactions between the Permitted Project and Phase 2 Project activities and this key migratory bird habitat site is discussed further in the Volume 5, Section 11: Marine Wildlife. A caribou freshwater crossing area occurs to the northeast of the Hope Bay Project between the mainland and habitat on the Kent Peninsula as well as a caribou ice crossing area at the eastern end of Elu Inlet to the northeast of the Hope Bay Project.

9.2.3 Regulatory Framework

Wildlife and wildlife habitat are protected by both federal and territorial legislation, including the Nunavut *Wildlife Act* (2003), *Nunavut Land Claims Agreement Act* (1993a), Canada *Wildlife Act* (1994a), the *Migratory Birds Convention Act* (1994b), and the *Species at Risk Act* (SARA; 2002). The following sections describe these acts and their subsidiary regulations, and guidelines and how they apply to the protection of wildlife and wildlife habitat.

9.2.3.1 Nunavut Wildlife Act

The Nunavut *Wildlife Act* (2003) identifies and defines wildlife management in Nunavut, including legislated responsibilities for the conservation, protection and recovery of species at risk, managing nuisance wildlife, and possession of wildlife. The Act provides interpretation of approved and restricted hunting and related activities, including the possession of wildlife, and the enforcement that will follow should the Act or corresponding regulations be contravened. The Act protects against significant disturbance to wildlife (Section 73(1)) and the unlawful harvesting of bird eggs (includes all species) and destruction of bird nests (Sections 72(1) and 72(2)). The residences of certain wildlife (bear, fox, beaver, muskrat, weasel, wolf or wolverine) are also protected (Section 73(1)(b)).

9.2.3.2 Nunavut Agreement

The *Nunavut Land Claims Agreement Act* (1993a) is legislation that enables the *Nunavut Land Claims Agreement* (NLCA; 1993b). The Nunavut Wildlife Management Board (NWMB), established under the NLCA, is the responsible authority for the management of wildlife and wildlife habitat in conjunction with government bodies. Section 5.2.34 of the NLCA outlines additional responsibilities for the NWMB, including the approval of conservation areas, wildlife management zones, wildlife management strategies, species at risk recovery plans, the designation of species of conservation concern, and dissemination of wildlife management information to appropriate government bodies.

9.2.3.3 Canada Wildlife Act

The Canada *Wildlife Act* (1994a) identifies and defines actions for wildlife research and conservation, and allows for the creation, management, and protection of wildlife areas. The purpose of wildlife areas is to preserve habitats that are critical to migratory birds and other wildlife species, focusing on species that are at risk. The Wildlife Area Regulations under the Canada *Wildlife Act* (1994a) outline the activities that are prohibited within designated National Wildlife Areas, such as hunting or fishing, unless these activities are deemed permissible by the Minister and posted in said National Wildlife Areas (Section 3(2)) or persons have been granted a permit to conduct prohibited activities provided those activities will not interfere with the conservation of wildlife (Section 4).

9.2.3.4 Migratory Birds Convention Act

The *Migratory Birds Convention Act* (1994b) prohibits the taking or killing of migratory birds, their nests, and eggs (Section 5(a)), and the deposition of harmful substances in areas frequented by migratory birds (Sections 5.1(1) and 5.1(2)). The species protected include waterfowl, cranes, rails and coots, shorebirds including gulls and terns, pigeons and doves, insectivorous songbirds (excluding blackbirds), seabirds, loons, grebes, herons, egrets, and bitterns.

9.2.3.5 Species at Risk Act

The federal *Species at Risk Act* (SARA; 2002) is designed to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses and identifies species at risk. COSEWIC is mandated under SARA to classify species according to their level of conservation concern: *extinct*, *extirpated*, *endangered*, *threatened*, *special concern*, *not at risk* or *data deficient*. Currently, only those species that have been designated by COSEWIC and are subsequently listed in Schedule 1[1] of the Species at Risk Public Registry may qualify for legal protection and recovery under SARA. The Act prohibits the killing, harming, harassing, capturing or taking of an individual of a species that is listed in Schedule 1 as *extirpated*, *endangered* or *threatened* (SARA Section 32(1)). SARA (Section 33) protects the residences of species listed as *extirpated*, *endangered* or *threatened* from being damaged and destroyed. Section 79 of the Act contains regulation in relation to assessment of environmental effects on listed wildlife or its critical habitat. Section 79(1) states that "…every person who is required by or under an Act of Parliament to ensure that an assessment of the environmental effects of a project is conducted, and every authority who makes a determination under paragraph 67(a) or (b) of the *Canadian Environmental Assessment Act*, 2012 in relation to a project, must, without delay, notify the competent minister or ministers in writing of the project if it is likely to affect a listed wildlife species or its critical habitat." Section 79(2) states "…the person must identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans."

[1]Schedule 2 lists the species that were assessed by COSEWIC prior to the proclamation of SARA in 2003. Since then all of the species on Schedule 2 have been reassessed using the new assessment criteria adopted in October 1999. The species that did not meet the new risk criteria have remained on Schedule 2. Schedule 3 lists species of Special Concern that have yet to be assessed. After assessment reporting and following consultations, the Minister makes a recommendation to Governor in Council; Governor in Council then decides on whether or not they should be added to Schedule 1, the List of Wildlife Species at Risk. The protection and/or conservation measures afforded by SARA apply only to species once they are on Schedule 1.

9.2.4 Data Sources

Baseline data on terrestrial wildlife has been collected in the Hope Bay Greenstone Belt since the 1990s. For the EIS, baseline data collected since 2006 were used because these data represent the most relevant pre-development data for the Hope Bay Project. The exceptions are the ungulate aerial surveys in the RSA. These were conducted between 1996 and 2011, after which aerial surveys were discontinued due to low numbers of animals observed.

Baseline data to support the EIS were obtained from the following reports:

- *Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* (Banci and Spicker 2016);
- *Doris North Project: 2016 Wildlife Mitigation and Monitoring Plan Compliance Monitoring Report* (ERM 2017a);
- *Hope Bay Project Phase 2: Migratory Standwatch Surveys Report, 2017* (EDI 2017)
- *Doris North Project: 2015 Wildlife Mitigation and Monitoring Plan Compliance Monitoring Report* (ERM 2016a);
- *Doris North Project: 2014 Wildlife Mitigation and Monitoring Plan Compliance Monitoring Report* (ERM 2015b);
- *Doris North Project: 2013 Wildlife Compliance Monitoring Report* (ERM Rescan 2014a);
- *Doris North Project: Wildlife Mitigation and Monitoring Program Report, 2012* (Rescan 2013d);
- *Doris North Gold Mine Project: 2012 Final Grizzly Bear DNA Report* (Rescan 2012a);
- *Doris North Project: Wildlife Mitigation and Monitoring Program, 2011* (Rescan 2011f);
- *Hope Bay Belt Project: Marine Wildlife Baseline Report, 2011* (Rescan 2011g);
- *Hope Bay Belt Project: 2010 Wildlife Habitat Suitability Baseline Report* (Rescan 2011h);
- *Doris North Gold Mine Project: 2011 Interim Grizzly Bear DNA Report* (Rescan 2011a);
- *Doris North Gold Mine Project: Wildlife Mitigation and Monitoring Program, 2010* (Rescan 2011c);
- *Doris North Gold Mine Project: Wildlife Mitigation and Monitoring Program, 2009* (Rescan 2010);
- *Doris North Project: Wildlife Mitigation and Monitoring Program – 2008 Final Report* (Golder 2009);
- *Doris North Project: Wildlife Mitigation and Monitoring Program – 2007 Final Report* (Golder 2008a);
- *Doris North Project: Wildlife Mitigation and Monitoring Program – 2006 Final Report* (Golder 2007);
- *BHP Diamonds Inc. Hope Bay Belt Project: 1998 Environmental Data Report* (Rescan 1999);
- *BHP World Minerals Hope Bay Belt Project: Environmental Baseline Studies Report 1996* (Rescan 1997);
- *Doris Project Final Impact Statement. 2005, Supporting Document D2. Terrestrial Wildlife of Hope Bay, Nunavut: An integration and overview of data collected from 1994 – 2002*. Prepared by Hubert and Associates, November 2002 (Miramar 2005).

- *Doris North Project Final Impact Statement. 2005, Supporting Document D3. Data Report Wildlife Studies: June – July 2003*. Prepared by Hubert and Associates, September 2003 (Miramar 2005).
- *Doris North Project Final Impact Statement. 2005, Supporting Document D4. Wildlife Baseline Data Synthesis*. Prepared by Golder Associates Ltd., October 2005 (Miramar 2005).

In addition to the reports listed above, unpublished data collected in 2014 on waterbirds and furbearers near the Boston property were incorporated into the EIS. Publicly available data from other nearby studies (e.g., Back River Project; Sabina 2015a) were also compared to data from the Hope Bay baseline and monitoring programs to provide a regional context.

9.2.5 Methods

Baseline studies were conducted to document wildlife activity and distribution within the LSA and RSA, and to inventory the available habitat for wildlife VECs considered in the assessment. This included a detailed literature review, the examination of existing wildlife inventories, identification of species of conservation concern, field surveys, habitat suitability modeling, and DNA programs. Study objectives for each wildlife group are summarized in Table 9.2-1.

9.2.6 Characterization of Baseline Conditions for Caribou

This section outlines the existing baseline conditions for caribou. Section 9.2.6.1 describes population trends and conservation, distribution and migration patterns, habitat use, and caribou crossings. Section 9.2.6.2 presents baseline data collected on caribou for the Hope Bay Project.

9.2.6.1 Introduction

Caribou (*Rangifer tarandus groenlandicus*) and caribou harvest are central to Inuit culture, identity, recreation, and kinship. Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut, and the most important wildlife species for the western Kitikmeot region (Banci and Spicker 2016). The life cycle of the caribou was a major influence on where Inuit travelled and lived as they relied on caribou for food and clothing (Banci and Spicker 2016). Most northern communities, including Cambridge Bay, Bathurst Inlet, Kugluktuk, and Omingmaktok, harvest caribou, including the Bathurst, Beverly, Ahiak, Dolphin and Union (Island), and Bluenose East caribou (GNWT ENR 2012). Further information on the Inuit's reliance and relationship with caribou can be found in the socio-economics section of the EIS (Volume 6, Section 3).

In addition to their importance to Inuit, barren-ground caribou are a biological keystone species in the Arctic. Caribou are a main prey item for grizzly bears and wolves. Other carnivores such as wolverine, foxes, and golden eagles scavenge on the caribou remains left from grizzly bear and wolf predation. Inuit TK of the Kitikmeot region includes observations of close associations of the abundance of these carnivore species to caribou abundance at a local scale (Banci and Spicker 2016).

Two caribou herds have the potential to interact with the Hope Bay Project. The range of the Dolphin and Union caribou herd overlaps the RSA during winter and the range of the Beverly herd (includes Beverly herd and Ahiak herd) caribou herd overlaps the RSA during summer (Figure 9.2-1).

Figure 9.2-1

Annual Ranges of Beverly and Ahiak (Mainland) Caribou Subpopulations and Dolphin and Union (Island) Caribou Herd that interact with the Project

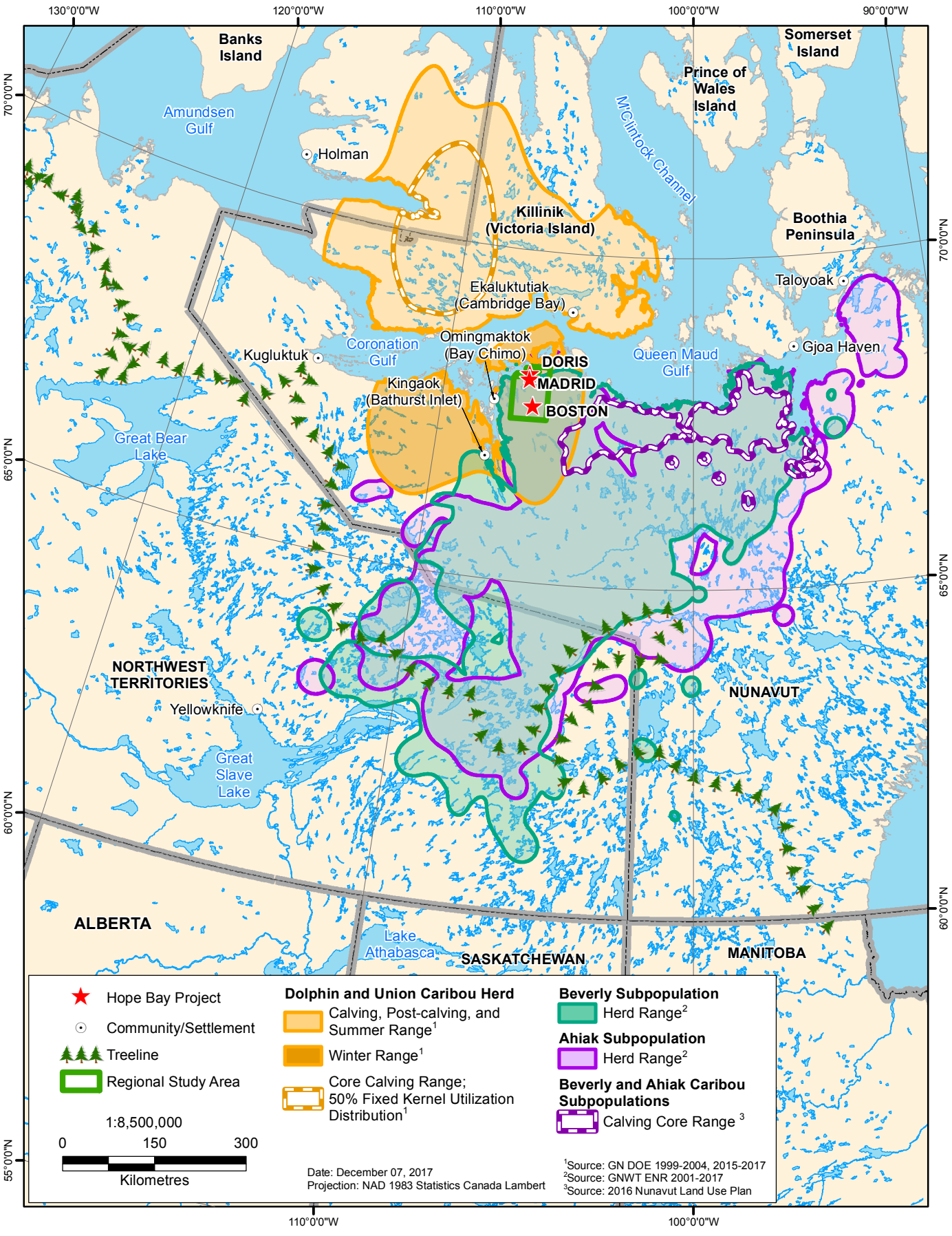


Table 9.2-1. Baseline Study Objectives for Wildlife for the Phase 2 Project

Wildlife Group	Species	Baseline Objectives
Mammal Species		
Ungulates	Caribou	• Determine the abundance and distribution within the RSA. • Quantify seasonal habitat in the RSA by developing habitat suitability models for 1) calving, 2) post-calving and summer, 3) fall, and 4) winter.
	Muskox	• Collect information on seasonal distribution within the RSA. • Quantify seasonal habitat in the RSA by developing habitat suitability models for 1) late winter and early spring, 2) summer and 3) fall (rutting).
Bears	Grizzly Bear	• Determine the relative abundance and distribution in the RSA. • Estimate the local population in the RSA using DNA mark-recapture techniques. • Quantify seasonal habitat in the RSA by developing habitat suitability models for 1) spring, 2) summer, and 3) fall and by conducting den surveys.
Furbearers	Furbearers (general)	• Document the presence of furbearer species in the RSA, with a particular emphasis on determining presence of wolverine and grey wolves in the area.
	Wolverine	• Estimate the local population in a sub-set of the RSA using DNA mark-recapture techniques. • Quantify suitable denning habitat in the RSA by developing habitat suitability models and conducting den surveys.
	Grey Wolf	• Quantify suitable denning habitat in the RSA by developing habitat suitability models and conducting den surveys.
Avian Species		
Raptors	General	• Document the presence of raptor species in the LSA and RSA, particularly those listed as Sensitive in Nunavut. • Determine occupancy and productivity of cliff-nesting raptor species in the LSA and RSA through location and inspection of nests. • Determine peregrine falcon abundance and distribution in the LSA and RSA. • Quantify suitable cliff-nesting and ground-nesting habitat in the RSA by developing habitat suitability models. • Document the use of the area by diurnal migrants, including their altitude flying over the Project area in relation to proposed wind turbine height.
Waterbirds	General	• Document seasonal presence of species and spatial distribution of waterbirds throughout the LSA and RSA. • Identify important habitats and map their locations (e.g., breeding sites and migratory staging lakes) in the LSA and RSA. • Document species of conservation concern in the LSA and RSA during breeding and staging periods. • Document the use of the area by diurnal migrants, including their altitude flying over the Project area in relation to proposed wind turbine height.
Upland Birds	General	• Determine the abundance and species richness of upland birds in the RSA. • Document breeding evidence and presence of species of conservation concern in the RSA. • Document the use of the area by diurnal migrants, including their altitude flying over the Project area in relation to proposed wind turbine height.

The Dolphin and Union caribou herd is named after the Dolphin and Union Strait on which they travel during their annual spring and fall migrations between the mainland and Victoria Island. Dolphin and Union caribou are genetically distinct from Peary caribou and barren-ground caribou (COSEWIC 2004). Inuit TK distinguishes Dolphin and Union caribou from mainland caribou by their light color, and are locally referred to as “island caribou”(Banci and Spicker 2016). The Dolphin and Union caribou herd is

federally listed as Special Concern on Schedule 1 of SARA (COSEWIC 2004). The species was announced as being classified as Endangered by COSEWIC in a press release in December 2017, but the assessment report had not been released at the data of production of EIS and no decision had been made by the responsible Minister to list the species as Endangered on Schedule 1 of SARA (Government of Canada 2017).

At present, the Beverly/Ahiak herd calves within the Queen Maud Gulf area; the Beverly sub-population to the west and the Ahiak sub-population to the east. Collared females have been observed switching use of calving grounds between the two (Nagy et al. 2011; M. Campbell et al. 2012; Nagy, Campbell, and Kelly 2012). Currently there is some disagreement over whether these herds should be referred to separately or together. The Governments of Nunavut and Northwest Territories survey the two herds separately and refers to them as two sub-populations in their population survey reports. This document refers to these herds either separately or together as the Beverly/Ahiak herd where relevant. The barren-ground population of caribou, to which the Beverly/Ahiak herd in addition to the Bathurst herd (described below) was announced as being classified as Threatened by COSEWIC in a press release in December 2016 (COSEWIC 2016).

The calving grounds of the Ahiak caribou (previously known at the Queen Maud Gulf herd) extend over about 31,000 km^2 along the coast of the Queen Maud Gulf. These are the largest calving grounds of any mainland barren-ground caribou herd in Nunavut and the Northwest Territories (D. Johnson, Nagy, and Williams 2008).

The Beverly caribou traditionally calved to the south of the Ahiak caribou near Garry Lake. Recently, it was postulated that low cow survival and low calf productivity have led to the Beverly caribou to join the Ahiak caribou on their calving grounds 250 km to the north in the western Queen Maud Gulf calving area (Adamczewski et al. 2015). This may have started as early as the mid-1990s and integration seems to have been complete by 2011.

Two other notable caribou herds are not expected to interact with the Hope Bay Project. The Bathurst caribou herd does not overlap the Hope Bay Project site and occurs to the west of the RSA, on the west side of Bathurst Inlet (Figure 9.2-1). The Peary caribou herd (*R.t. pearyi*) may spatially overlap the Northwest Passage shipping route outside of the marine wildlife RSA, but their on-ice movements are not expected to interact with shipping because the Hope Bay Project will be shipping during the open water season.

For the purposes of the assessment, population trends, distribution, and habitat associations are described for the Beverly/Ahiak caribou herd and Dolphin and Union caribou herd because these two herds have the potential to interact with the Hope Bay Project.

Population Trends and Conservation

Beverly/Ahiak Caribou

The Ahiak caribou were formerly known as the Queen Maud Gulf (QMG) herd and is also referred to as the QMG sub-population in some recent publications, e.g., (Nagy et al. 2011; Nagy, Campbell, and Kelly 2012). Aerial surveys have been conducted several times in the QMG, however, until recently the methods and area surveys have not been consistent.

Pre-calving surveys were conducted during the late spring migration in 1983 and 1995. Pre-calving surveys produced population estimates of 33,000 (± 5,100) animals in May 1983 (Heard, Williams, and Jingfors 1986) and 31,556 (± 4,879) caribou in May 1995 (Buckland et al. 2000). Both of these surveys were in the late portion of the spring migration and covered similar areas as the more recent survey in 2011.

Early aerial surveys were conducted over different sized areas, depending on the year, in 1986, 1996, and 2006:

- The aerial survey of the QMG in 1986 surveyed the eastern third of the QMG, east of the Simpson River, and produced a population estimate of 11,265 (± 1,615) caribou (Gunn, Fournier, and Nishi 2000).
- In 1996, collar data indicated that a much larger area of the QMG was being used for calving than through in the 1980s and a high-level reconnaissance survey was conducted roughly within the Queen Maud Gulf Bird Sanctuary (QMGBS) from approximately 80 km west of the Elise River to Chantrey Bay. This survey estimated a population of 83,134 (± 5,298) within this larger area (Gunn, Fournier, and Nishi 2000).
- In 2006, a survey of the QMG area estimated 123,226 (± 14,500) caribou although the methods and data have not been published so comparisons of area surveyed cannot be made (Gunn, Russell, and Eamer 2011).

The surveys conducted in 1996 and 2006 included both the eastern and western QMG areas. These surveys likely counted both Ahiak caribou (in the east) and Beverly caribou (in the west). During the 1990s and 2000s, the Beverly caribou moved their calving grounds into the QMG to join the Ahiak (Nagy et al. 2011). As a consequence, these surveys likely should not be used to determine population trends for the Ahiak population.

In 2011, the first systematic survey was conducted of the entire Queen Maud Gulf area, including the Boothia Peninsula and the calving grounds of both Beverly and Ahiak sub-populations. This survey produced a population estimate for the Ahiak sub-populations of 71,340 adults (± 3,882) of which 27,729 (± 1,579) were breeding females (M. Campbell et al. 2012).

The areas surveyed for the Ahiak caribou were similar during the 1983 and 1995 pre-calving surveys and the 2011 survey. As part of the analysis for the 2011 survey, the densities of caribou in these matching survey blocks were compared. The density roughly doubled from 0.27/km^2 in 1983 and 0.32/km^2 in 1995 to 0.73/km^2 in 2011 (M. Campbell et al. 2014). This suggests that the Ahiak sub-population is increasing in size although it is not understood whether this is from the growth of the herd, or immigration of Beverly caribou.

The Beverly caribou have historically calved between Garry Lake to the north and Beverly Lake to the south. Aerial surveys conducted on this calving ground between 1967 and 1994 reported that the Beverly caribou were generally increasing. The sub-population size was estimated at fairly stable numbers between 1967 and 1982, with similar herd sizes values in 1967 (159,000), 1971 (164,000), 1974 (124,000) and 1982 (164,338 ± 72,332).

However, between 1984 and 1994, the Beverly sub-population estimates fluctuated by approximately 50-100,000 caribou between years; 1984 (263,691 ± 80,652), 1987 (93,546 ± 19,423), 1988 (189,561 ± 70,961), 1993 (86, 728 ± 17,943), and 1994 (276,000 ± 106,600) (M. Campbell et al. 2012). A survey conducted in 2002 indicated low numbers of caribou on the traditional calving grounds, which created concern that the Beverly sub-population was declining (M. Campbell et al. 2012).

An analysis of collaring data provided an indication of the cause of the decline of observed caribou on the traditional Beverly calving area. This analysis indicated that the Beverly caribou had moved their calving area from the traditional area between Garry and Beverly Lakes to the QMG area, immediately to the west of the Ahiak herd (Nagy et al. 2011). An aerial survey was conducted in 2011 in both the Beverly and Garry Lakes calving area and the QMG area. This survey estimated the size of the Beverly

sub-population as 124,189 (± 13,996) caribou, of which 52,825 (± 2,638) were breeding females (M. Campbell et al. 2012).

Hence, the apparent decline in the Beverly caribou on the traditional (Beverly and Garry Lakes) calving areas after 1994 was likely caused by the departure of cows for the QMG calving area. Likewise, the apparent increase in the Ahiak caribou reported from the 1996 and 2006 surveys of the QMG area may have been caused by the immigration of the Beverly caribou (Gunn, Russell, and Eamer 2011; Nagy et al. 2011). Once the Beverly and Ahiak caribou were shown to both calve in the QMG area, thereafter they have been referred to as "sub-populations" in GN survey reports.

As a whole, it is likely that the Beverly sub-population of caribou has declined in abundance and there is some evidence that the Ahiak sub-population has increased in size (M. Campbell et al. 2012). It is not well understood whether movement from the Beverly sub-population to the Ahiak sub-population can explain these population changes.

Several factors are thought to affect the populations of barren-ground caribou. These include, harvest, predation, insect harassment, disease, road and industrial development, and climate change (Solberg et al. 2001; Tews, Ferguson, and Fahrig 2007; Joly et al. 2011b; Banci and Spicker 2016).

Beverly/Ahiak caribou are harvested by people from the communities of Gjoa Haven, Omingmaktok, Cambridge Bay, and Lutsel K'e, and in winter by people from northern Saskatchewan where some of the herd overwinters (Gunn, Russell, and Eamer 2011). In NWT, harvesting is managed following the 2011–2015 Caribou Management Strategy. Aboriginal harvesters with a General Hunting License (GHL) are not restricted from harvest of the Beverly/Ahiak herd. In 2010, local resident (non-aboriginal), outfitted and commercial harvest of Beverly caribou was suspended. Starting in January 2014, the area U/BC/01 to the east of Great Slave Lake is open for resident hunting, which includes some of the wintering grounds of the Beverly herd. In this area resident hunters must have a tag and are allowed one male caribou between 15 August and 30 April. In Nunavut, non-aboriginal resident hunters are limited to five caribou per year, while non-residents (person who is not a resident of Nunavut but who is a Canadian citizen) and non-resident aliens (person who is neither a resident of Nunavut nor a non-resident) are limited to two caribou per year. In Saskatchewan, resident hunters are limited to one caribou of either gender (Saskatchewan 2016)

Harvest estimates for the Beverly sub-population were last recorded systematically in 2005–2006 (BQCMB 2006) (Table 9.2-2). These estimates indicate that approximately 75% of Beverly harvest was occurring in Saskatchewan, however the government of Saskatchewan report that the Beverly caribou no longer winter in Saskatchewan (Saskatchewan 2016). With the decline in the Bathurst herd, there are some indications that there is increasing harvesting pressure on the Beverly herd on their winter range to the east of Great Slave Lake.

There is very little information on harvest rates of Ahiak caribou. Given that their wintering range is generally to the north of the tree-line and communities in NWT and Saskatchewan and west of communities in Nunavut this herd may not experience significant harvest pressure.

In addition to harvest, the barrenland caribou populations are also thought to be affected by parasites, weather, forest fires and development pressures. Harassment by black flies and especially bot (oestrid) flies can cause significant disturbances to tundra caribou in July and August (Witter et al. 2012). Insects are abundant on warm days when wind speeds are low (Boulanger, Poole, et al. 2004) especially for the two weeks spanning late June to early July (Thorpe et al. 2001). Caribou compensate for harassment by engaging in avoidance behaviours (on average 5% of the day) such as head tossing and erratic running when insects are active, from about 0800 to 2100 hours (Witter et al. 2012).

Table 9.2-2. Harvest Rates of Beverly Caribou 2005-2006

Province/Territory	Community	Traditional Use	Resident Hunter	Commercial
Nunavut	Baker Lake	400	n/a	50
NWT	Fort Resolution	0		
	Fort Smith	100	75	20
	Lutsel K'e	100		150
Saskatchewan	Black Lake	1,600		
	Camsell Portage	0		
	Fond du Lac	1,000		
	Stoney Rapids	200	2	
	Uranium City	0		
Alberta	Fort Chipewyan	75		
Total		**3,475**	**77**	**220**

Source: (BQCMB 2006)

The Beverly caribou spend the winter within the boreal forest, in mature forest stands where their main forage item, mat-forming lichens, are most abundant (Chen et al. 2009; Province of British Columbia 2014). An increase in the number of forest fires within the winter range of Beverly caribou, is resulting in decreased availability of lichen, which require many years to grow back after fire (Chen, Russell, et al. 2013). The frequency of forest fires in the caribou winter range below treeline is largely determined by decadal changes in climate such as the Arctic Oscillation (Overland and Wang 2005).

Recent evidence suggests that over-winter survival of the Bathurst caribou herd, and possibly other herds such as the Beverly/Ahiak may be related to forage conditions on the summer range (McDonald and Wilcockson 2003). Chen, Foy, et al. (2013) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate.

The BQCMB also identified industrial development, including low level aircraft overflights and the increase in all-season resource roads in northern Saskatchewan and Manitoba as increasing the access to formerly inaccessible areas, thereby increasing the level of disturbance and harvest for the Beverly and Qamanirjuaq herds (BQCMB 2014).

Dolphin and Union (Island) Caribou

In the early 1900s, the Dolphin and Union (Island) caribou herd was estimated at 100,000 animals (COSEWIC 2004). Overhunting and possibly also rain-on-snow events caused a population decline between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland after about 1930; and instead, remained on Victoria Island year-round (Gunn 2005). Beginning in the 1970s, the herd size increased, and in the late 1980s the herd resumed its migration to the mainland (Gunn et al. 1997). In 1993, approximately 7,200 Dolphin and Union caribou were counted on the mainland prior to migrating over the ice in spring (Gunn et al. 1997). In 1997, the Dolphin and Union caribou herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn 2004), about one-third of its historic size. The most recent population estimate was conducted in 2015 and estimated 18,413 ± 6,795 caribou (Environment and Climate Change Canada 2017a), a reduction from 2007 estimates of 27,787 ± 7,537 caribou suggesting a decline in the population from its historic size (M. Dumond, GN, unpublished data, cited from Poole et al. 2010; COSEWIC 2004; Environment and Climate Change Canada 2017a). Inuit TK parallels these findings; Dolphin and Union caribou were rarely

observed after the 1920s and into the 1950s, but observations had become regular by the 1990s (Banci and Spicker 2016).

Threats to the Dolphin and Union caribou herd have been identified as climate change, and winter shipping activity along the herd's migration route (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait, and the Queen Maud Gulf (COSEWIC 2004). Climate change has shortened the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Since 1982, freeze-up between Victoria Island and the mainland has occurred 8-10 days later which may have affected the timing of fall migration (K. G. Poole et al. 2010). There is concern that this trend will continue with a declining period for Dolphin and Union caribou on the mainland during winter. Concern has also been raised about increased winter shipping activity which may break up the ice in Dease Strait or the Queen Maud Gulf, causing the Dolphin and Union caribou migration to be blocked or animals may fall through the recently broken ice (COSEWIC 2004; K. G. Poole et al. 2010; Festa-Bianchet et al. 2011). Dolphin and Union caribou have been observed by hunters to die after breaking through newly-forming ice, and caribou have been observed with ice on their fur in December, possibly from falling through sea ice during southward migration (reviewed in K. G. Poole et al. 2010).

In addition to affecting migration of Dolphin and Union caribou, climate change may result in an increase in the number of rain-on-snow events, which are thought cause mortality due to starvation during winters with severe ice conditions (COSEWIC 2004). In some high-arctic herds, such as the Peary caribou herd, scientists have observed hundreds of caribou carcasses after winters associated with severe weather and have attributed these die offs to icing events (Gunn and Dragon 2002). A study in the Norwegian Arctic has documented low calf production following all but one winter with high ice cover (Stien et al. 2012), and a strong correlation between icing and population size (Hansen et al. 2011).

Caribou harvest in Nunavut was systematically measured during a five year period between June 1996 and May 2001 (Priest and Usher 2004). Harvesters reported that they harvested both mainland (likely Bluenose east and Beverly/Ahiak) and island (Dolphin and Union) caribou, however the numbers were reported together (Priest and Usher 2004) and summarized in Table 9.2-3.

Table 9.2-3. Harvest of Caribou in Cambridge Bay, Bathurst Inlet, Kugluktuk, Omingmaktok 1996-2001

Caribou Harvest	96/97	97/98	98/99	99/00	00/01	Mean
Cambridge Bay	1,653	359	654	715	672	811
Kingaut (Bathurst Inlet)	117	83	98	75	94	93
Omingmaktok (Bay Chimo)	314	247	155	111	52	176
Kugluktuk	1,561	1,462	1,913	1,584	1,355	1,575
Number of Harvesters	**96/97**	**97/98**	**98/99**	**99/00**	**00/01**	**Total**
Cambridge Bay	39	40	53	50	54	92
Kingaut (Bathurst Inlet)	18	17	17	18	17	21
Omingmaktok (Bay Chimo)	19	16	10	8	8	23
Kugluktuk*	106	88	104	105	100	146

** Harvest predominantly Bathurst caribou*

In each of these four communities, harvest was concentrated from the fall to the winter, from August to January. In Cambridge Bay, almost half of the harvest was concentrated in October, which

corresponds to the rutting period when Dolphin and Union caribou are near the community, congregating on the south shore of Victoria Island waiting to cross the sea ice to the mainland. In Kingaut, harvest was spread throughout the year, and due to the herd distributions, it is likely that winter harvests from this community were Dolphin and Union, while those harvested in summer were Beverly/Ahiak or Bathurst. In Omingmaktok, harvest was also spread throughout the year, with a peak in November through February, likely of Dolphin and Union caribou. In Kugluktuk, harvest was spread throughout the year, and due to the herd distributions, it is likely that harvests from this community were Bluenose East and possibly Bathurst caribou. If all harvested caribou by these four communities were Dolphin and Union, the average rate of harvest would represent 9.5% of the Dolphin and Union herd counted in 1997.

Bathurst Caribou

In the 1980s, the Bathurst caribou herd was one of the largest migratory herds in Arctic Canada, estimated at approximately 450,000 animals in 1986 (Heard and Williams 1991; Boulanger et al. 2011). Similar to other North American caribou herds, the Bathurst caribou herd has declined in size (Vors and Boyce 2009; Boulanger et al. 2011), to approximately 31,900 individuals in 2009, likely due, in part, to relatively high winter harvests of females (4,000 to 5,000 per year), which coincided with declines between 1986 and 2006 (Adamczewski et al. 2009). Between 2006 and 2012, assessments of caribou body condition, pregnancy rates, and cow-calf ratios suggested improvements in breeding productivity, and the population appeared to be stabilizing or increasing slightly (Adamczewski et al. 2015). However, recent reconnaissance surveys conducted on the calving grounds in 2014 suggest that the herd may be in further decline (GNWT ENR 2014). The current Bathurst caribou population is low compared to its historic size, which can make the herd vulnerable to disturbance, weather and other factors (BCMPC 2004; GNWT ENR, pers. comm.).

Most northern communities, including Kingaut (Bathurst Inlet), Kugluktuk, and Omingmaktok, have likely historically harvested Bathurst caribou during spring migration and post-calving (GNWT ENR 2012). Data from Inuit hunters between 1996 and 2001 indicate that the average number of caribou harvested annually by Inuit hunters (averaged by community) were: 93 in Bathurst Inlet, 1,575 in Kugluktuk, and 176 in Omingmaktok (Priest and Usher 2004). However, these data also include harvest of caribou from the Dolphin and Union caribou herd and the Bluenose East caribou herd. Limits on the number of caribou that can be harvested for both traditional and commercial use have recently been implemented (GNWT ENR 2016a). The annual harvest for the herd in Nunavut was set at 240 males and 60 females for the 2012-2013 winter hunting season (Adamczewski et al. 2009; Wekʼèezhìi Renewable Resources Board 2012). All Bathurst caribou harvest has since been suspended in Nunavut (Nunavut 2016). Since 2014, the Northwest Territories has placed a total harvest ban on Bathurst caribou during the winter hunting season, aside from a 15-individual limit for Aboriginal ceremonial use. These harvest restrictions remain in effect (Nunavut 2016).

Distribution and Migration Patterns

Most of the barren-ground caribou migrate annually between the calving grounds on the tundra and overwintering grounds in the south. During winter, some herds migrate south below or near the treeline, such as the Beverly and Bathurst caribou herds, while other herds overwinter on the tundra including the Dolphin and Union caribou herd.

Herd specific seasonal distribution patterns are discussed for the Beverly/Ahiak and Dolphin Union herds in Section 9.2.6.5. These patterns are interpreted in relation to the Hope Bay Project area. A discussion on the movement of the calving grounds for the Bathurst caribou herd is also included, although this herd does not overlap the Hope Bay Project area.

Habitat Use

Caribou habitat is one of six main issues identified in the 2011/2012, 2014, and 2016 Draft Nunavut Land Use Plans for protecting and sustaining the environment (NPC 2012, 2014, 2016). Habitat selection on the tundra by caribou is mainly dictated by predator and insect avoidance, and the distribution and availability of suitable forage (G. W. Calef 1981; Heard, Williams, and Melton 1996; Russell J.H. 1998; Wilson R. R. et al. 2012). Caribou also select travel routes during migration that provide easier movement, such as frozen lakes in winter, and sometimes eskers (Thorpe et al. 2001; Banci and Spicker 2016). Inuit TK has also identified important habitat for caribou including nadlok (shallow lake crossings and narrows of rivers during the ice-free season), wetlands, eskers, and other high land features used for insect and heat relief (Banci and Spicker 2016).

The following sections outline habitat selection of caribou during each of the six life history/life cycle stages: calving, post-calving, summer, fall migration, winter, and spring migration. Detailed habitat mapping for caribou is included in Section 9.2.6.2 in the sections on habitat suitability modeling.

Calving

Caribou calving grounds on the tundra are areas that facilitate predator avoidance, and offer forage availability after snowmelt for lactating females (Griffith et al. 2001; Wilson R. R. et al. 2012). However, a potential trade-off exists between safety and forage availability; calving females may choose calving grounds that are relatively safe from predators but are not necessarily places where snow melts earlier nor where vegetation biomass is greatest (Wilson R. R. et al. 2012). Though forage availability may be lower, some have suggested that calving grounds are located in areas where forage quality is high (reviewed in Griffith et al. 2001; Wilson R. R. et al. 2012). Inuit TK identified wetlands as important areas for calving, as wetlands provided flat areas with a source of water, and provided a source of high quality food for their calves (Banci and Spicker 2016).

Post-calving and Summer

Access to high quality forage is likely the key driver of habitat selection in the post-calving period (Witter et al. 2012). Females need to acquire adequate nutrient reserves for lactation. Calves feed exclusively on their mother's milk until about three weeks of age when calves begin foraging on their own. Calf body condition at birth and in the first few weeks of life, and thus calf survival, are highly dependent on female nutritional status (reviewed in Couturier et al. 2009).

Summer

During summer, caribou are thought to select habitat based on forage quality and insect harassment (Skarin et al. 2008). Females must acquire adequate forage to store enough nutrient resources to survive and to maintain pregnancy throughout the winter (Helle and Tarvainen 1984; Colman et al. 2003). Thus, access to high quality forage is not only important to calf survival within the year, but also to the survival of females and yearlings in the subsequent winter, and to the ability of females to birth healthy calves in the subsequent spring (White R. G. 1983; Couturier et al. 2009). Foraging throughout summer predominately occurs in sedge meadows, where caribou can graze up to 50% of the net primary productivity (Jefferies 1992).

During periods when insect harassment is high, caribou may trade off foraging quality for habitat that provides relief from insects. Caribou are often seen swimming in lakes to escape the heat and insects (Thorpe et al. 2001) and along the ocean or lake shorelines where the breezes provide relief from heat and insects (Banci and Spicker 2016). Caribou will stand in the shade of cliffs, eskers or hills to get relief from the heat (Banci and Spicker 2016). Caribou also attempt to avoid insects by moving for some part of the daytime to windier, cooler places, such as on top of eskers and hills and to higher elevation tundra where insects are less dense (Russell, Martell, and Nixon 1993; Skarin et al. 2008; Wilson R. R. et

al. 2012; Witter et al. 2012; Banci and Spicker 2016). At night when there are few insects, caribou move to lower elevation sites where the forage quality is usually higher (Skarin et al. 2008). Caribou also make large-scale seasonal movements to areas with fewer insects (Wilson R. R. et al. 2012). Depending on topography and the location of large lakes, such movements may occur through relatively narrow travel corridors (Wilson R. R. et al. 2012).

Fall Migration

During the fall, caribou require habitats that provide abundant forage and facilitate travel. Caribou breed in the fall during the rut but implantation of the fertilized egg is delayed and can be aborted if animal condition is poor during the winter. Hence, high quality forage is important in the fall. Green forage becomes less available as the fall progresses and caribou choose lichen veneer for foraging (C.J. Johnson et al. 2005). Sedge wetland and riparian tall shrub habitats may also be used depending on the availability of green forage. However, a habitat modeling study by Johnson et al. (2005) indicated that caribou may avoid areas dominated by sedge, peat bog, and heath tundra during the fall. Eskers, ridges, and other high points are selected for easy travel (Thorpe et al. 2001).

Winter

High quality winter habitat for tundra-wintering caribou includes low snow depth and abundant lichen (reviewed in Ferguson M. A. D., Gauthier L., and Messier F. 2001; Joly, Chapin, and Klein 2010). Inuit TK includes observations of wintering caribou in areas where snow is relatively shallow, such as in rocky or elevated wind-swept areas where caribou could more easily crater for lichen (Banci and Spicker 2016). Insufficient forage availability in winter can have a large impact on population dynamics of tundra-wintering caribou. Poor female body condition during winter can affect calf weights and survival, and thus population recruitment (Couturier et al. 2009). Due to the energetic demands of their growing foetuses, female caribou may choose riskier habitats that provide good forage relative to bulls (Joly 2008).

Spring Migration

Snow and ice remain on the tundra during spring migration and thus Beverly caribou use large frozen lakes and rivers as travel corridors, while the Dolphin and Union caribou travel across the frozen ocean. Caribou also use other areas that facilitate travel on the tundra, such as eskers and open snow-free upland, and follow the contours of steeper terrain before crossing over (LeResche and Linderman 1975; Thorpe et al. 2001). When travelling over tundra, caribou must also seek places where snow cover is shallow so they can more easily dig for graminoids and lichen (Russell, Martell, and Nixon 1993; Ferguson M. A. D., Gauthier L., and Messier F. 2001).

Caribou Crossings and Migration Routes

Migration routes across the sea ice have been identified as key aspects of caribou habitat. The 2016 Draft Nunavut Land Use Plan indicates that herds are vulnerable to changing sea ice conditions and disturbance by ice breaking, and management direction within the plan states “Regulatory Authorities, where appropriate, need to mitigate impacts of project proposals with ship traffic on spring and fall caribou sea ice crossing.” Water crossings are also considered within the 2005 Draft West Kitikmeot Regional Land Use Plan (NPC 2005).

The Dease Strait, between Victoria Island and the mainland, and the Queen Maud Gulf are important crossing areas for the Dolphin and Union caribou herd during their annual spring and fall migrations (COSEWIC 2004; K. G. Poole et al. 2010). Dolphin and Union caribou travel across the sea ice twice as fast during the (fall) south migration to the mainland (23 days) than the (spring) north migration (on average 48 days) (K. G. Poole et al. 2010). Caribou cannot cross south to the mainland until ice has formed, and cannot cross north to Victoria Island once the sea ice has melted.

Inuit TK identified several important crossing areas for Dolphin and Union caribou. During the spring and fall migration periods, the most important migration crossing route was at the west end of the Queen Maud Gulf at the Kent Peninsula isthmus (Banci and Spicker 2016). Migration routes for Dolphin and Union caribou were also identified over the sea ice on Dease Strait. Crossing areas were also identified in the southern portion of Bathurst Inlet for the Beverly caribou herd (Banci and Spicker 2016).

Nadloks, or shallow areas of lakes and narrows of rivers, on the mainland were also identified by TK as important crossing areas for mainland caribou during the open water season in summer and fall (Banci and Spicker 2016). Terrestrial and marine caribou crossing locations identified by the Inuit as well as in the 2016 Nunavut Land Use Plan are presented in Figure 9.2-2.

9.2.6.2 Baseline Data for Caribou

The objectives of baseline studies were to determine the movements the Beverly/Ahiak caribou herd and the Dolphin and Union caribou herd during each season, to what degree these movements overlapped with the Hope Bay Project area, and how caribou use habitat within the wildlife RSA over a number of ecologically significant scales.

Baseline data is available from government agencies and was also directly collected in the field. Four baseline characterization studies were conducted:

1. analysis of satellite collar data (2001 to 2017 for Beverly/Ahiak caribou, 1999 to 2004 and 2015 to 2017 for Dolphin and Union caribou) to determine movement patterns and seasonal ranges;
2. aerial surveys conducted from 1996 to 2011 in the RSA and in 2010 on sea ice transects located in Bathurst Inlet and Melville Sound during key life history/life cycle stages for caribou;
3. motion-triggered cameras (2012 to 2016) for monitoring habitat use of key habitat features including detailed timing information for when caribou use these features; and
4. habitat suitability modeling to determine the importance, location, and abundance of caribou habitat.

Analysis of Satellite Collar Data

General Methods

Caribou use of the land can broadly be classified into two groups: 1) migrations (spring and fall) when large herds of caribou relocate to specific locations, and 2) resident periods (calving, post-calving, summer, and winter) when the daily movement rate of caribou is lower than migrations and the herd occupies a distinct range for that season. In order to map habitat use by caribou during each season, two methods were used. Satellite collar data provides data on the movement of caribou during the migratory period. During migrations, satellite collars provided a series of point data on the locations of individual caribou traversing the landscape. Collectively, these data summarize the herd's migration routes highlighting key corridors and river crossings.

Habitat use was analyzed using fixed kernel utilization distributions (UDs) that indicate areas of high usage. Core use areas were estimated using the 50% fixed kernel UD, which represents an area with a 50% probability that an animal (or group of animals) is inside that area. Seasonal ranges or areas of active use were estimated using the 95% fixed kernel UD which represents a 95% probability that caribou will be inside the area.

Data was analyzed by season/life history stage. These stages vary between herds and are defined by movement rates for migrations vs. winter and summer ranges (C.J. Johnson et al. 2005). The peak of calving (the day when 50% of the caribou have calved) and the weaning of calves are used to define the

calving period and post-calving period, respectively. Calving is synchronized to occur within a short, typically a 10–15 day, period, and calves are generally weaned three to five weeks after they are born (Russell, Kofinas, and Griffith 2002).

Beverly and Ahiak Caribou

A collaring program for the Beverly and Ahiak herd was initiated in 2001 by the governments of Northwest Territories and Nunavut. Each year, satellite collars are fitted on female caribou during the winter. The data generated from this program allows researchers to investigate seasonal trends in habitat use as well as track the real time movement patterns of caribou. Prior to 2008, all collars deployed on caribou were satellite collars which typically provided one (fixed) location every one to five days (depending on programming and season). Each location had an associated error between 150 m and 1,000 m depending upon the location class (Johnson C.J. and Gillingham M.P. 2005). Beginning in 2008, GPS collars with satellite uplink were deployed providing three to six locations daily with much greater location accuracy (generally < 15 to 25 m).

The yearly distribution and movements of Beverly and Ahiak caribou are classified into six distinct periods, based on the seasonal period for Beverly caribou reported in the literature (Table 9.2-4). The timing of spring migration and calving can vary up to a week between years (Gunn, Fournier, and Nishi 2000; D. Johnson, Nagy, and Williams 2008).

Table 9.2-4. Timing of Life History Stages of Beverly Caribou

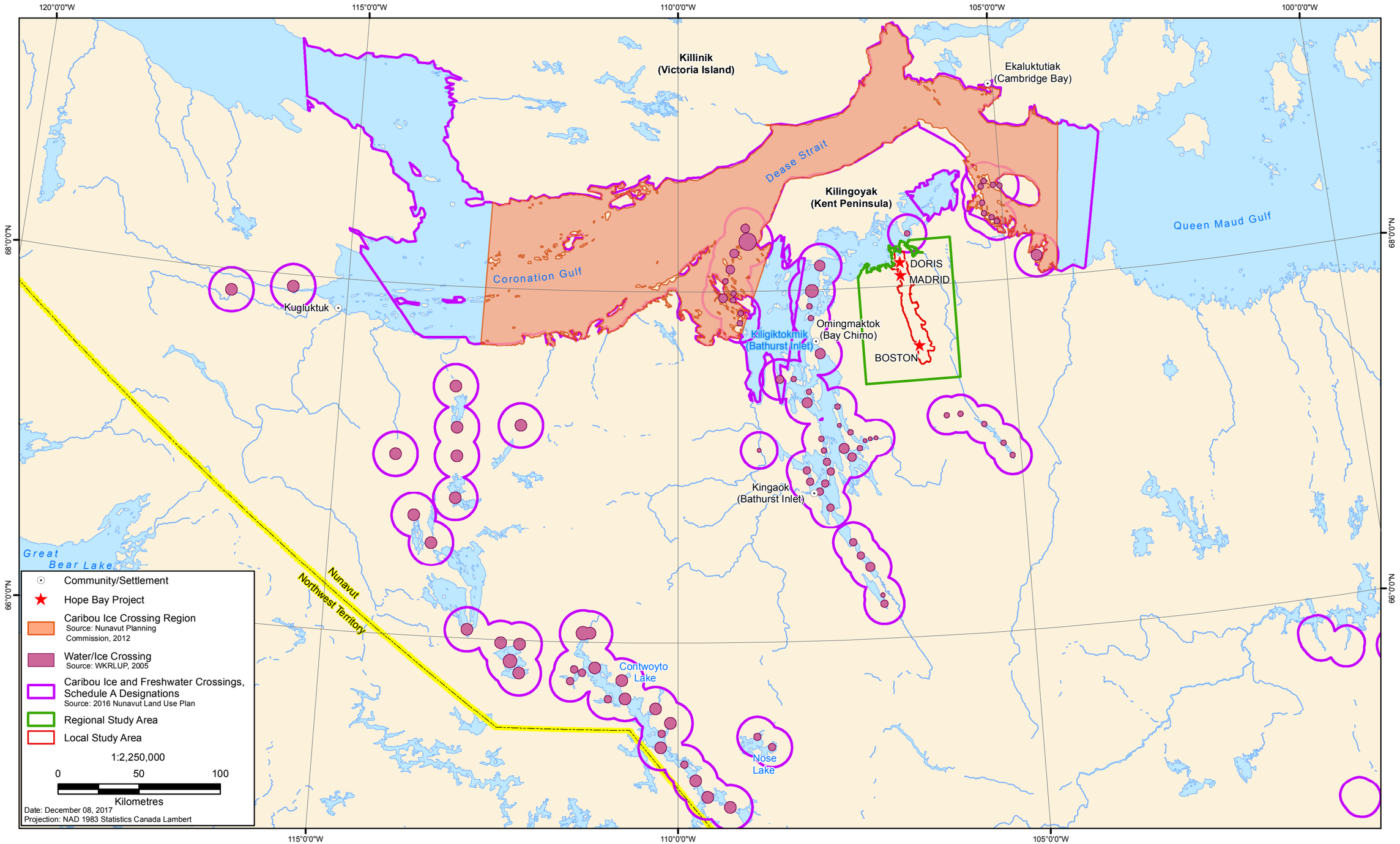
Cycle Stage	Start Date	End Date
Calving[1]	June 5	June 20[2]
Post-calving[3]	June 21	July 25
Summer[4]	July 26	August 31
Fall Migration[5]	September 1	October 31
Winter[6]	November 1	April 14
Spring Migration[7]	April 15	June 4

[1] Gunn, Fournier, and Nishi (2000).
[2] Gunn, Fournier, and Nishi (2000); Gunn and D'Hont (2002); Johnson et al. (2008); Campbell et al. (2012)
[3] Five weeks post-calving, which extends into post-calving and early summer periods (early summer period is defined in Gunn et al. (2008)); Russell, Kofinas, and Griffith (2002).
[4] Gunn et al. (2008).
[5] Johnson et al. (2005); includes rut period defined in Gunn et al. (2008).
[6] Includes late fall and winter periods defined in Gunn et al. (2008).
[7] Gunn, Fournier, and Nishi (2000).

Calving (June 5 to June 20)

During calving, Beverly and Ahiak caribou primarily occur in the Queen Maud Gulf Migratory Bird Sanctuary (Gunn, Fournier, and Nishi 2000; Gunn A. and D'Hont A. 2002; A. D'Hont, GNWT ENR, unpublished data) east of the RSA. Inuit TK indicated the main calving areas occurring in the Queen Maud Gulf area in several concentrated areas including near the Ellice River, Tingmeak River, Whitebear Point, Kuugaarjuk River, and Haloakhiokvik (Banci and Spicker 2016). Beverly and Ahiak caribou are segregated by age and gender on the calving grounds, with bulls occurring mostly on the eastern edge, females with cows in the middle, and non-parturient females and yearlings on the western edge (M. Campbell et al. 2012).

Figure 9.2-2
Designated Caribou Crossings



The Beverly/Ahiak caribou occur in adjacent calving ranges, with the Beverly sub-population typically west of the Perry River and the Ahiak sub-population to the east. Most caribou returned to their individual calving grounds in each year, however a total of three instances (of an average of 17 collared individuals per year) occurred where Beverly or Ahiak caribou switched calving grounds for a single year.

For the most part, Beverly and Ahiak female caribou are not expected to occur in the RSA during calving, as their calving grounds are located to the east of the RSA in the Queen Maud Gulf Migratory Bird Sanctuary (Figure 9.2-3).

Currently, satellite collar data and an aerial survey conducted in 2011 of both the historic (Beverly and Garry Lakes) calving area and the Queen Maud Gulf area indicated that the majority of Beverly caribou are using the Queen Maud Gulf area, while a small proportion are using the Beverly and Garry Lakes area for calving. Hence, maps of Beverly calving show two distinct calving areas, a large one in the Queen Maud Gulf and a small one north of Garry Lake.

Post-calving (June 21 to July 25)

Following calving, Beverly and Ahiak caribou typically remain on the calving grounds for the post calving period (Gunn, Fournier, and Nishi 2000). Caribou may stay on the calving grounds because the Queen Maud Gulf area hosts productive wetland vegetation, and/or because there are large watercourses in the area that caribou are reluctant to cross until water levels have receded (M. Campbell et al. 2012). During post-calving, cows and calves may aggregate into large groups ranging from hundreds to thousands of individuals (Gunn A. and D'Hont A. 2002). Inuit TK indicates that sometime during the post-calving and summer season, Beverly/Ahiak caribou travel south from their calving grounds or north towards the coast (Banci and Spicker 2016). Collared female Beverly and Ahiak caribou are generally not anticipated to occur in the RSA during post-calving (Figure 9.2-4). At this time, their range primarily overlaps their calving grounds on the Queen Maud Migratory Bird Sanctuary.

Summer (July 26 to August 31)

During the summer and into the fall, Beverly and Ahiak caribou generally continue to move south from the Queen Maud Gulf Migratory Bird Sanctuary towards the Thelon Game Sanctuary, located on the Northwest Territories/Nunavut border east of Great Slave Lake (Figure 9.2-5) (Gunn, Fournier, and Nishi 2000; Banci and Spicker 2016). However, while Inuit TK generally agrees with the trend in the southern movement of Beverly/Ahiak caribou during the summer months, the occurrence of caribou during the summer months was considered to be unpredictable and variable, and does not reflect Inuit TK information that during summer season, Beverly/Ahiak caribou travel south from their calving grounds or north towards the coast (Banci and Spicker 2016). From mid-July onward, most bulls and juveniles have joined females on summer ranges (Heard, Williams, and Melton 1996). Movement rates of collared females increase steadily from mid- to the end of June from about 5 to 12 km/day (Nishi et al. 2010). A small proportion of the Beverly caribou herd summer ranges (UD 95%) overlaps the RSA before shifting southward to the treeline for the winter. Along with bulls and juveniles, Beverly cows and calves are expected to occur in the RSA during summer.

Fall Migration (September 1 to October 31)

During the fall, Beverly caribou generally continue to move south from the summer range towards the Thelon Game Sanctuary where the fall rut occurs while the fall distribution of Ahiak caribou remains north of treeline (Figure 9.2-5) (Gunn, Fournier, and Nishi 2000; Banci and Spicker 2016). Both the Beverly and Ahiak caribou fall ranges (95% UD) overlapped with the RSA. The core fall range (50% UD) of the Ahiak caribou overlapped with the RSA during the fall.

Figure 9.2-3

Range of Satellite-collared Caribou from the Beverly and Ahiak Subpopulations during Calving

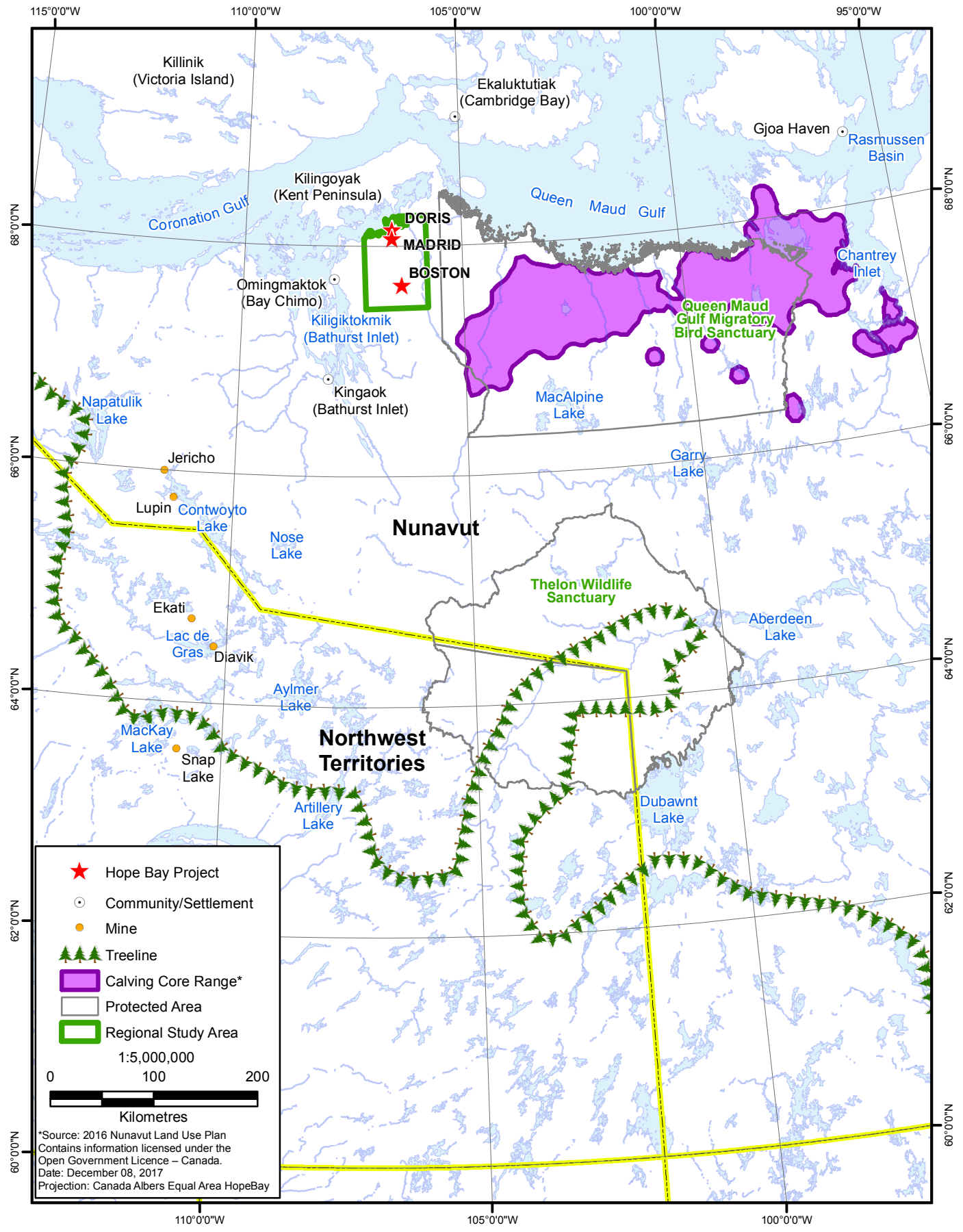
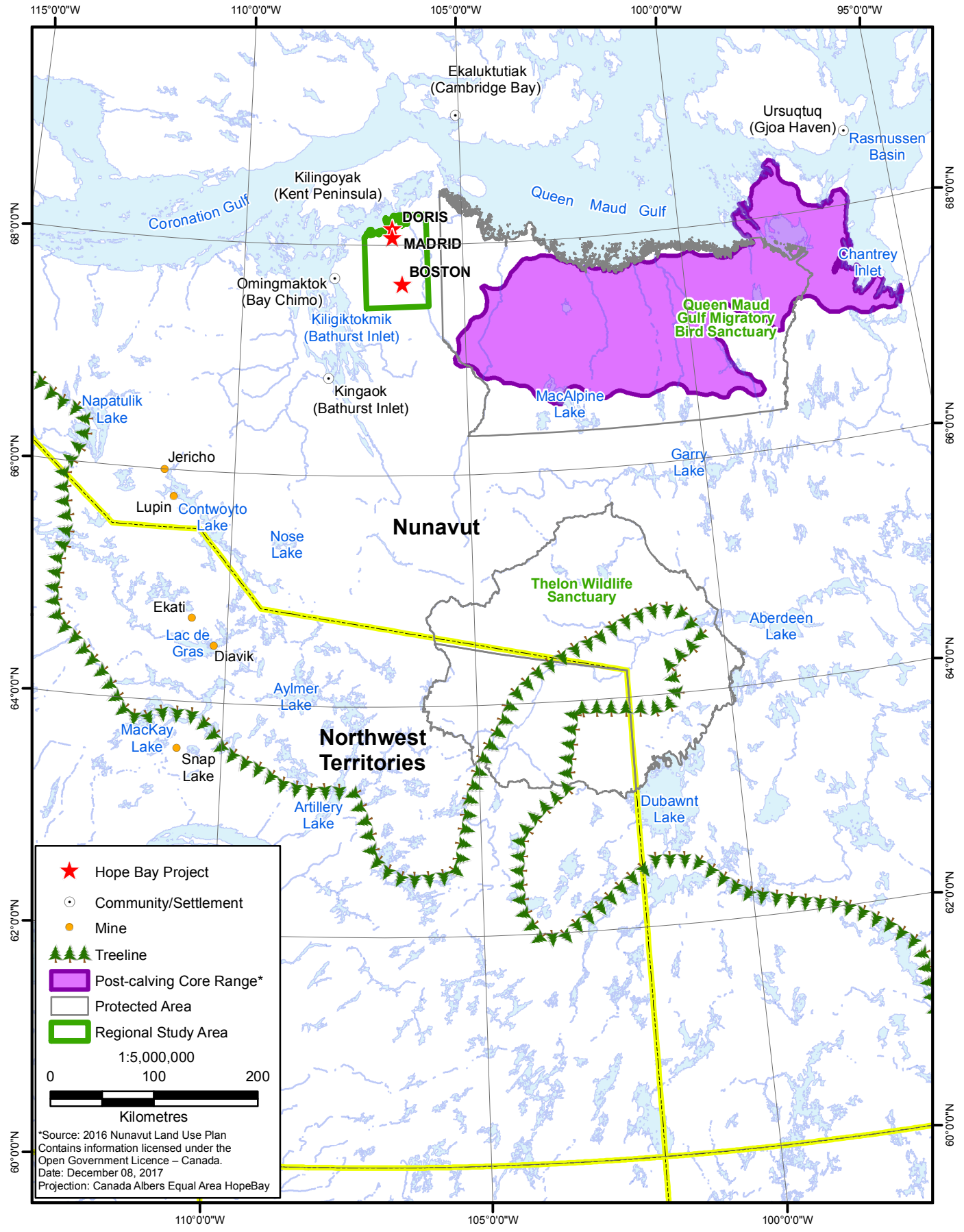


Figure 9.2-4

Range of Satellite-collared Caribou from the Beverly and Ahiak Subpopulations during Post-calving



Winter (November 1 to April 14)

Beverly caribou winter over a broad area extending from the east side of Bathurst Inlet (above tree line) south to the area east of Great Slave Lake close to the Saskatchewan border in the boreal forest (Figure 9.2-6) (Gunn, Fournier, and Nishi 2000). The winter distribution of Ahiak caribou overlaps the Beverly winter range, but is generally above treeline, and so they are classified as tundra-wintering caribou (Gunn, Fournier, and Nishi 2000).

Inuit TK indicates that, during the winter, mainland caribou overwinter in the northern portion of Bathurst Inlet on both the east and west sides of the inlet (Banci and Spicker 2016). Observations of mainland caribou intermixed with Dolphin and Union caribou in winter on either side of Bathurst Inlet may have been Beverly or Ahiak caribou (Banci and Spicker 2016). During winter, caribou are relatively sedentary, usually moving less than 2 km per day (Joly 2008).

Based on the 95% kernel distribution of collared female caribou, Beverly or Ahiak caribou occur in the RSA during the winter period. The winter range (95% UD) and core range (50%) of the Beverly and Ahiak caribou overlapped with the RSA (Figure 9.2-6).

Spring Migration (April 15 to June 4)

Both evidence from the satellite collars and Inuit TK indicate that Beverly/Ahiak caribou migrate northwards relatively quickly from their wintering grounds to their calving grounds along the Queen Maud Gulf to the east of the RSA (Banci and Spicker 2016). Female barren-ground caribou were estimated to move about 14 to 20 km/day during the last three weeks of May (versus < 4 km/day during calving; Gunn and Poole 2009; Nishi et al. 2010). Pregnant females initiate migration to calving grounds, while non-parturient females follow at a slower speed (Gunn A. and D'Hont A. 2002). Female Beverly and Ahiak caribou do not cross through the RSA on their way to the calving grounds (Figure 9.2-6). Inuit TK indicates that all of Bathurst Inlet, including the areas on the east including the RSA, was used by migratory caribou due to the proximity to the calving grounds (Banci and Spicker 2016). Bulls and juvenile Beverly caribou follow the females north (Bear Scare Ltd. 2005; Young et al. 2010). By mid-June bulls comprise up to 10% of caribou on the calving grounds (Heard, Williams, and Melton 1996; Gunn, Dragon, and Boulanger 2002; Gunn A. and D'Hont A. 2002). In years with delayed snow melt or deep snow that makes travel difficult, some females may calve before reaching calving grounds, while other females birth low weight calves with reduced chances of survival (Griffith et al. 2001).

Summary

Overall, collar data suggests that Beverly caribou are most commonly present in the RSA in the summer, fall, and winter, while the Ahiak caribou are mostly present during the fall and winter. The wildlife RSA overlaps the northwestern range extent of both the Beverly and Ahiak herd ranges. The seasonal core use habitat based on 50% kernel distributions fell outside of the RSA during most seasons except for fall (Ahiak caribou) and winter (Beverly and Ahiak caribou). The calving and post-calving range of the Beverly and Ahiak populations lie outside of the RSA. Inuit TK generally agreed with caribou distribution and movement patterns determined within baseline studies and within the literature (Banci and Spicker 2016).

Dolphin and Union Caribou

Inuit TK describes that Dolphin and Union caribou winter on the mainland and calve and summer on Victoria Island (Banci and Spicker 2016). Spring migration occurs in May across the sea ice to Victoria Island. These caribou return to the mainland during the fall migration, generally starting following sea ice formation in late October.

Figure 9.2-5
Range of Satellite-collared Caribou from the Beverly and Ahiak Subpopulations during Summer (26 July to 31 August) and Fall (1 September to 31 October), 2001 to 2017

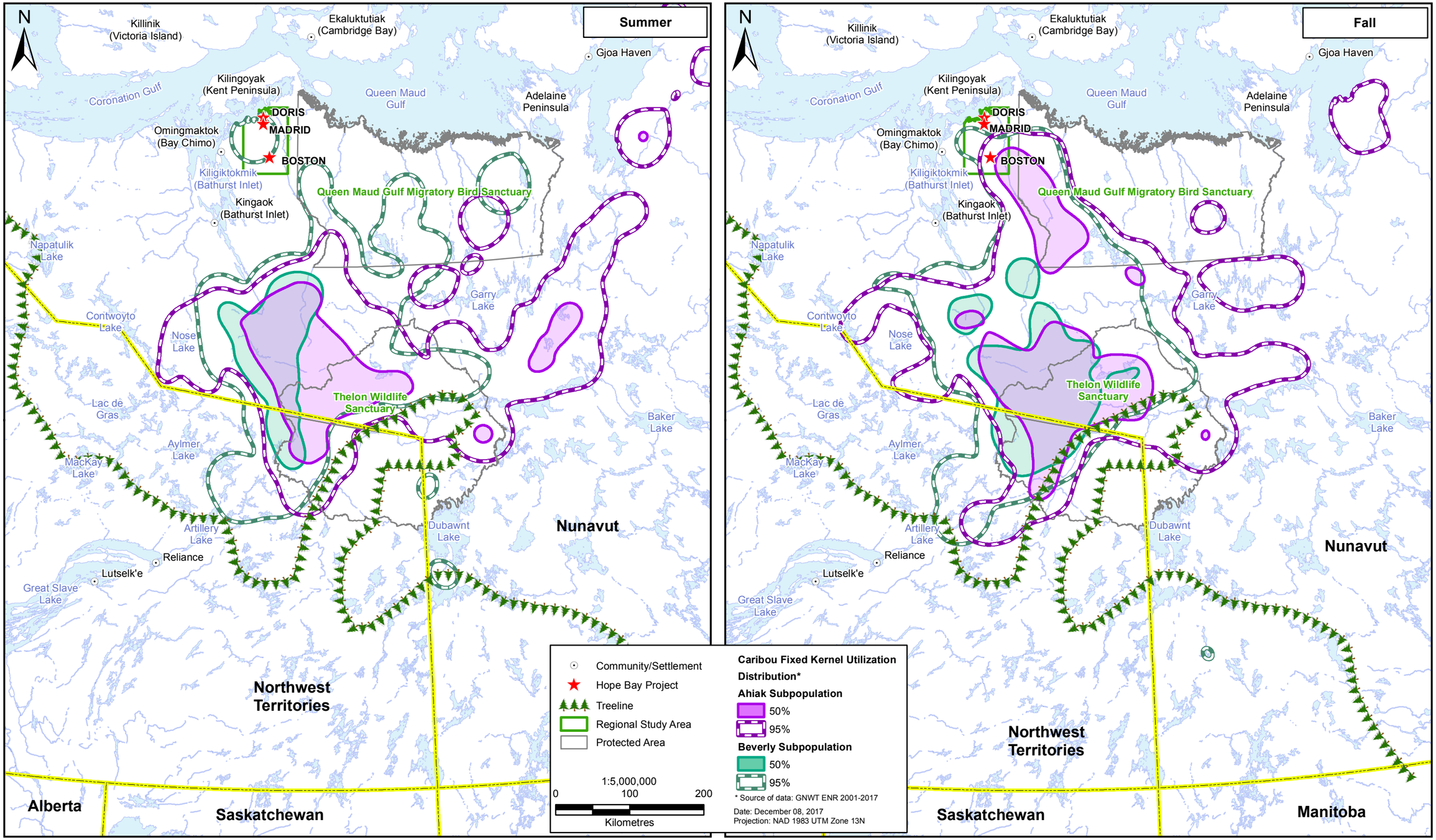
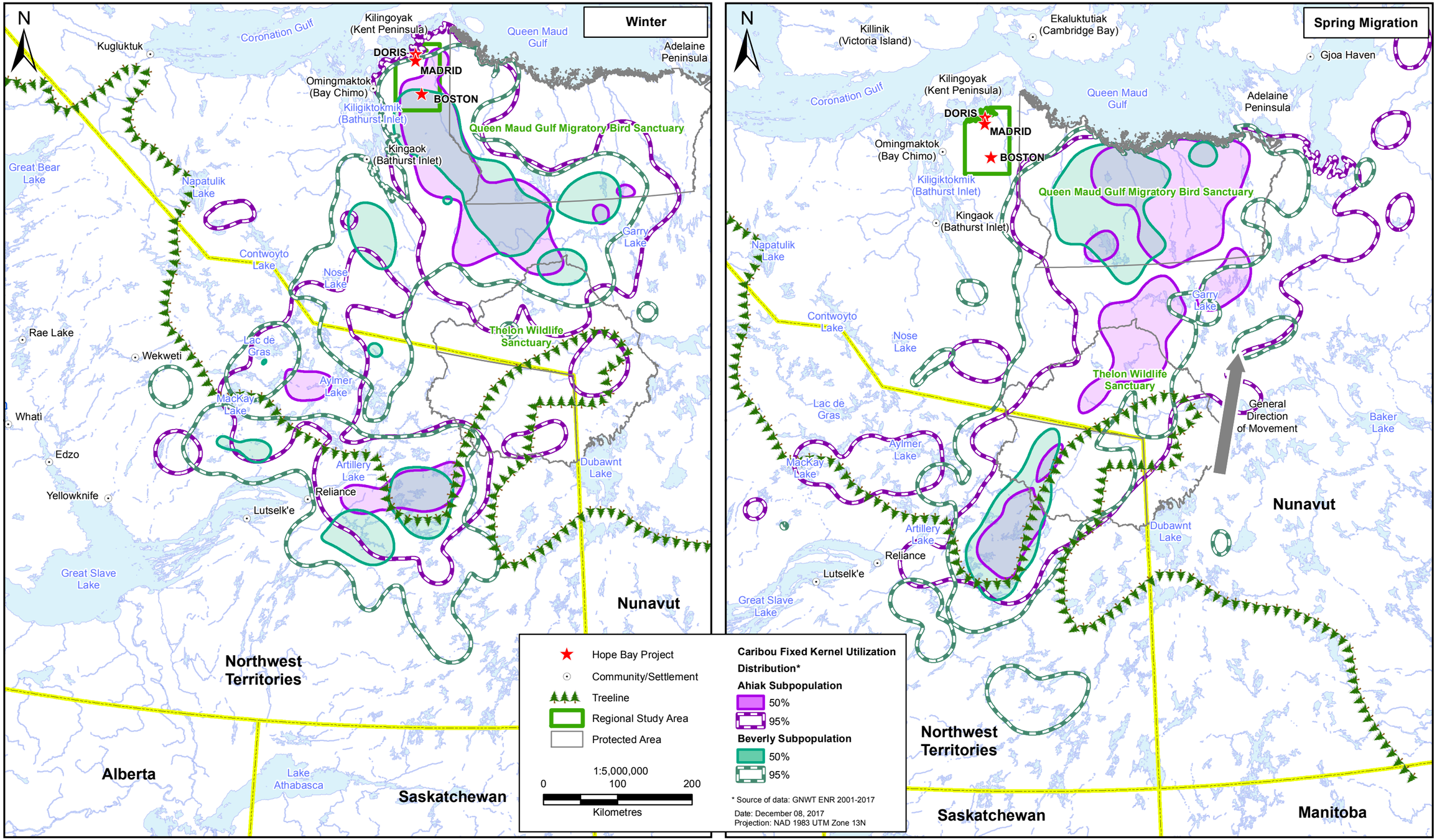


Figure 9.2-6
Range of Satellite-collared Caribou from the Beverly and Ahiak Subpopulations during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 2001 to 2017



The yearly distribution and movements of Dolphin and Union caribou can be classified into six distinct periods: winter, spring migration, calving, post-calving, summer, and fall migration (Table 9.2-5). The following sections discuss the demography and distribution of the Dolphin and Union caribou herd with emphasis on migration timing and routes across sea ice.

Table 9.2-5. Timing of Life History Stages of Dolphin and Union Caribou

Cycle Stage	Start Date	End Date
Calving	June[1]	June[1]
Post-calving and Summer	July 1[2]	October 19
Fall Migration	October 20[4]	December 8
Winter	December 8[3]	April 16
Spring Migration	April 17[4]	June 29

[1] General calving period (Nishi 2000); specific dates not given due to limited data.
[2] Post-calving and summer defined as the period after calving and before fall migration.
[3] Winter defined as the period when satellite-collared caribou were located on the Nunavut mainland, between fall and spring migrations.
[4] Spring and fall migration dates defined as the periods when satellite-collared Dolphin and Union caribou crossed the Coronation Gulf, Dease Strait, and the Queen Maud Gulf from 1999 to 2004.

Collaring programs for the Dolphin and Union caribou herd began in the 1980s (Gunn, Fournier, and Nishi 2000). The program started with VHF radio transmitter collars, with 8 to 22 animals collared at any one time. These collars were progressively replaced with satellite collars and then GPS collars in the 2000s, which ended in 2006. A new collaring program was initiated by GN DOE in 2015, with 25 collars installed in 2015 and 19 collar installed in 2016.

Calving, Post-calving, and Summer

Dolphin and Union caribou calve on Victoria Island, and remain there for the post-calving and summer seasons and the rutting period (COSEWIC 2004; K. G. Poole et al. 2010; Banci and Spicker 2016). Thus, there is no overlap with the Hope Bay Project RSA during these periods (Figure 9.2-7).

Fall Migration

During the fall, the Dolphin and Union caribou herd migrates to the southern coast of Victoria Island for the rut, before migrating across the sea ice between late October and early November to overwinter on the mainland (median date of 1 November; Figure 9.2-8) (K. G. Poole et al. 2010; Banci and Spicker 2016). Some caribou cross the sea ice as late as December 8 (K. G. Poole et al. 2010). During the latter part of fall migration, satellite collared Dolphin and Union caribou have been observed within the RSA (Figure 9.2-8). Inuit TK indicates that caribou will often cross Dease Strait where islands or points of land provide navigation cues, with a notable crossing location at the west end of the Queen Maud Gulf at the Kent Peninsula isthmus (Banci and Spicker 2016).

Winter

Dolphin and Union caribou winter on the north coast of the Nunavut mainland generally within 150 km of the ocean (Figure 9.2-9), including east and west of Bathurst Inlet, the Kent Peninsula, and along the western edge of the Queen Maud Gulf (COSEWIC 2004; K. G. Poole et al. 2010). Inuit TK, satellite collars, aerial surveys, wildlife cameras and incidental observations indicate that Dolphin and Union caribou occur in the RSA during the winter, generally at low densities and in small groups (Figure 9.2-9).

Inuit TK indicates that during the winter period, the occurrence of island caribou was less predictable in any specific location and their spatial distribution was variable on a year to year basis (Banci and Spicker 2016). During the winter, the majority of island caribou were found near the Perry and Ellice River and in the Queen Maud Bird Sanctuary (Banci and Spicker 2016). Wintering areas were also

located near Omingmaktok and south of the Boston property area, according to Inuit TK (Banci and Spicker 2016), however collar data does not reflect this information save for the wintering area south of the Boston property, which has been used by collared caribou over time (Figure 9.2-9). Inuit TK includes observations of some Dolphin and Union caribou overwintering on Victoria Island prior to the 1950s, but not since then (Banci and Spicker 2016).

Spring Migration

The Dolphin and Union caribou herd migrates from their wintering grounds on the northern coast of the mainland across the sea ice between April and June back to Victoria Island (Figure 9.2-10). During the spring migration, collared Dolphin and Union caribou are found in the RSA, with the majority of animals crossing the sea ice northward from mid-May to late June (Figure 9.2-10; K. G. Poole et al. 2010). The median date of crossing in the spring is 24 May; (K. G. Poole et al. 2010). The Kent Peninsula and islands in the Coronation and Queen Maud Gulf are used as staging sites during crossing, especially during the north migration (Gunn et al. 1997; K. G. Poole et al. 2010). According to Inuit TK, the same migration routes were used during both the spring and fall migration periods (Banci and Spicker 2016). Aerial surveys observed concentrations of caribou tracks on the sea ice at the islands in Hope Bay (west of the Hope Bay Project) and the archipelago in eastern Melville Sound (east of the Hope Bay Project) but few tracks in Roberts Bay where the marine laydown area is located.

Summary

Dolphin and Union caribou do not interact with the Hope Bay Project area during calving, post-calving, summer, fall or rut periods. Dolphin and Union caribou occur in the RSA during winter and during the spring and fall migration periods when caribou are moving between the mainland and Victoria Island. During these periods, Dolphin and Union caribou are generally dispersed in small groups.

Bathurst Caribou

Seasonal movements of the Bathurst caribou herd have been tracked from 1996 to 2016 using satellite collars (between 8 and 35 caribou per year), primarily on cows with several males collared in 2015 (GNWT ENR 2015, unpublished data). Currently the seasonal ranges of the Bathurst caribou herd do not overlap with the Hope Bay Project and occur west of Bathurst Inlet and the RSA. Hence, this section will describe the spatial distribution and movements of this herd to provide broad regional context for historic changes in caribou distribution.

Inuit TK indicates that the calving range of the Bathurst caribou has historically occurred both east and west of Bathurst Inlet, after which the herd is named (Banci and Spicker 2016). Currently, the calving grounds of the Bathurst caribou occur west of Bathurst Inlet and are concentrated between the James and Burnside Rivers (Figure 9.2-11; Gunn, Poole, and Wierzchowski 2008; Nishi et al. 2010). Inuit TK and scientific studies indicate that the Bathurst herd has calved both east and west of Bathurst Inlet, with a gradual shift to their current location, west of Bathurst Inlet (Russell, Kofinas, and Griffith 2002). Urquhart (1981) compiled the historical evidence for the location of the Bathurst caribou from the 1930s to the 1970s, reporting that there was evidence of calving both east, west, and south of Bathurst Inlet. Kelsall (1953) reported calving both east and west of Bathurst Inlet, however the majority of calving was thought to be on the eastern side of the Inlet (Kelsall 1955).

The first formal aerial surveys for the calving grounds were conducted in 1965 and 1966 on the eastern side of Bathurst Inlet. These surveys reported that the Bathurst caribou were calving on the western boundary of what is today the QMGMBS overlapping with the area currently used by the Beverly sub-population for calving (Williams 1966). Subsequent aerial surveys were conducted on the east side of Bathurst Inlet throughout the late-1960s and into the late 1970s, although there were reports of additional calving west of Bathurst Inlet (Sutherland and Gunn 1996). During all years, these calving grounds were located outside of the Hope Bay Project RSA.

Figure 9.2-7
Range and Locations of Satellite-collared Dolphin and Union Caribou Herd during Calving, Post-calving, and Summer (30 June to 19 October), 1999 to 2004 and 2015 to 2017

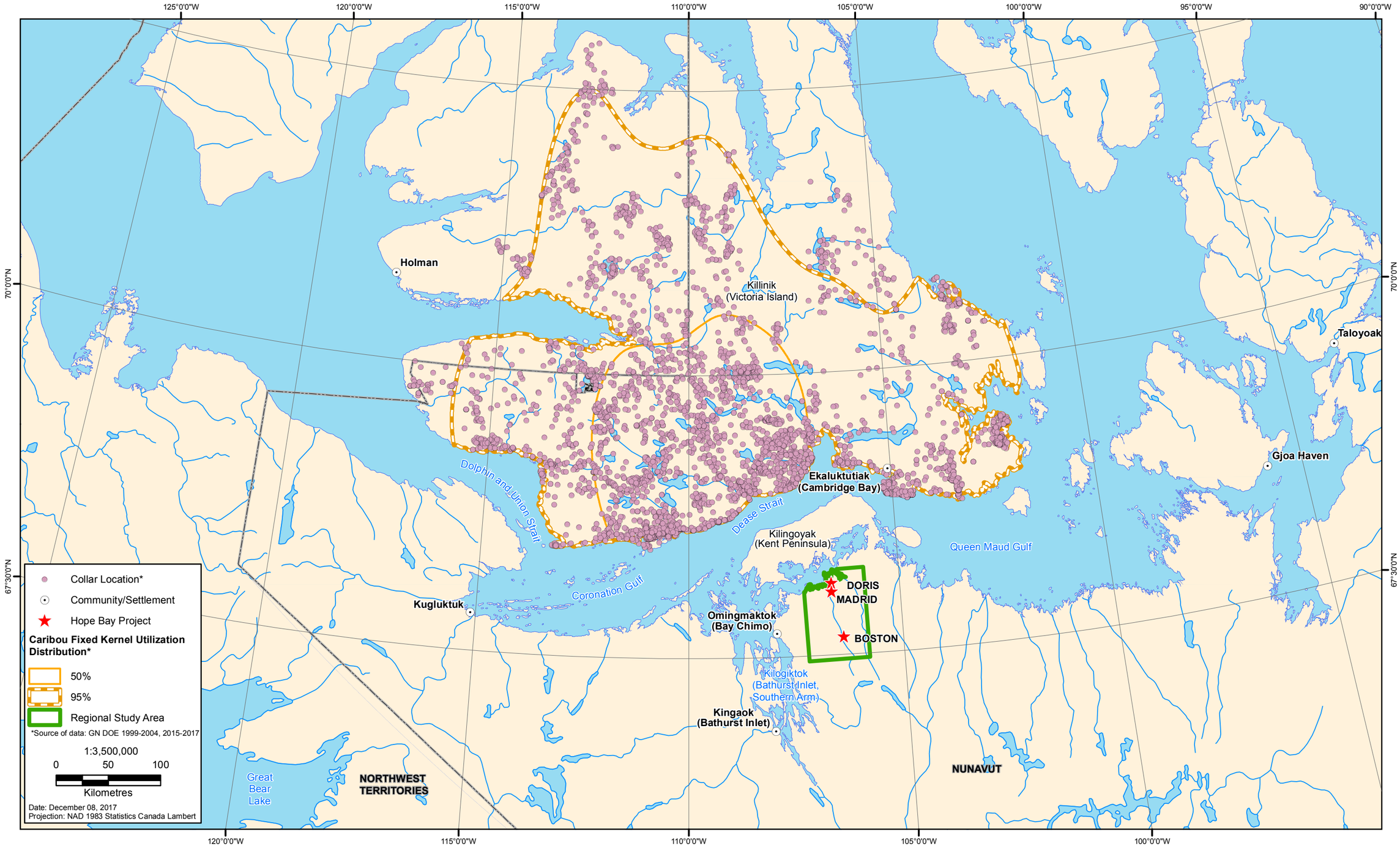


Figure 9.2-8
Locations of Satellite-collared Dolphin and Union Caribou Herd during the Southward Fall Migration (20 October to 8 December), 1999 to 2004 and 2015 to 2017

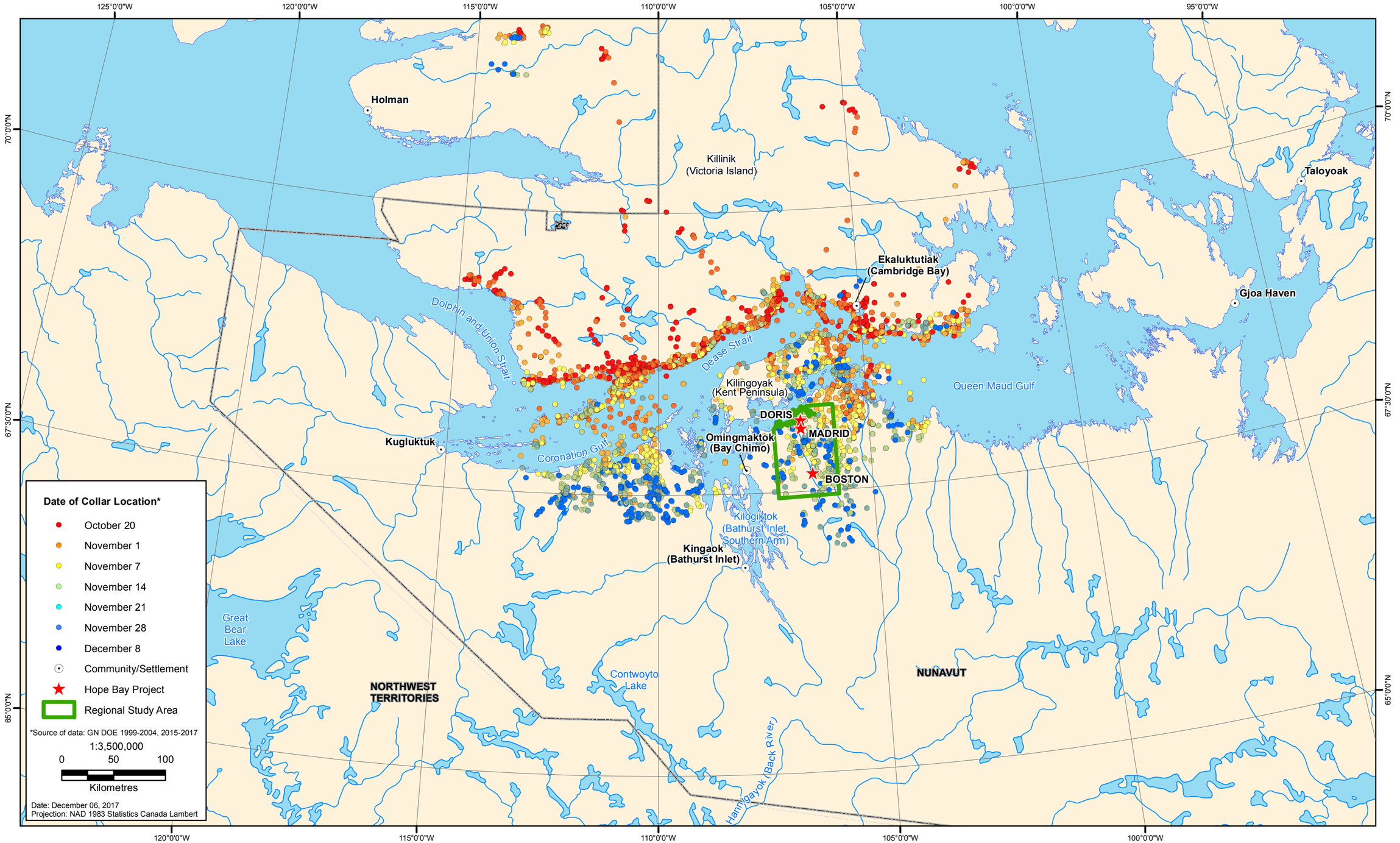


Figure 9.2-9
Range and Locations of Satellite-collared Dolphin and Union Caribou Herd during Winter (9 December to 16 April),1999 to 2004 and 2015 to 2017

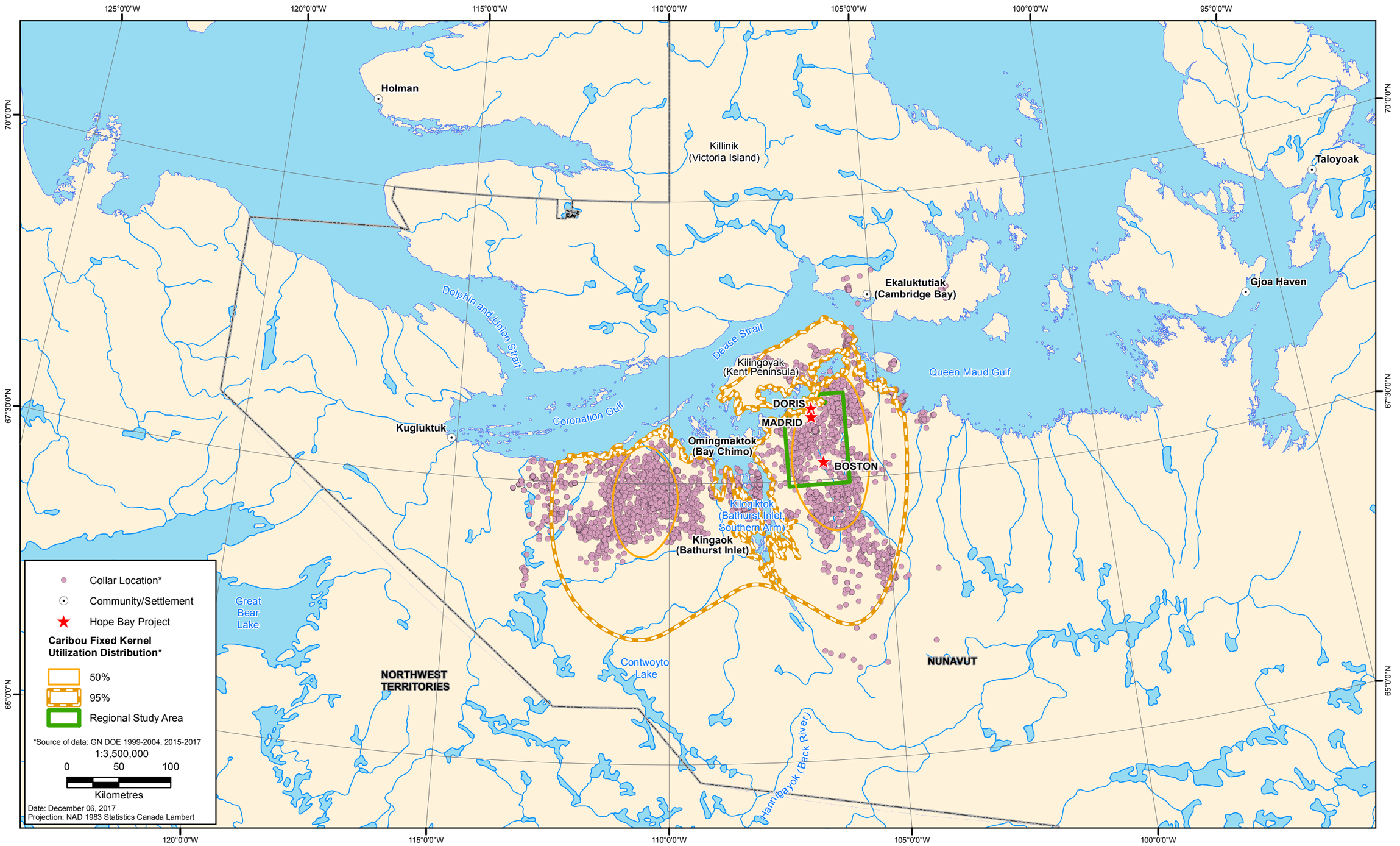


Figure 9.2-10
Locations of Satellite-collared Dolphin and Union Caribou Herd during the Northward Spring Migration (17 April to 29 June), 1999 to 2004 and 2015 to 2017

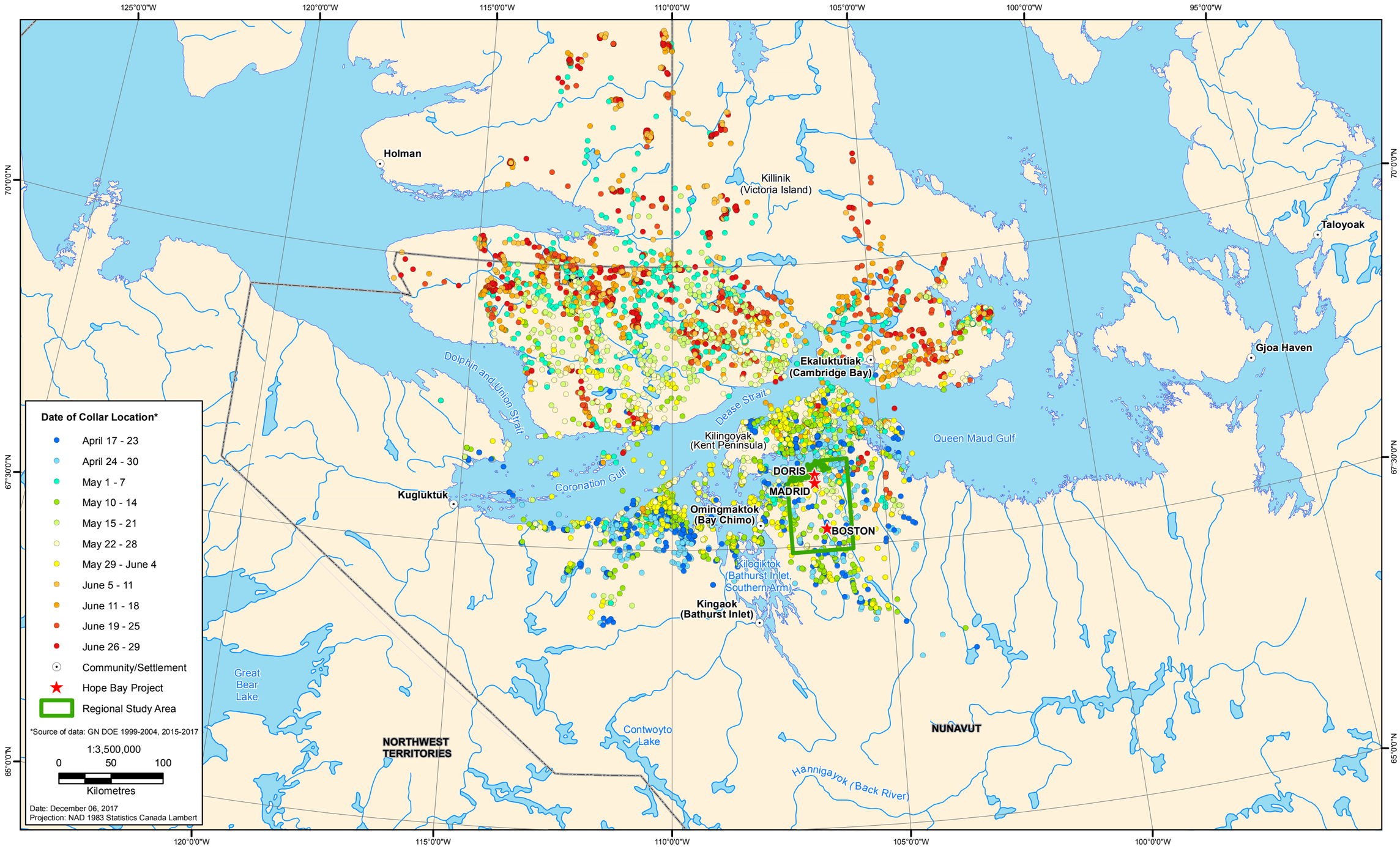
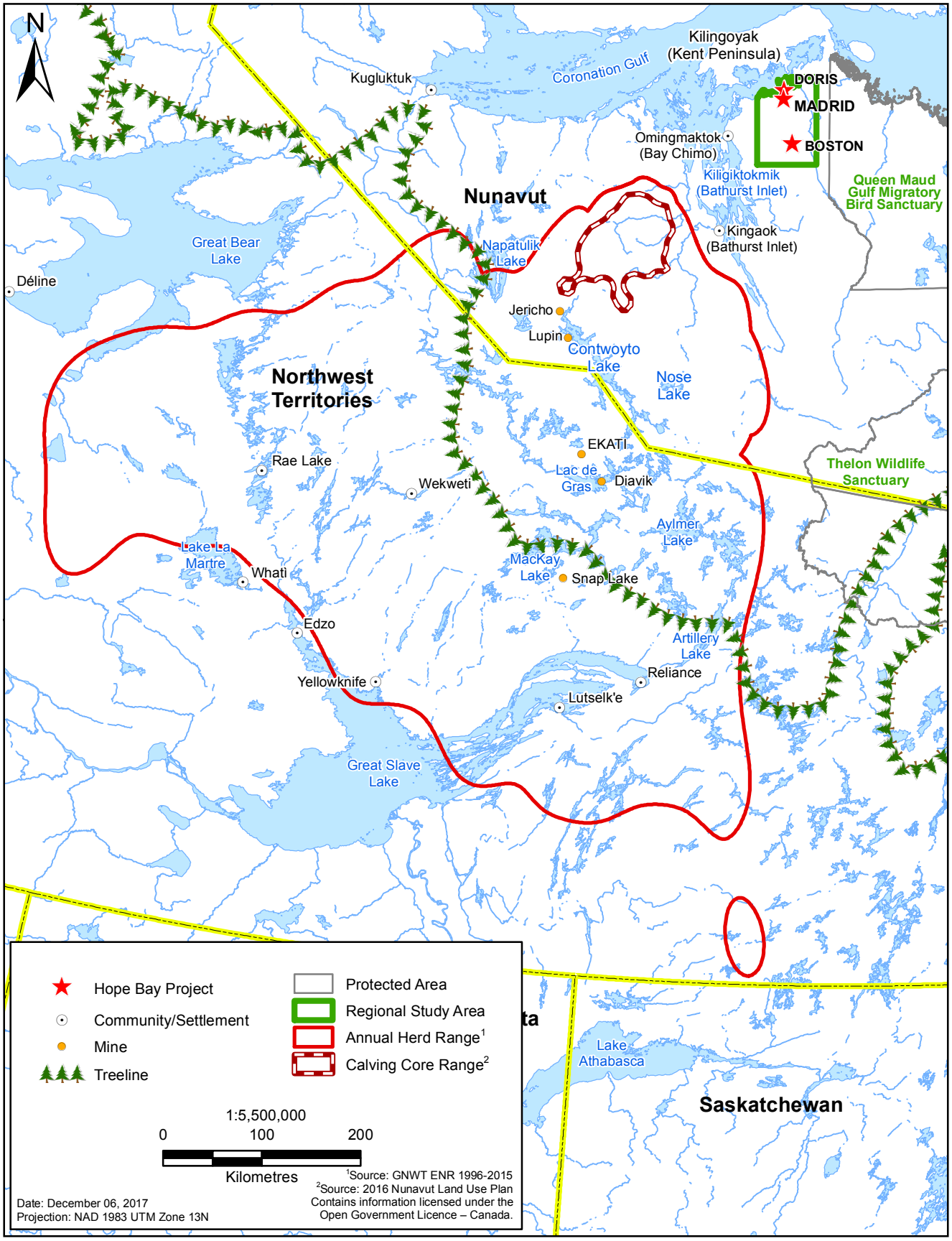


Figure 9.2-11
Annual and Calving Range of Satellite-collared Bathurst Caribou Herd



During the 1970s and early 1980s calving appears to have occurred primarily on the eastern side of Bathurst Inlet adjacent to the QMGMBS (Gunn, Poole, and Wierzchowski 2008). Starting in the early 1980s, aerial surveys indicated that the calving area began moving west each year. Surveys in 1986 and 1990 indicated that the calving area had moved west to the eastern coastline of Bathurst Inlet. Sometime between the aerial survey conducted in 1990 and the next survey in 1996 (the year in which caribou collaring began), the Bathurst caribou shifted their calving range from the east side of Bathurst Inlet to the west side of the Inlet. Since 1996, the calving area has been located west of Bathurst Inlet, between the Hood and Burnside Rivers (Gunn, Poole, and Wierzchowski 2008).

Aerial Surveys

An aerial survey program was conducted within the Hope Bay Belt from 1996 to 2011 for baseline and monitoring purposes. Aerial surveys were discontinued after that time due to low numbers of observations and following discussions with the GN DOE. The Program was altered several times in response to regulator comments, most notably following 2005, when the survey transects were doubled in length and reduced in number. The following sections discuss the methods and results of these surveys.

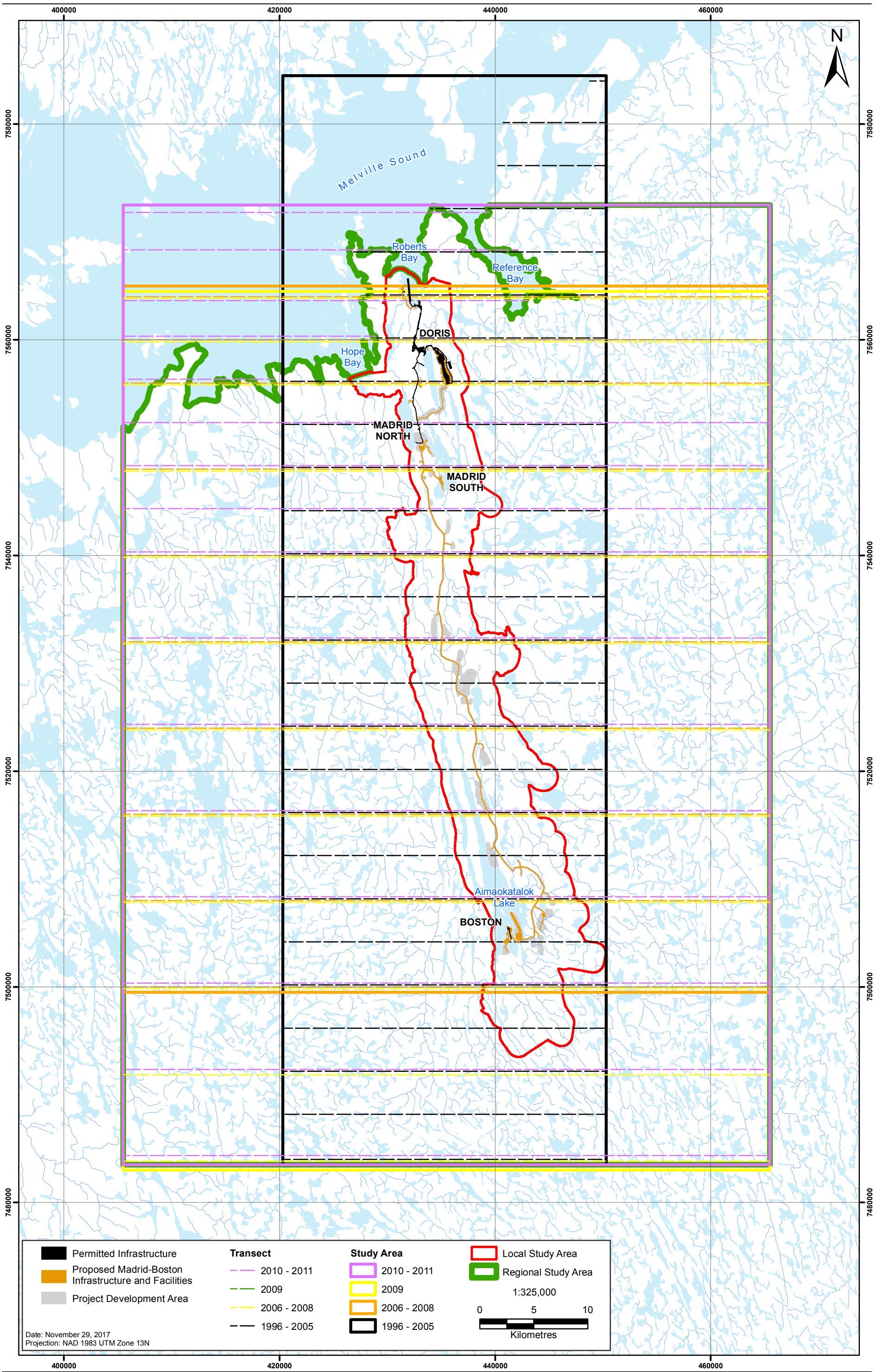
Methods

From 1996 to 2005, aerial surveys were conducted in an area encompassing the Hope Bay Belt and generally centred on a line connecting Doris and the Boston camp. Surveys followed 26 east-west transect lines, each 30 km in length, and spaced 4 km apart. In 2006 the study design was changed to 10 east-west transect lines, 60 km in length, with the northern three transects spaced 4 km apart and the other seven transects spaced 8 km apart. This was done to provide greater coverage of the areas east and west of the Hope Bay Project. In 2009, two additional transects were added to the south, also spaced 8 km between transects. The expanded set of transects provided additional coverage to the south of the Boston area.

In 2010, the study area was extended northward by an additional two transects each spaced 4 km from each other and the previous transect. Two additional transects were also added between those in the northern portion of the 2009 study area (between the third and fourth and fourth and fifth transects of the 2009 study area) to increase the density of transects in the northern area. This new transect design (9 northern transects spaced 4 km apart and the following 7 southern transects spaced 8 km apart) was surveyed in 2010 and 2011.

The study areas, which are bounded 0.5 km to the north and south of the northern and southernmost transects, respectively, and transect layouts are presented in Figure 9.2-12. The study area refers to the area of interest over which extrapolation of the survey data is applicable. The sampled area is the total transect length flown within the study area, multiplied by 1 km (surveys consisted of 1-km strip transects, with observers recording observations within 500 m to either side of the helicopter). The percent coverage refers to the ratio of the sampled area to the total study area. The number of caribou observed in the sampled area can be used to estimate density in the study area across seasons and years. In an effort to increase the extent of the survey area and maintain a relatively consistent survey grid spacing and survey length, some changes were accepted in the percent direct survey coverage. The survey area, and the percent direct survey coverage were: 3,030 km^2 and 26% coverage in 1996 to 2005; 3,900 km^2 and 15% coverage in 2006 to 2008; 4,860 km^2 and 15% coverage in 2009; and 5,340 km^2 and 18% coverage in 2010 and 2011. The percent direct survey coverage is within values from other regional caribou surveys, e.g., western Victoria Island 10 km transect spacing for 10% direct survey coverage (Nishi and Buckland 1994) and within values typically applied to transect aerial surveys (Buckland et al. 2004).

Figure 9.2-12
Ungulate Aerial Survey Areas, 1996 to 2011



Surveys were conducted during five periods that align with seasonal periods for Beverly/Ahiak caribou (Table 9.2-4):

1. Spring Migration: April 15 to June 4;
2. Calving: June 5 to June 20;
3. Post-calving: June 20 to July 25;
4. Summer/Fall: July 25 to October 31; and
5. Winter: November 1 to April 14.

The exact timing of aerial surveys (seasonality) and number of surveys varied by year (Table 9.2-6). During some years, multiple surveys were conducted within any one seasonal period. After 1999, winter aerial surveys were discontinued except for one survey in late-winter 2010. Overall, seven years of survey were conducted during the spring migration period (eight surveys total), nine years of survey (10 surveys total) during the calving period, 10 years of survey during the post-calving period (19 surveys total), eight years of survey (10 surveys total) during the summer/fall period and five years of survey during the winter period (seven surveys total) for a total of 54 surveys conducted between 1996 and 2011. Detailed survey methodology can be found in The Doris Project Wildlife Mitigation and Monitoring Program, 2011 (Rescan 2011f). Note that the above aerial survey seasonal periods may differ relative to those reported in Rescan (2011f) as the above dates have been grouped to align with seasonal periods for Beverly/Ahiak caribou based on the current, improved knowledge of seasonal timing in these herds. Note that the spring migration and winter periods above roughly align with the time when Dolphin and Union caribou are expected to be on the arctic mainland (see above).

Table 9.2-6. Aerial Survey Dates for Caribou and Muskox, 1996 to 2011

Year	Spring Migration	Calving	Post-calving	Summer/Fall	Winter
1996	May 31	ns	June 20-21; July 3, 19, 23	October 18	November 27
1997	May 30–31	ns	June 21; July 13, 23	August 18; September 11	February 12–13; November 28
1998	ns	June 2*	June 25; July 11	August 19–20; October 15	February 28; December 2–3
1999	ns	ns	June 20; July 11	ns	February 28–March 1
2000	May 18–19	June 1-2*, 11	ns	ns	ns
2001	May 23	June 9	ns	ns	ns
2002	ns	June 8-9	ns	ns	ns
2003	ns	June 8-10	ns	ns	ns
2004	ns	June 11	ns	ns	ns
2005	ns	ns	June 26-27, 29	August 10	ns
2006	ns	June 14	July 6	ns	ns
2007	ns	June 17	June 29	August 3	ns
2008	May 15–16	ns	June 29; July 6;	September 15–16	ns
2009	ns	June 8,9	ns	ns	ns
2010	May 11	ns	July 24–25	Sept 13–14	April 5–6
2011	April 18-19; May 21-22	ns	July 9-10	August 15-16	ns

ns = not surveyed
** Just prior to the calving period*

The mean densities of caribou in the study areas were calculated during each seasonal period for each year of study and plotted, along with standard errors when more than one survey was conducted in a given period, to assess seasonal and annual differences in caribou density in the study areas.

Results

Data collected between 1996 and 2011 was used to calculate caribou density estimates for the study area for each survey flight (Figure 9.2-13, Table 9.2-7). In general, very few caribou were observed within the study areas during aerial surveys conducted between 1996 and 2011. After correcting for survey effort, the greatest estimated density of caribou during a single survey was 5.73 individuals/km^2 (on the June 20, 1999 survey). However, the majority (48 of 54 surveys) of densities calculated during the surveys was under 1.0 individual/km^2 and 38 of these surveys had densities of less than 0.5 individuals/km^2.

Overall, density was very low during all seasons surveyed within the survey areas. Caribou densities were lowest during the summer/fall period, and during the spring migration period, consistently below 0.5 individuals/km^2 (Table 9.2-7). Winter densities ranged from 0.22 to 1.3 individuals/km^2. Density during the calving season was initially high, between 1 and 5 individuals/km^2, between 1996 and 2002, but fell to low densities of 0.00 to 0.13 after 2002.

This was consistent with the period in the late 1990s and early 2000s when the Beverly caribou were shifting their calving range north from the area near Beverly Lake to the Queen Maud Gulf area. Collar data show Beverly caribou calving in a more diffuse area during this period. After approximately 2002, the Beverly caribou appear to have settled on their new calving ground in the Queen Maud Gulf area, where it has remained to this day.

During the late 1990s, larger groups of Beverly were also observed during the post-calving period, presumably as caribou were moving from the calving ground to the summer range. Again, after 2002, observations of large groups in the post calving period ceased (Table 9.2-7).

Caribou observed during aerial surveys are likely Dolphin and Union caribou and Beverly/Ahiak caribou. Dolphin and Union caribou winter on the Nunavut mainland and have been recorded in the RSA between November 7 and June 9. Beverly/Ahiak caribou may also occur in the study area during some years in winter and spring migration periods as indicated by collaring data collected for Beverly caribou between 2001 and 2011.

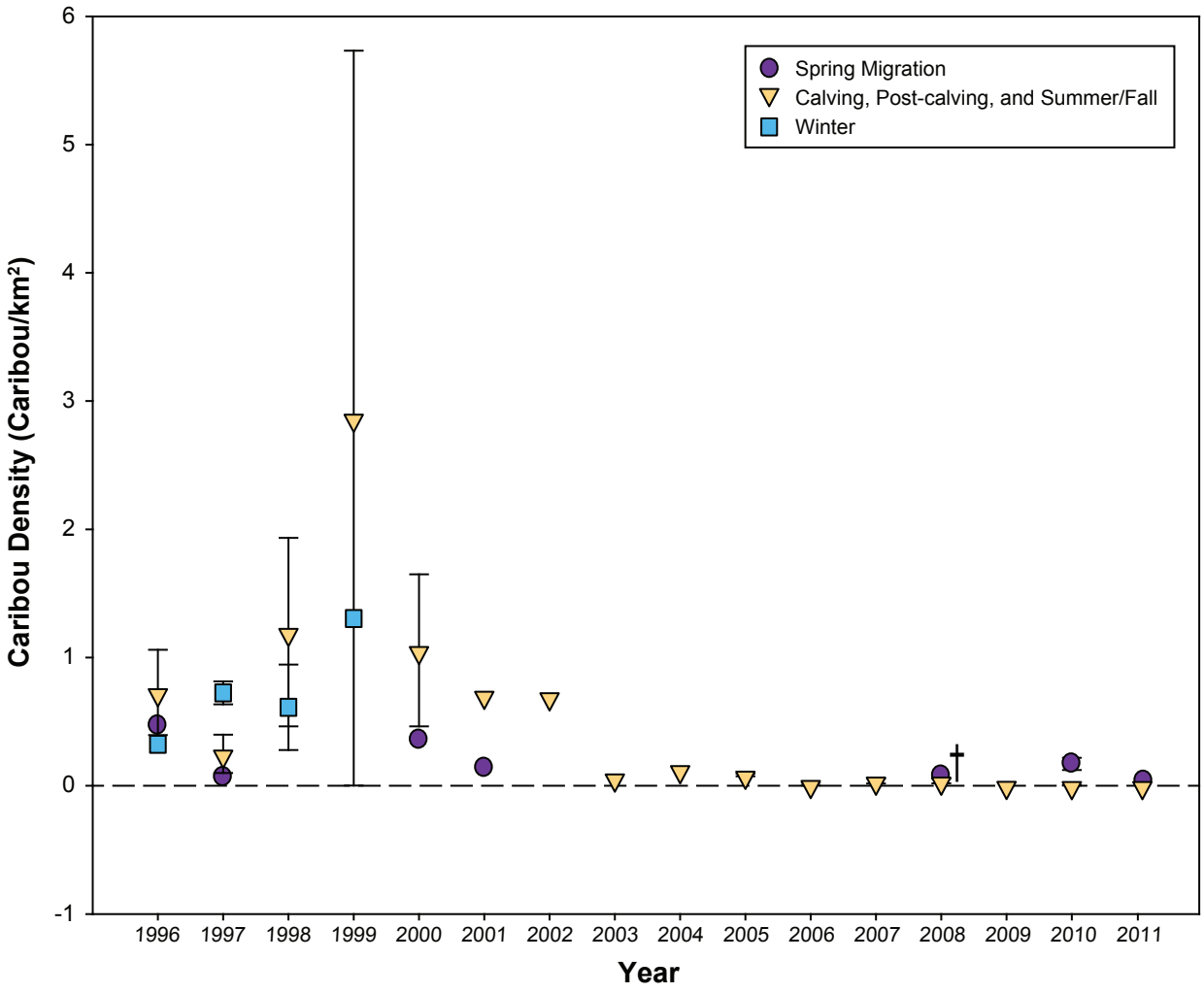
Sea Ice Crossing Surveys

Methods

Aerial surveys were conducted June 3 to 5, 2010 in Melville Sound and northern Bathurst Inlet to document sea ice crossing locations used by Dolphin and Union caribou in the marine RSA (Figure 9.2-14). Transect lines were spaced 8 km apart and oriented east to west in Melville Sound. Three transect lines were oriented north to south in northern Bathurst Inlet and Coronation Gulf (Figure 9.2-14). Surveys were timed to capture the latter part of the spring (northern) migration for Dolphin and Union caribou. Incidental observations of caribou trails were also recorded during caribou surveys conducted on May 22, 2011 as part of the annual WMMP monitoring program (Rescan 2011f).

Figure 9.2-13

Caribou Densities in the Aerial Survey Area between 1996 and 2011



Note: Error bars represent standard error of the mean.

† Caribou counted in only 7 of the 15 groups observed in May; group size of uncounted groups assumed to be one for graphical and analysis purposes.

Table 9.2-7. Aerial Caribou Survey Details and Results, 1996 to 2011

Year	Month	Date	Survey Category	Number of Transects Surveyed	Transect Length (km)	Transect Width (km)	Total Transect Area (km^2)	Total Number of Caribou Observed (on transect)	Estimated Caribou Density ($ind./km^2$)
1996	May	31	Spring Migration	22	30	1	584.5	273	0.47
	June	20, 21	Post-calving	26	30	1	674.5	1,198	1.78
	July	3	Post-calving	26	30	1	674.5	4	0.01
	July	19	Post-calving	26	30	1	674.5	653	0.97
	July	23	Post-calving	26	30	1	480	420	0.88
	Oct	18, 19	Summer/Fall	26	30	1	300	4	0.01
	Nov	27, 28	Winter	26	30	1	674.5	218	0.32
1997	Feb	12, 13	Winter	26	30	1	674.5	428	0.63
	May	30	Spring Migration	26	30	1	674.5	44	0.07
	June	21	Post-calving	26	30	1	674.5	545	0.81
	July	14	Post-calving	26	30	1	674.5	3	0
	July	23	Post-calving	26	30	1	674.5	0	0
	Aug	18	Summer/Fall	26	30	1	674.5	93	0.14
	Sept	11	Summer/Fall	26	30	1	674.5	199	0.3
	Nov	28, 29	Winter	26	30	1	674.5	549	0.81
1998	Feb	28	Winter	26	30	1	674.5	188	0.28
	June	2	Calving	26	30	1	674.5	893	1.32
	June	25	Post-calving	26	30	1	674.5	451	0.67
	July	11	Post-calving	26	30	1	674.5	2,680	3.97
	Aug	19, 20	Summer/Fall	26	30	1	674.5	17	0.03
	Oct	15	Summer/Fall	26	30	1	674.5	0	0
	Dec	2, 3	Winter	26	30	1	674.5	637	0.94
1999	Feb, Mar	28, 1	Winter	26	30	1	674.5	880	1.3
	June	20	Post-calving	26	30	1	674.5	3,867	5.73
	July	11	Post-calving	26	30	1	674.5	1	0
2000	May	18, 19	Spring Migration	26	30	2	1349	481	0.36
	June	1, 2	Calving	26	30	1	674.5	752	1.11
	June	11	Calving	26	30	1	674.5	1,384	2.05
	July	20	Post-calving	26	30	1	674.5	1	0

Year	Month	Date	Survey Category	Number of Transects Surveyed	Transect Length (km)	Transect Width (km)	Total Transect Area (km^2)	Total Number of Caribou Observed (on transect)	Estimated Caribou Density ($ind./km^2$)
2001	May	23	Spring Migration	23[1]	30	1	584.5	80	0.14
	June	9	Calving	23[2]	30	1	652.5	461	0.71
2002	June	8, 9	Calving	26	30	1	674.5	469	0.7
2003	June	8, 9, 10	Calving	26	30	1	674.5	42	0.06
2004	June	11	Calving	26	30	1	674.5	86	0.13
2005	June	26, 27, 29	Post-calving	26	30	1	674.5	63	0.09
	Aug	10	Summer/Fall	26	30	1	674.5	50	0.07
2006	June	14	Calving	10	60	1	600	14	0.02
	July	6	Post-calving	10	60	1	600	1	0
2007	June	17	Calving	10	60	1	600	40	0.07
	June	29	Post-calving	10	60	1	600	27	0.05
	Aug	3	Summer/Fall	10	60	1	600	0	0
2008	May	15, 16	Spring Migration	10	60	1	600	46[3]	0.08
	June	29	Post-calving	10	60	1	600	12	0.02
	July	6	Post-calving	10	60	1	600	11	0.02
	Sept	15, 16	Summer/Fall	10	60	1	600	44	0.07
2009	June	8, 9	Calving	12	60	1	720	3	0
2010	April	5, 6	Winter	16	60	1	960	209	0.22
	May	11	Spring Migration	16	60	1	960	118	0.12
	July	24, 25	Post-calving	16	60	1	845[4]	2	0
	Sept	13, 14	Summer/Fall	16	60	1	845[4]	4	0
2011	April	18, 19	Spring Migration	16	60	1	960	124	0.13
	May	21, 22	Spring Migration	16	60	1	960	6	0.01
	July	9, 10	Post-calving	16	60	1	845[4]	1	0
	Aug	15, 16	Summer/Fall	16	60	1	845[4]	4	0

[1] *The three southern transects were omitted*
[2] *The three northern transects were omitted*
[3] *Caribou were only counted for 7 of the 15 groups observed. For analytical purposes, uncounted groups were assumed to have 1 caribou each.*
[4] *Northern transects were not flown over open water.*

Results

A total of 18 caribou and 114 caribou tracks were observed on the sea ice during aerial surveys during spring migration (June 3 to 5, 2010) of Dolphin and Union caribou (Rescan 2011g)). One group of 13 bull caribou were observed off-transect and five bull caribou were incidentally observed during travel to and from Doris Site (Figure 9.2-14). Of the 114 caribou tracks observed, the majority were documented along the shoreline of northern Melville Sound (Figure 9.2-14). In several areas, caribou tracks were grouped together, suggesting that larger groups of caribou (~5-10 individuals) were travelling together. Generally, caribou tracks were oriented in a northerly direction and followed shorelines of the Kent Peninsula (Figure 9.2-14).

A total of 10 caribou and 17 groups of trails were observed during the May 22, 2011 caribou survey (Figure 9.2-14) (Rescan 2011g). The majority of observations were recorded west of Roberts Bay and toward the western extent of the survey area. Caribou were observed using a group of small islands to cross to the Kent Peninsula. The annual movement patterns of Dolphin and Union caribou vary between sexes. Cows generally start their northward migration in May; the median migration initiation date of female caribou based on a decade of satellite collar data was May 24 (K. G. Poole et al. 2010). Females generally take less than five days to complete the northward trip (K. G. Poole et al. 2010). Males and juveniles tend to be the last members of the herd to travel to Victoria Island, crossing well into June (Gunn et al. 1997). This pattern agrees with the results of the ice crossing survey, since only male caribou were observed crossing in late May. It is likely by the time of the survey that most female caribou had crossed and were on their calving grounds on Victoria Island.

The results of the ice crossing surveys agree with historical and current movement patterns of Dolphin and Union caribou. The majority of caribou tracks documented during the ice crossing surveys were oriented in a north or north-westerly direction, suggestive of caribou that pass from the northern edge of the Kent Peninsula towards Byron Bay on Victoria Island.

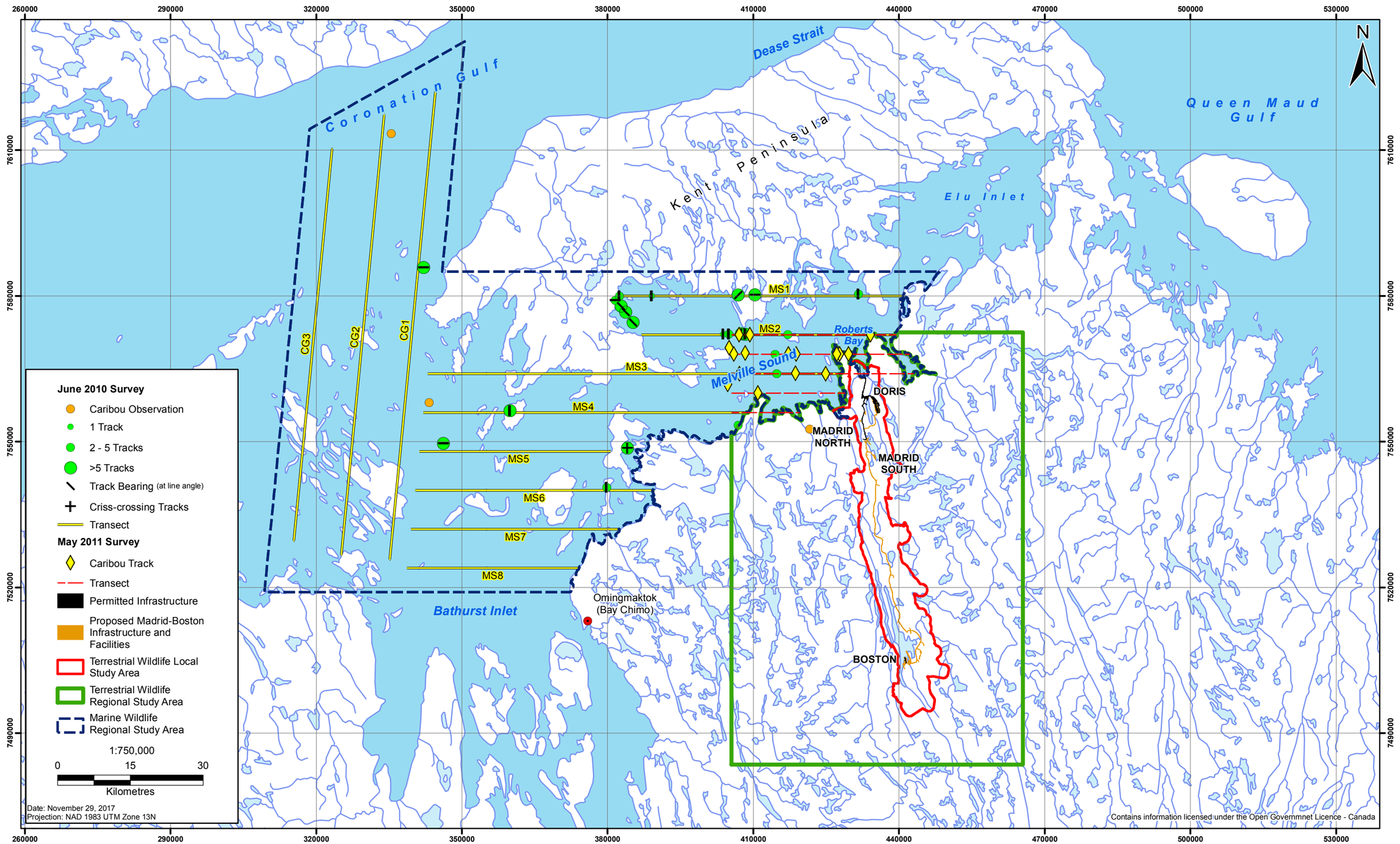
Dolphin and Union caribou exhibit fidelity to crossing areas to move across Dease Strait from the Kent Peninsula and for movement across Coronation Gulf and Queen Maud Gulf. Based on 20 years of satellite collar data, groups of female caribou begin ice crossing from the same general area on the Arctic mainland for 5 or 6 years, consecutively (K. G. Poole et al. 2010). Several areas east and west of Bathurst Inlet appear to be used consistently across years. West of Bathurst Inlet, many female caribou started their northward migration near Grays Bay and proceed northwards towards the Richardson Islands (K. G. Poole et al. 2010). East of Bathurst Inlet, several females consistently started their northward migration from the edge of the Kent Peninsula and crossed eastward towards Cape Colborne just south of Cambridge Bay and roughly northward towards Byron Bay (K. G. Poole et al. 2010). This crossing location is consistent with Inuit TK on crossing locations (Banci and Spicker 2016). The annual fidelity may be an artefact of the shortest possible “over ice” crossing distance, for example, island chains shorten the ice crossing distance west of Bathurst Inlet (e.g., Richardson Islands).

Wildlife Camera Monitoring

Methods

In 2012, a passive wildlife monitoring program was initiated using motion-triggered cameras and has continued to collect data to present. The camera program focused primarily on the northern portion of the Hope Bay Belt, as a part of monitoring for the Doris Project. Cameras were placed near to the Doris Project site (“on-site” cameras), and > 1 km from the Doris Project (“off-site” cameras) for most years except in 2016, when the camera program was redesigned in collaboration with the KIA and the GN, in a meeting in February 2016.

Figure 9.2-14
Observations of Caribou and Tracks Recorded during Aerial Surveys, June 2010 and May 2011



In June 2016, the cameras were redistributed into three zones based on distance to the Doris Project (Zone 1, within 2 km of the Project; Zone 2, 2 to 10 km from the Project; and Zone 3, beyond 10 km of the Project). Data from September 2012 to September 2016 were used in this report to characterize existing caribou use of the northern portion of the Belt, including seasonal and spatial use patterns, and usage differences associated with the existing Doris Project.

Remote digital cameras are a reliable method for examining ungulate migratory timing and habitat associations given the landscape's short vegetation and features such as eskers and river crossings that direct caribou movement through the landscape (Cutler and Swann 1999; Noel et al. 2006). Motion triggered cameras can also be used to monitor activities at important wildlife habitat features such as road crossing areas for caribou and at camps and infrastructure.

For the purposes of the EIS, off-site camera data (September 2012 – June 2016) were used to characterize caribou activity in the RSA, with the objective of: 1) evaluating caribou use of high value areas identified by TK, and 2) characterize activity of Dolphin and Union caribou in the marine RSA (Volume 5, Section 11) during winter. A comparison to on-site camera data was also made between off-site and on-site cameras to evaluate the existing influence of the Doris Project.

Off-site cameras were placed in areas of likely caribou movement (lake shores and existing caribou trails), areas of high value to caribou (such as eskers and probable crossing locations on rivers), and adjacent to the sea ice at potential crossing points in Roberts Bay, Ida Bay, and Hope Bay.

On-site cameras were deployed in key areas within 1 km of current infrastructure and on infrastructure around the Doris site. On-site cameras were placed sites with similar features to off-site cameras and/or specific locations such as camps, waste management facilities and road crossings to examine caribou use of these areas. The number of cameras deployed varied by year and season due to logistical reasons (Table 9.2-8a).

Table 9.2-8a. Number of Wildlife Cameras Deployed During Each Survey Period, 2012 to 2016

Survey Period	Dates	No. Days	Camera Location	No. Cameras
1 (2012 – 2013)	September 12, 2012 to June 21, 2013	269	On-site - Within 1 km of Existing Infrastructure	30
			Off-site - Greater than 1 km from Existing Infrastructure	14
			All Cameras	**44**
2 (2013)	June 22, 2013 to September 28, 2013	98	On-site - Within 1 km of Existing Infrastructure	25
			Off-site - Greater than 1 km from Existing Infrastructure	33
			All Cameras	**58**
3 (2013-2014)	September 29, 2013 to May 31, 2014	244	On-site - Within 1 km of Existing Infrastructure	25
			Off-site - Greater than 1 km from Existing Infrastructure	34
			All Cameras	**59**
4 (2014)	June 1, 2014 to August 22, 2014	82	On-site - Within 1 km of Existing Infrastructure	25
			Off-site - Greater than 1 km from Existing Infrastructure	31
			All Cameras	**56**
5 (2014 – 2015)	August 23, 2014 to May 22, 2015	272	On-site - Within 1 km of Existing Infrastructure	25
			Off-site - Greater than 1 km from Existing Infrastructure	32
			All Cameras	**57**

Survey Period	Dates	No. Days	Camera Location	No. Cameras
6 (2015)	May 23, 2015 to August 7, 2015	76	On-site - Within 1 km of Existing Infrastructure	27
			Off-site - Greater than 1 km from Existing Infrastructure	30
			All Cameras	**57**
7 (2015 – 2016)	August 8, 2015 to June 21, 2016	319	On-site - Within 1 km of Existing Infrastructure	27
			Off-site - Greater than 1 km from Existing Infrastructure	30
			All Cameras	**57**
8 (2016)	June 22, 2016 to Sept 22, 2016	93	Zone 1 - Within 2 km of Existing Infrastructure	21
			Zone 2 – 2-10 km of Existing Infrastructure	17
			Zone 3 - > 10 km of Existing Infrastructure	19
			All Cameras	**57**

Camera data from June to September 2016 is used in a similar fashion as the above, with data from cameras in Zone 1 representing use of habitats near the Doris Project, including specific Project facilities, and data from Zones 2 and 3 representing use of habitats on a regional scale.

Observations of caribou (and other wildlife) on motion-triggered photographs were recorded and termed “an event” where the triggers were separated by 30 minutes. Results were summarized for each species by several periods during which cameras remained in the same position throughout the entire period. Adjustments were made to camera positions over time due to changes to monitoring objectives for Doris Project locations (Table 9.2-8a).

To evaluate seasonal trends in camera detection events, camera events were summarized by week number. Seasonal analyses used camera data that were corrected for two factors: darkness and camera effort. Across a year, the amount of daylight varies from effective darkness throughout the day in December up to 24 hours of daylight in June. The ability of wildlife cameras to detect wildlife varies across the year in the dark relative to daylight. Therefore, a correction factor was applied to event data to account for a reduced detection radius in the darker months (Table 9.2-8b). The correction factor was supplied by the KIA and used the approximate day length recorded at Kugluktuk, which is at a similar latitude to the Project. Camera effort refers to the total number of active deployment days and takes into account (i.e., removing) the days when cameras were obscured by snow or ice, were knocked over or damaged by wildlife, or were not functioning due to technical issues. Camera events, controlled for darkness factor and camera effort, were standardized to events per 100 camera days (i.e., events/day x 100) to provide comparable values. The data from period 1 (September 2012 to June 2013) were not considered in seasonal analysis as cameras were primarily distributed on or near Doris Project infrastructure with few cameras deployed in reference areas further away from the Project. For the remainder of the camera monitoring program, cameras were more equally balanced between locations near and far from the Doris Project (Table 9.2-8a).

Further details on the rational for camera placement, image retrieval, and data analysis are described in the annual WMMP reports from 2012 to 2016 for the Doris Project (ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Results

A total of 44 to 59 cameras were deployed in the RSA between 2012 and 2016; the camera program has been running for a total of 1,453 days. Caribou events on photos from motion-triggered cameras were infrequent, with a total of 216 events recorded during those 1,453 days (Figure 9.2-15; Table 9.2-9a).

Most events were of a single individual (178 events, 82.4%) with a few pairs (20 events, 9.3%). The remainder of the events recorded groups of 3-6 individuals (11 events; 5.1%) and 10-13 individuals (7 events; 3.2%). This equates to an average of 0.0044 caribou events per camera per day.

Table 9.2-8b. Darkness Factor Correction for Camera Data by Month

Month	Average Day Length (Hours:Minutes:Seconds)	Average Day Length (Hours)	Proportion of Light during Day	Darkness Factor
January	3:23:50	3	0.13	1.26
February	7:52:52	8	0.33	1.2
March	11:51:19	12	0.5	1.15
April	15:57:32	16	0.67	1.1
May	20:52:32	21	0.88	1.04
June	24:00:00	24	1	1
July	22:29:10	22	0.92	1.03
August	17:11:01	17	0.71	1.09
September	13:05:46	13	0.54	1.14
October	9:09:50	9	0.38	1.19
November	4:54:51	5	0.21	1.24
December	0:30:14	0	0	1.3

Note: Data supplied by the KIA during review of the WMMP in 2017

Table 9.2-9a. Caribou Detection Summary across All Cameras, September 2012 to September 2016

Survey Period	Camera Location	No. Events[1]	No. Events/camera/day[1]	Total No. Ind. Recorded on Events[1,2]
1 (2012-2013)	On-site	0	0	0
	Off-site	4	0.0011	5
	All Cameras	**4**	**0.0003**	**5**
2 (2013)	On-site	27	0.0110	29
	Off-site	39	0.0121	40
	All Cameras	**66**	**0.0116**	**69**
3 (2013-2014)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
4 (2014)	On-site	17	0.0083	20
	Off-site	21	0.0083	21
	All Cameras	**38**	**0.0083**	**41**
5 (2014-2015)	On-site	0	0	0
	Off-site	4	0.0005	15
	All Cameras	**4**	**0.0003**	**15**
6 (2015)	On-site	12	0.0058	12
	Off-site	10	0.0044	10
	All Cameras	**22**	**0.0051**	**22**

Survey Period	Camera Location	No. Events[1]	No. Events/camera/day[1]	Total No. Ind. Recorded on Events[1,2]
7 (2015-2016)	On-site	19	0.0022	73
	Off-site	28	0.0029	83
	All Cameras	**47**	**0.0026**	**161**
8 (2016)	Zone 1	3	0.0015	3
	Zone 2	21	0.0133	22
	Zone 3	11	0.0062	11
	All Cameras	**35**	**0.0066**	**36**

[1] *Event data are not corrected for camera effort or for darkness factor.*
[2] *The number of individuals does not represent total number of individuals recorded across all events, as multiple events can be of the same individual utilizing the area surrounding the wildlife camera.*

These results indicate that the Hope Bay Project RSA is not heavily used by caribou. In comparison, cameras placed in the post-calving range of the Bathurst caribou in 2013, north of Contwoyto Lake recorded 5,300 caribou on 30 cameras in 34 days, for an average of 5.19 caribou events per camera per day; approximately 2,000 times the capture rate in the Hope Bay Project RSA (Sabina 2015a).

Seasonal Differences

Camera data indicate that caribou use was most consistent during the period spanning Week 25 through 37 (roughly mid-June through mid-September), with a peak of over 2 events/100 camera days during Week 30 (end of July; Figure 9.2-16; Table 9.2-9b). These camera events are of Beverly/Ahiak caribou during their summer period, for Dolphin and Union herd spent the spring and summer on Victoria Island (Figure 9.2-16). The event recording rate during other times of the year were lower and more sporadic by comparison, with rates generally of 1 event/camera day or lower and several weeks with no events separating weeks with events. The exception was during Week 1 and 2 (early January), when the event recording rate was 2.37 and 1.97 events/100 camera days. The timing of events corresponds to the winter period when Dolphin and Union caribou (and also tundra wintering Ahiak and Beverly caribou) are present near the Doris Project, during the spring migration period for both herds, and the fall migration period for Dolphin and Union caribou. Evidence recorded from satellite collared Beverly/Ahiak caribou indicates that few individuals travel through the RSA during their spring migration, thus it is likely that caribou recorded in the spring were Dolphin and Union caribou travelling towards Victoria Island (Figure 9.2-16).

Coastal Monitoring

Ten cameras were located on the land/sea-ice boundary, and were evaluated for evidence Dolphin and Union caribou crossing onto the ice at these locations. These cameras were located along the Hope Bay, Roberts Bay, and Reference (Ida) Bay shorelines (Cameras 6b, 9a, 10a, 17a, 23b, 55a, 56a, 57a, 59a, and 60a). Four of the cameras (9a, 10a, 57a, and 60a) captured motion-triggered photo events in fall and spring, during migration periods (Figure 9.2-15). At Camera 9a, events were recorded in 2013 and 2016. In 2013, four events were recorded across the span of April 11- 13; three of the events were of single individuals and one event was of two caribou. In 2016, one event was recorded on April 6 consisting of a detection of 11 individuals. At Camera 10a, one event consisting of a detection of six individuals was on May 12, 2015. At camera 57a, two events were recorded on January 7, 2016 each consisting of a detection of a single individual. At camera 60a, several events were recorded, including one event on December 30, 2015 (1 individual), January 3, 2016 (1 individual), two events on March 29, 2016 (10 and 13 individuals), and two events on April 21, 2016 (1 and 11 individuals). These events confirm that Dolphin and Union caribou do make on-off ice crossings near the Hope Bay Project.

Figure 9.2-15
Caribou Detected on Cameras Located in the Regional Study Area, 2012 to 2016

TMAC RESOURCES

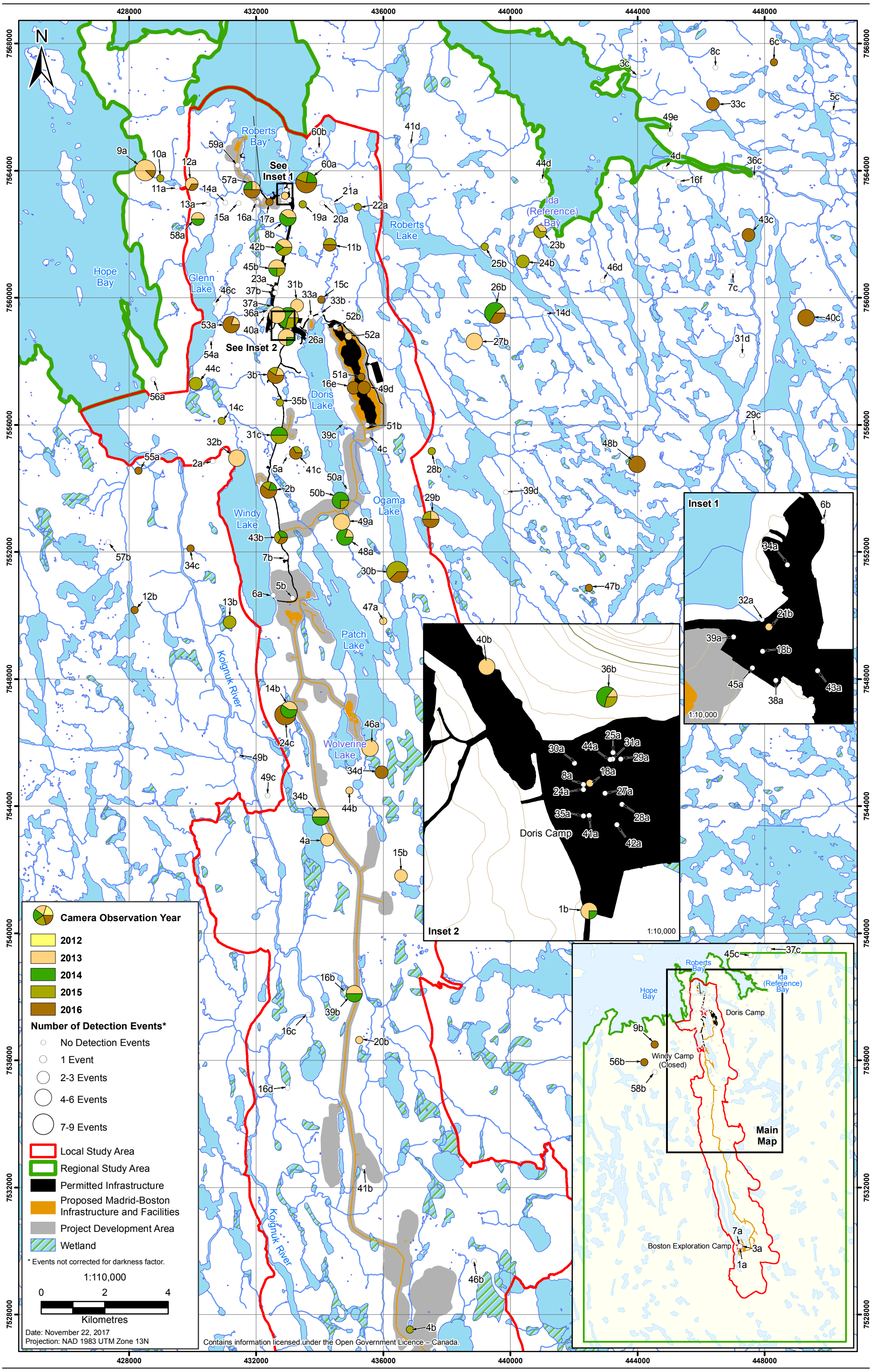
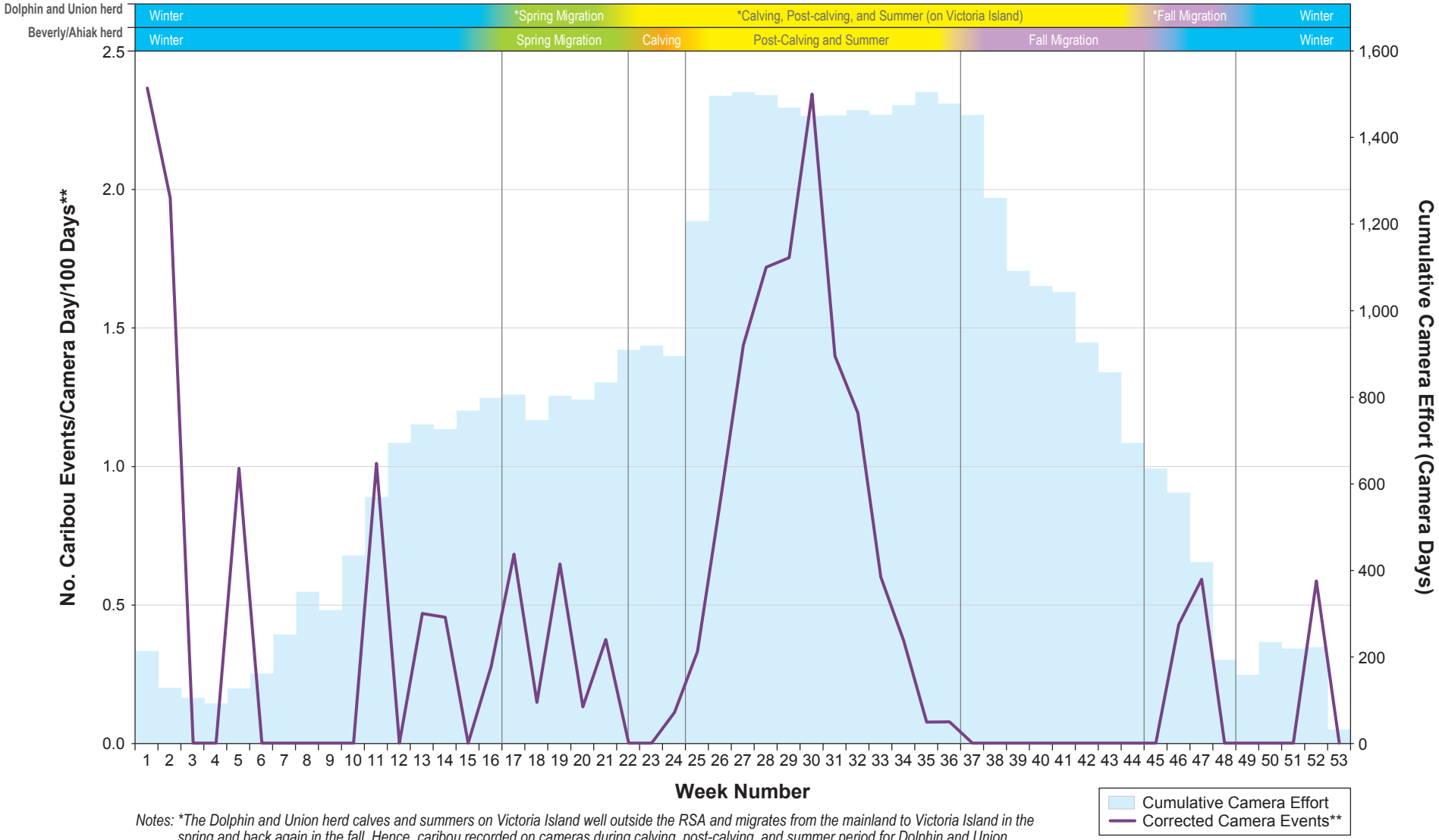


Figure 9.2-16

Caribou Camera Detection Events (Corrected Events/100 Camera Days) by Week Number and Caribou Seasonal Periods



*Notes: *The Dolphin and Union herd calves and summers on Victoria Island well outside the RSA and migrates from the mainland to Victoria Island in the spring and back again in the fall. Hence, caribou recorded on cameras during calving, post-calving, and summer period for Dolphin and Union caribou can only be from the Beverly/Ahiak herd.*

*** Camera event data are corrected for the darkness factor.*

Table 9.2-9b. Caribou Detection Summary across All Cameras by Week Number, June 2013 to September 2016

Month	Week Number	No. Events	No. Events (Corrected)[1]	Cumulative Camera Effort	Event Recording Rate (Events/100 Camera Days)[2]
January	1	4	5.0	213	2.37
	2	2	2.5	128	1.97
	3	0	0	105	0
	4	0	0	92	0
	5	1	1.26	127	0.99
February	6	0	0	161	0
	7	0	0	251	0
	8	0	0	350	0
	9	0	0	308	0
March	10	0	0	434	0
	11	5	5.75	569	1.01
	12	0	0	694	0
	13	3	3.45	737	0.47
April	14	3	3.3	726	0.45
	15	0	0	769	0
	16	2	2.2	798	0.28
	17	5	5.5	806	0.68
May	18	1	1.1	747	0.15
	19	5	5.2	803	0.65
	20	1	1.04	794	0.13
	21	3	3.12	834	0.37
	22	0	0	909	0
June	23	0	0	919	0
	24	1	1	895	0.11
	25	4	4	1,207	0.33
	26	13	13.09	1,496	0.88
July	27	21	21.63	1,505	1.44
	28	25	25.75	1,498	1.72
	29	25	25.75	1,469	1.75
	30	33	33.99	1,450	2.34
August	31	19	20.29	1,451	1.40
	32	16	17.44	1,463	1.19
	33	8	8.72	1,452	0.60
	34	5	5.45	1,475	0.37
September	35	1	1.14	1,505	0.08
	36	1	1.14	1,478	0.08
	37	0	0	1,452	0
	38	0	0	1,260	0
	39	0	0	1,092	0

Month	Week Number	No. Events	No. Events (Corrected)[1]	Cumulative Camera Effort	Event Recording Rate (Events/100 Camera Days)[2]
October	40	0	0	1,057	0
	41	0	0	1,043	0
	42	0	0	926	0
	43	0	0	857	0
November	44	0	0	694	0
	45	0	0	635	0
	46	2	2.48	579	0.43
	47	2	2.48	419	0.59
December	48	0	0	193	0
	49	0	0	158	0
	50	0	0	234	0
	51	0	0	219	0
	52	1	1.3	222	0.59
	53	0	0	32	0

[1] *Corrected for darkness factor.*
[2] *Event recording rate calculated using the events corrected for the darkness factor.*

Incidental Observations

Methods

Incidental observations of wildlife were recorded by Hope Bay Belt personnel during normal activities and by environmental personnel and contractors while conducting environmental monitoring work. Incidental data are useful for documenting which species are present in the area, timing of migrations (caribou, various bird species), information on group sizes, emergence from hibernation (grizzly bears), and calving (muskox, caribou). However, minimal information on density or abundance can be gleaned from this type of data, as it is highly influenced by observer reporting biases such as work activity and locations, preferential and multiple reporting of large mammals/novel occurrences, and visibility.

Incidental observations can include actual observations of wildlife, wildlife sign, including tracks, excrement, body parts (antlers, fur), bones, residences (e.g., dens, nests), or signs of activity (e.g., grizzly bear digging). However, for the purposed of the EIS, only observations of animals were considered. Incidental observations were reviewed to ensure that only observations collected within the RSA were included.

Incidental observations of caribou were recorded between 2006 and 2016, when:

1. observed by personnel near the Doris Project site and recorded in the wildlife sighting log; and
2. observed incidentally by wildlife biologists and environmental personnel when conducting baseline and monitoring programs.

Incidental observations at the Doris Project were summarized monthly as observations per person on site. Although this provides some level of standardization, densities and abundance inferences remain heavily influenced by other observer biases such as those mentioned above and any inferences made must be viewed with caution. Incidental observations by environmental personnel were summarized annually because of the high variability in the number of environmental personnel on site and their much higher

per-capita reporting rate; which is largely a product of specific work activities and experience (e.g., many incidental sightings are recorded during a single caribou aerial survey or point count survey).

Results

Incidental Observations of Caribou by Site Personnel

Personnel recorded incidental observations of caribou in all months 2009 to 2016 (Table 9.2-10). The number of caribou recorded varied both annually and seasonally (Table 9.2-10); the highest number of animals reported was approximately 152 animals in March 2016. Caribou were generally recorded as being in small groups of 1 to 10 individuals (154 of 182 records where group size specified; 84%), with only 28 observations of groups over 10 individuals, and the largest observed group size of approximately 100 individuals (recorded once in 2009 and 2016).

Table 9.2-10. Caribou Observations from the Wildlife Sightings Log Standardized by Number of Personnel on Site, 2009 to 2016

Year	Month	Number of Observations*		Monthly Average of Personnel on Site**	Observations/Personnel*	
		No. Individuals	No. Records		No. Individuals	No. Records
2009	Jan	0	0	69	0	0
	Feb	0	0	84	0	0
	Mar	0	0	94	0	0
	Apr	141	3	102	1.38	0.03
	May	114	7	102	1.12	0.07
	Jun	10	2	103	0.1	0.02
	Jul	21	6	113	0.19	0.05
	Aug	0	0	109	0	0
	Sep	14	1	98	0.14	0.01
	Oct	0	0	66	0	0
	Nov	0	0	16	0	0
	Dec	0	0	14	0	0
2010	Jan	0	0	83	0	0
	Feb	0	0	106	0	0
	Mar	1	1	131	0.01	0.01
	Apr	16	1	172	0.09	0.01
	May	148	16**	182	0.81	0.09
	Jun	1	1	200	0.01	0.01
	Jul	9	4	220	0.04	0.02
	Aug	2	2	205	0.01	0.01
	Sept	0	0	484	0	0
	Oct	0	0	332	0	0
	Nov	0	0	147	0	0
	Dec	0	0	108	0	0
2011	Jan	0	0	214	0	0
	Feb	0	0	250	0	0
	Mar	0	0	265	0	0
	Apr	24	4	278	0.09	0.01

Year	Month	Number of Observations*		Monthly Average of Personnel on Site**	Observations/Personnel*	
		No. Individuals	No. Records		No. Individuals	No. Records
	May	43	5	274	0.16	0.02
	Jun	9	2	280	0.03	0.01
	Jul	4	2	284	0.01	0.01
	Aug	0	0	277	0	0
	Sept	0	0	277	0	0
	Oct	0	0	270	0	0
	Nov	0	0	252	0	0
2012	Jan	0	0	183	0	0
	Feb	0	0	193	0	0
	Mar	0	0	180	0	0
	Apr	7	1	127	0.06	0.01
	May	28	6	90	0.31	0.07
	Jun	0	0	103	0	0
	Jul	2	2	90	0.02	0.02
	Aug	1	1	93	0.01	0.01
2013	Mar	0	0	3	0	0
	Apr	0	0	13	0	0
	May	6	2	20	0.3	0.1
	Jun	4	4	44	0.09	0.09
	Jul	5	4	61	0.08	0.07
	Aug	5	4	59	0.08	0.07
	Sept	0	0	54	0	0
	Oct	0	0	49	0	0
	Nov	0	0	19	0	0
	Dec	0	0	8	0	0
2014	Jan	0	0	7	0	0
	Feb	0	0	7	0	0
	Mar	0	0	8	0	0
	Apr	10	1	14	0.71	0.07
	May	3	1	63	0.05	0.02
	Jun	11	5	71	0.15	0.07
	Jul	23	13	77	0.3	0.17
	Aug	0	0	79	0	0
	Sept	0	0	73	0	0
	Oct	0	0	79	0	0
	Nov	0	0	44	0	0
	Dec	10	1	7	1.43	0.14
2015	Jan	0	0	13	0	0
	Feb	6	1	16	0.38	0.06
	Mar	0	0	30	0	0
	Apr	0	0	28	0	0
	May	34	3	32	1.06	0.09

Year	Month	Number of Observations*		Monthly Average of Personnel on Site**	Observations/Personnel*	
		No. Individuals	No. Records		No. Individuals	No. Records
	Jun	9	3	41	0.22	0.07
	Jul	2	2	46	0.04	0.04
	Aug	10	7	84	0.12	0.08
	Sept	0	0	105	0	0
	Oct	0	0	114	0	0
	Nov	44	5	93	0.47	0.05
	Dec	66	4	89	0.74	0.04
2016	Jan	29	5	60	0.48	0.08
	Feb	27	3	73	0.37	0.04
	Mar	152	9	78	1.95	0.12
	Apr	51	5	93	0.55	0.05
	May	79	14	110	0.72	0.13
	Jun	0	0	123	0	0
	Jul	10	9	123	0.08	0.07
	Aug	1	1	129	0.01	0.01
	Sept	0	0	144	0	0
	Oct	0	0	158	0	0
	Nov	11	2	172	0.06	0.01
	Dec	51	6	169	0.30	0.04

** Whether or not wildlife are recorded can vary by factors other than number of personnel on site, e.g.; the type of animal, multiple reporting of same individuals by different observers, work activities (indoor vs outdoor; site-based vs field-based), number of daylight hours, visibility, novelty of the sighting, observer reporting enthusiasm, ability to identify animal, etc. Personnel were on site in all months between 2009 and December 2016 except October to December 2012. Personnel totals do not include personnel at Boston Site.*
*** Includes one record where group size not specified.*

After correcting for the number of personnel on site, there are peaks in the observations/person of caribou in spring (April and May) in all years and recent peaks (2014 and 2016) during the fall (November and December) which likely correspond to fall migration of Dolphin and Union caribou past the Doris site. Summer observations of caribou are likely Beverly/Ahiak caribou.

Incidental Observations of Caribou by Field Personnel

Incidental observations of wildlife recorded by field personnel including wildlife biologists and other environmental personnel conducting studies within the RSA indicate that caribou have been observed incidentally in the RSA at low densities during all years from 2006 to 2016 (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Habitat Suitability Modeling

Methods

Habitat suitability models provide a means of identifying the spatial extent and distribution of habitats across the landscape. Habitat suitability mapping was conducted for the RSA using West Kitikmeot / Slave Study (WKSS) ecosystem mapping to identify vegetation groups. Additional detailed mapping was conducted in the Local Study Area (LSA) surrounding the Hope Bay Project footprint using ecosystem mapping conducted for the Hope Bay Project using aerial photographs.

Habitat suitability models were developed for each of the seasons when caribou may interact with the RSA, including summer and fall (Beverly/Ahiak caribou) and winter (Dolphin and Union caribou). Habitat suitability modeling was conducted for caribou across the RSA. Individual herds are not assessed separately as it is assumed that habitat requirements are similar, if not identical, for all individuals by season (Gustine et al. 2012).

Habitat selection for each season was developed from literature searches, local knowledge, previous wildlife surveys, and Hope Bay Project-specific habitat assessments. A summary of the seasonal life requisites applied to the Habitat Suitability Ratings (HSR) is provided in Table 9.2-11.

Table 9.2-11. Seasonal Life Requisites of Caribou

Season	Date	Life Requisite	Habitat Preference
Summer	July 16 to August 31 (summer)	Living	Caribou use eskers for insect and heat relief, lakes for predator avoidance, insect, and heat relief, eat green plants from riparian and sedge communities. Cows require high quality forage to replenish fat reserves.
Fall (Rut)	September 1 to October 31	Living, Reproduction, and Travel	Caribou travel to southern rutting areas selecting habitat for ease of travel, predator avoidance, and late season forage.
Winter	November 1 to April 15	Living	Caribou rely on lichens in winter because they provide digestible carbohydrates and are generally abundant. Caribou concentrate in areas that provide foraging opportunities with limited snow depths.

A habitat suitability model was developed for caribou within the Local Study Area (LSA), in conjunction with ecosystem mapping studies (Appendix V4-9A) (Rescan 2011h). The caribou habitat suitability model was developed by adapting the BC Resources Information Standards Committee (RISC) standards for wildlife habitat suitability modeling (RIC 1999a, 1999b) for Nunavut. The suitability model identifies areas which, in their current condition, provide suitable (i.e., functioning) habitat for caribou. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for caribou. Suitability mapping does not imply that caribou actually use these areas, simply that they have the correct physical and vegetation characteristics to be used by caribou if they chose to do so.

Within the LSA, local scale Ecosystem Mapping (EM) described in Volume 4, Section 8 (Vegetation and Special Landscape Features) was used to identify vegetation ecosystems. However, the LSA mapped for habitat suitability modelling is slightly smaller (~56,277 ha) than the LSA defined for the EIS (56,340 ha), thus a small amount of habitat within LSA used for wildlife in the EIS could not be classified. The exception is for caribou fall habitat where models were adjusted for the EIS as fall habitat within the habitat suitability modelling boundary was not classified previously.

The West Kitikmeot / Slave Study (WKSS) ecosystem mapping was used to identify ecosystem units within the RSA (Matthews, Epp, and Smith 2001). A wildlife habitat suitability rating (WHR) was then assigned to each ecosystem unit, based on the characteristics of the vegetation community and season and caribou's requirements for food, security, and thermal protection. The WHRs developed for the Hope Bay Project were ranked according to a four-class (high, moderate, low, nil) system. Field surveys were conducted within the LSA in conjunction with ecosystem and soils mapping (see Section 8, Vegetation and Special Landscape Features) to verify the literature-based predictions of habitat values. Model adjustments were subsequently applied where necessary and sometimes a few iterations were

made prior to the final development of the Habitat Suitability Ratings (HSRs). Final HSR values were used to rank each ecosystem polygon by a weighted average of the decile values (percent of a polygon classified as a given ecosystem unit) of the representative composition of each polygon. Details of these rankings are reported in the 2010 Wildlife Habitat Suitability Baseline Report (Rescan 2011h).

The EM based habitat suitability mapping was used in the LSA to calculate habitat loss (Section 9.6) because it was the best available data; the EM data is not visually portrayed on maps. Maps are presented in this section for caribou (and all other VECs) that depicts the WHRs assigned to the WKSS data throughout the RSA to allow visual comparison of the LSA and RSA.

Results

Habitat suitability modeling indicates that the RSA and LSA contain vegetation communities that are suitable for use by caribou in summer, fall and winter seasons. It should be noted that this type of habitat mapping identifies vegetation communities that meet the characteristics listed in the scientific literature as preferred during various seasons by caribou. This mapping does not suggest that caribou are actively using this habitat. Use of habitat is likely governed at broader scales than the local vegetation communities, such as the presence of aggregations of higher quality vegetation, insect relief, movement corridors and predation risk.

Habitat suitability modeling based on EM data indicates that the LSA contains the highest proportions of summer habitat (34.9%) relative to other seasonal habitat. Lower amounts of high value fall (2.4%) and winter habitat (14.7%) occur in the LSA (Table 9.2-12). High value summer habitat in the LSA is relatively well distributed throughout the LSA, while high value fall and winter habitat are more dispersed and found in smaller patches within the LSA (Figures 9.2-17, 9.2-18 and 9.2-19).

Table 9.2-12. Area and Percentage of Seasonal Habitat within the Local Study Area and Regional Study Area for Caribou

		Local Study Area[1]		Regional Study Area[2]	
Season	**Suitability Rating**	**Area (ha)**	**Percent (%)**	**Area (ha)**	**Percent (%)**
Summer	High	19,640.0	34.9	116,846.7	23.7
	Moderate	28,086.3	49.9	308,912.7	62.8
	Low	7,746.2	13.7	5,623.1	1.1
	Nil	804.5	1.4	55,597.7	11.3
Fall	High	1,375.2	2.4	234,640.9	47.7
	Moderate	12,956.6	23.0	96,897.3	19.7
	Low	40,152.6	71.3	99,844.2	20.3
	Nil	1,855.6	3.3	55,597.7	11.3
Winter	High	8,283.4	14.7	32,166.6	6.5
	Moderate	11,495.5	20.4	196,454.3	39.9
	Low	25,313.9	44.9	197,138.5	40.1
	Nil	11,184.2	19.9	61,220.8	12.4

[1] *LSA = 56,340 ha. Habitat Suitability data in the LSA is based on the TEM data (see Section 9.2.3.10). With the exception of Fall habitat, approximately 63 ha (0.1% of the LSA) of habitat within the LSA were not classified due to differences in the LSA used for the habitat suitability baseline work (Rescan 2011) and that used for the EIS.*

[2] *RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.10). A total of 4,843.7 ha (1.0% of RSA) were categorized as unclassified likely due to coverage of the imagery by cloud cover.*

Figure 9.2-17
Caribou Summer Habitat Suitability in the Local Study Area and Regional Study Area

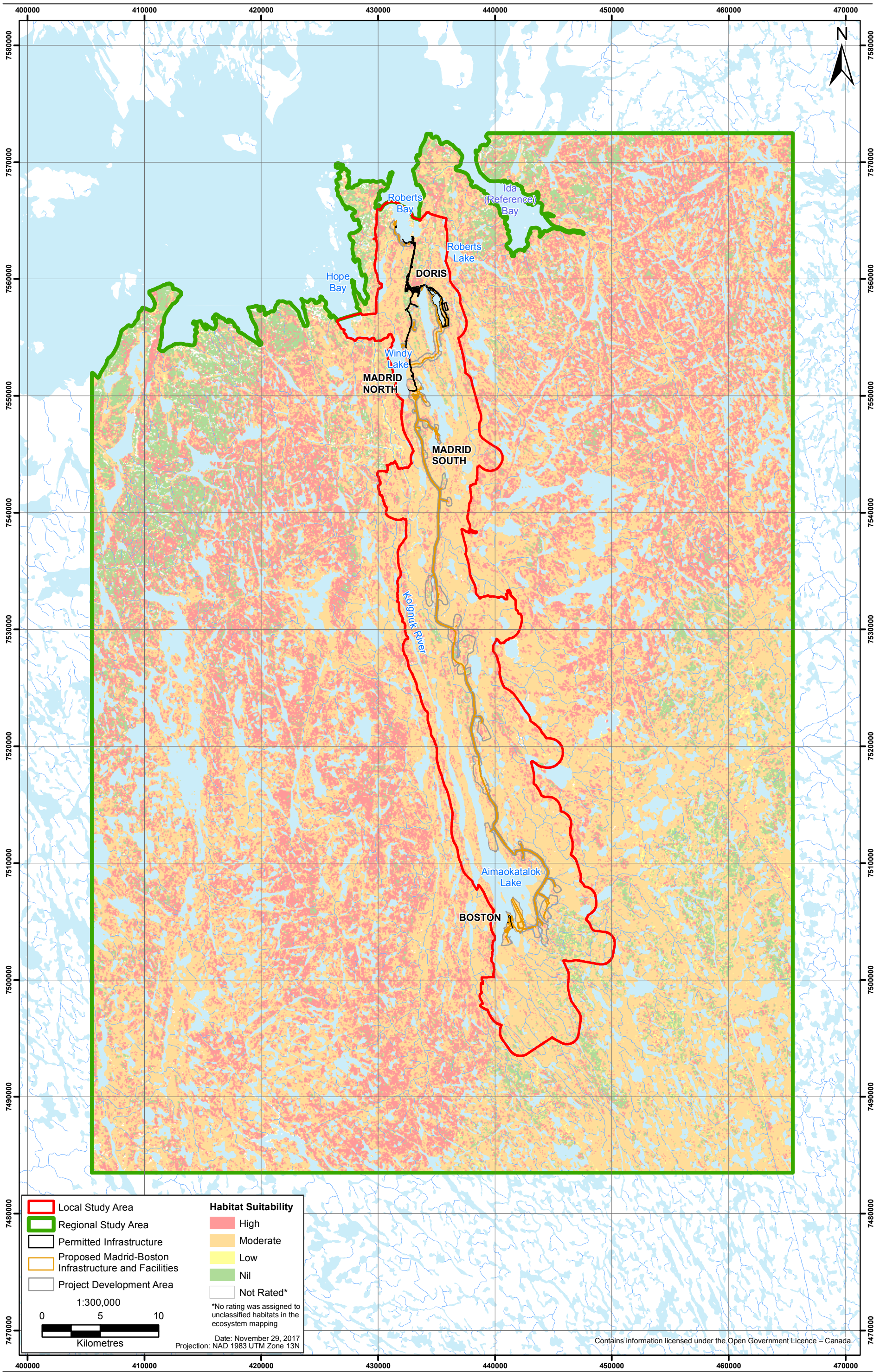


Figure 9.2-18
Caribou Fall Habitat Suitability in the Local Study Area and Regional Study Area

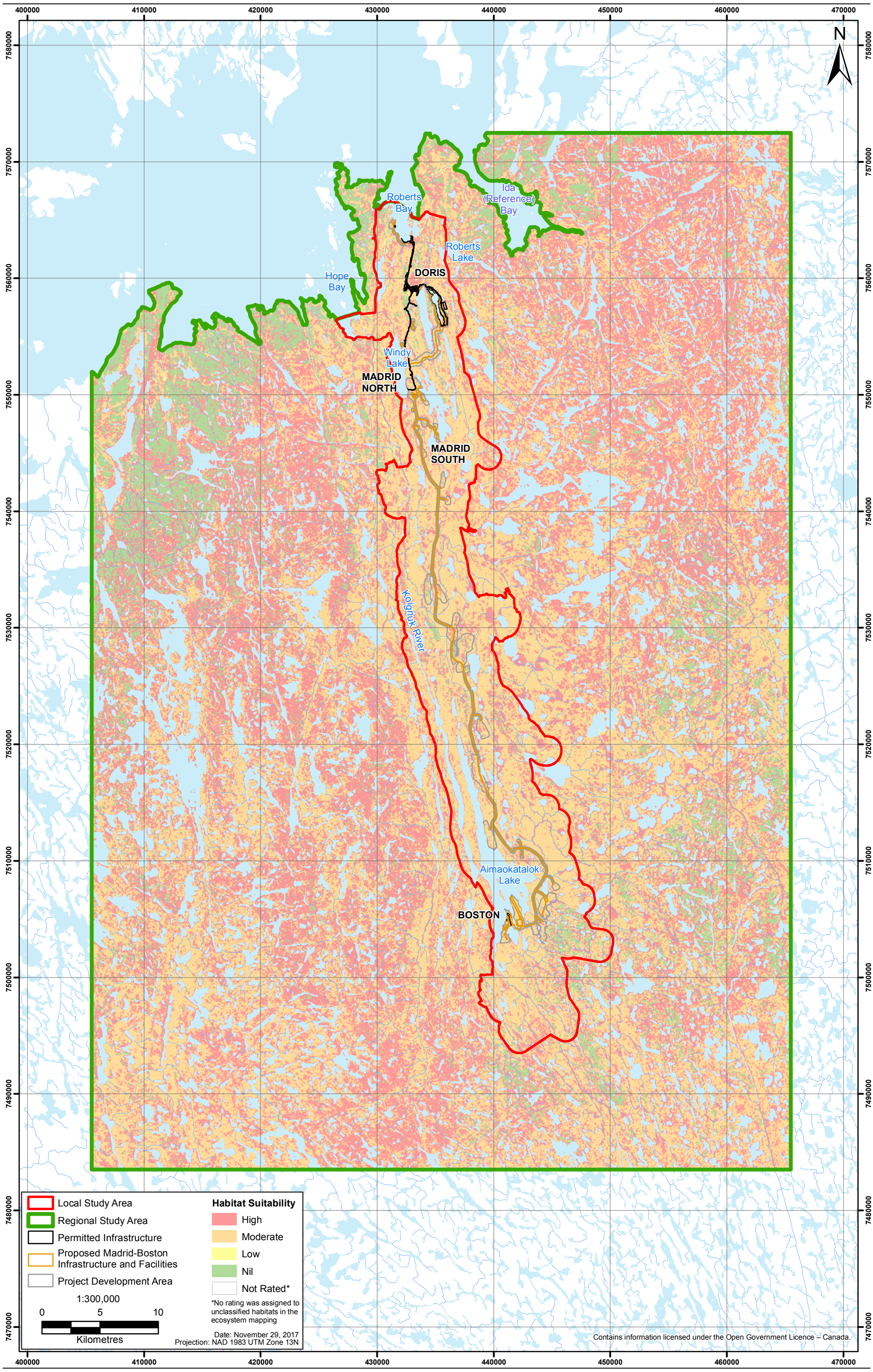
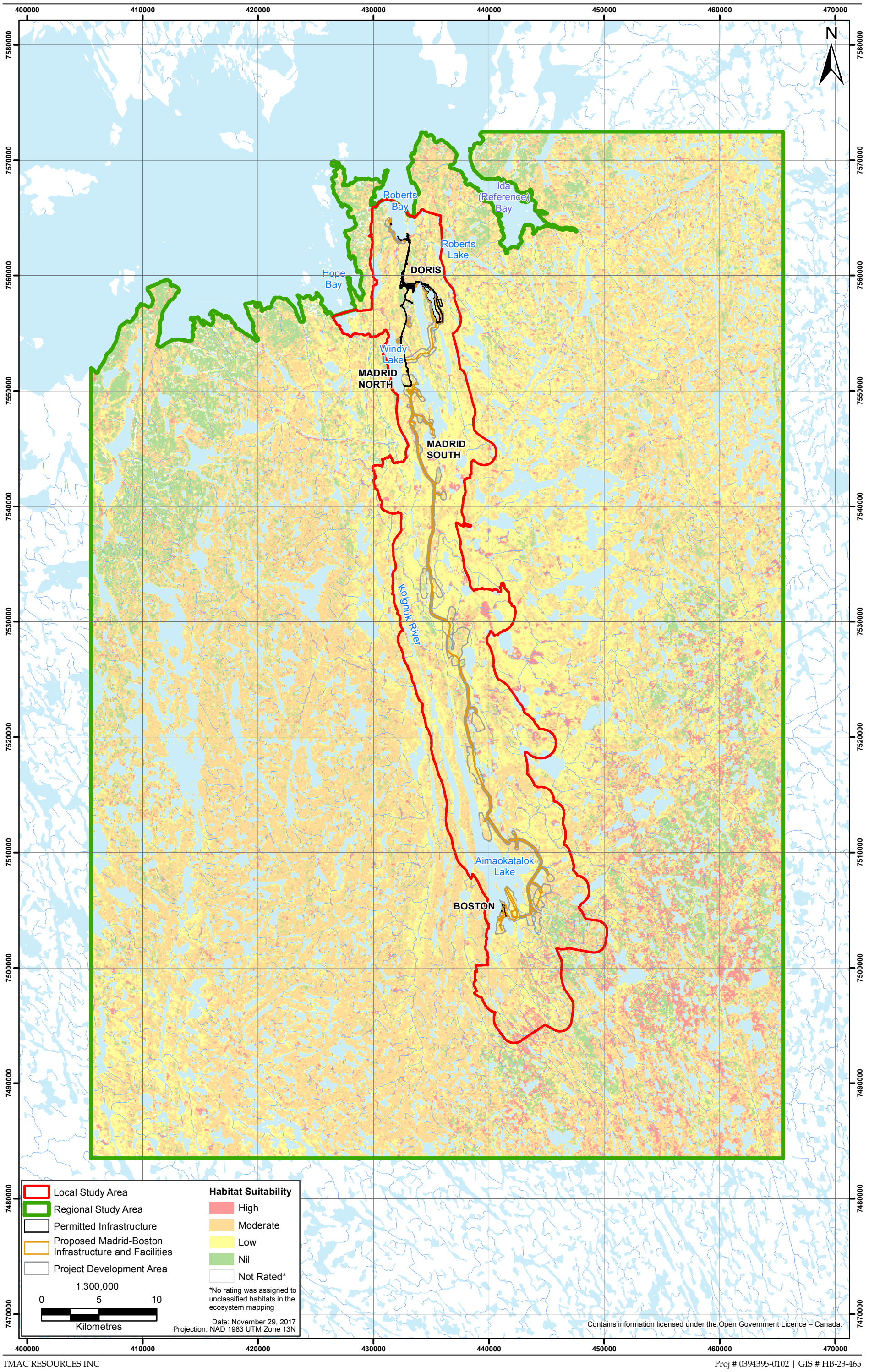


Figure 9.2-19
Caribou Winter Habitat Suitability in the Local Study Area and Regional Study Area



Habitat suitability modeling based on the WKSS ecosystem classification indicates that the RSA contains a considerable amount of high value summer (23.7%) and fall (47.7%) habitat (Table 9.2-12). Summer and fall habitat was dispersed throughout the RSA, with a concentration of high quality habitat for both seasons in the rocky and broken terrain on the west side of the RSA (Figures 9.2-17, 9.2-18, and 9.2-19). The majority of the RSA was classified as low or moderate value as winter habitat, with only 6.5% rated as high value (Table 9.2-12). Dolphin and Union caribou are found within the RSA in low numbers during the winter.

9.2.6.3 The Doris Project

Between 1996 and 2004, exploration occurred in the Hope Bay Belt, based out of the Windy Lake camp. In 2006, a project certificate was issued for the Doris Project. Construction of the Doris Project began in 2009, but was put into care and maintenance following changes in market conditions in 2010, and was re-opened for additional construction and resource exploration in 2015.

The Wildlife Mitigation and Monitoring Plan (WMMP) for the Doris Project included monitoring of caribou for habitat loss (measured as the area of the Doris Project footprint), possible sensory disturbance (avoidance of the Doris Project), and possible direct mortality through collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance phases since 2006. This section summarizes the results of these monitoring activities for caribou.

Habitat Loss

Habitat lost within the Doris footprint has been measured since construction started at the site in 2009. The total area of the existing footprint, is 83.0 ha, or 2.7% of the LSA from the 2006 FEIS for the Doris Project. The majority of habitat loss is heath tundra (33.6 ha), tussock/hummock (29.5 ha), and heath bedrock (4.1 ha; Table 9.2-13). Of the 83.0 ha of habitat lost, 82.3 ha of habitat lost was classified as suitable for caribou during the spring season (Table 9.2-14). This represents an actual loss of 0.03% of the total suitable habitat identified for caribou within the RSA during the spring period (Table 9.2-14).

Sensory Disturbance

The WMMP evaluated the potential for sensory disturbance to lead to caribou avoiding the Doris Project site. Monitoring for caribou used aerial surveys from 1996 to 2010 and wildlife cameras from 2010 to present.

Results of Aerial Survey Monitoring 1996-2005

Mineral exploration in the Hope Bay Greenstone Belt was based out of the Windy exploration camp from the mid-1990s until 2010. The camp supported helicopter-based exploration using several standard diamond drilling units, presumably producing some auditory and visual disturbance for wildlife.

Multiple aerial surveys were conducted in most years for caribou during the period between 1996 and 2010. As part of the 2008 and 2010 WMMP reports for the Doris Project, an analysis was conducted to examine if there was a detectible zone of influence (ZOI) for the Windy camp and it's helicopter-based drilling program during the period of 1996-2005 (Rescan 2011f). After 2006, there were generally too few caribou observed to be included in the analysis.

The analysis followed the methods of Boulanger et al (2012) using the number of observed caribou in each 1 km segment of the aerial transect lines. Habitat was evaluated for each segment using the Land Cover Map of Northern Canada (NLC; Olthof, Latifovic, and Pouliot 2009) and ten vegetation classes

(Table 9.2-15). A principal components analysis (PCA) was used to group the vegetation classes into three axes that together explained 96% of the variance in the habitat classes between transect segments. PC1 describes differences in segments with respect to water and low shrubs. Increasing values of PC1 indicate increasing amounts of low shrub and decreasing amounts of water. PC2 describes water and low shrubs together vs. other kinds of vegetation (e.g., lake shores), and PC3 describes bedrock-boulder vs. vegetation. The mean Normalized Difference Vegetation Index (NDVI) was also calculated for each segment using Landsat 7 imagery from August 10, 2000. A mixed-effects logistic regression was used on the post-calving data from 1996-2005 to develop the base habitat model (lme4 package in R; Bates and Maechler 2009).

Caribou presence in each segment was tested using a nested mixed-effects design, with segments nested within transects and transects nested within year to account for both the spatial autocorrelation of segments along transects. The maximal model was reduced by assessing the effect of sequentially removing variables with log-likelihood ratio tests. To test for a ZOI, an additional ZOI variable was added to the base habitat model and 71 ZOI models were fit to the data ranging from 1.5 to 72.5 km from Windy camp in 1-km increments and compared using log-likelihood. A 95% confidence interval for the ZOI was calculated as the distances for which the log-likelihood was within 1.92 of the maximum log-likelihood.

As suggested by GN DOE in 2009, the modelling procedure also incorporated counts of caribou observed in each transect segment, using negative-binomial regression (MASS package in R; Venables and Ripley 2002). The regression coefficient for the relationship between the ZOI variable and the number of caribou was used to describe the ZOI with year as a fixed effect in the regressions to account for differences between years in caribou abundance and location. Otherwise, the modelling procedure was the same as described for the presence/absence data.

The logistic analysis base habitat model was strongly significant for the presence/absence modelling (X^2 = 232.9, df = 11, p < 0.00001). These results suggest that there are many habitat characteristics that significantly affect caribou distribution, which is consistent with TK and scientific reports. The positive coefficient for PC2 suggests that caribou are found more often in areas that have more low shrubs and water (e.g., near lakes), while the negative coefficient for PC3 suggests that caribou are avoiding areas with a high proportion of bedrock-boulder. Similarly, the large positive coefficient for NDVI suggests that caribou prefer greener or more productive areas. The negative coefficients for distance from lakes suggest that caribou prefer to be near lakes.

The logistic ZOI analysis using the presence or absence of caribou did not find a ZOI for caribou. The analysis reported a maximum likelihood at an estimated ZOI of 20.5 km (CI = 12.5 - 42.5 km), with an odds ratio of 0.9 (SE = 1.1) meaning that caribou are ~10% more likely to be observed within 20.5 km of the camp than at greater distances. However, this odds ratio is not significantly different from 1, indicating that no ZOI was detected with this method.

The results using count data were very similar, with a significant base habitat model (X^2 = 1218.9, df = 23, p < 0.00001). The negative-binomial regressions on the count data resulted in a maximum likelihood at an estimated ZOI of 37.5 km (35.5 – 38.5 km) with the regression coefficient indicating that 20% more caribou are expected to occur within 37.5 km of the Windy camp.

Overall, the analysis using presence/absence of caribou did not find a statistically significant ZOI, while the analysis of the number of caribou in each segment suggested that there are more caribou within 37.5 km of the Windy camp. The end result of these analyses is that there was no biologically meaningful ZOI for the Windy camp during the period of 1996 to 2005; i.e., caribou did not avoid the Windy camp during this period.

Table 9.2-13. Actual Area of Habitat Loss by Habitat Type for all VEC Species

Habitat	Habitat Suitability							Vegetation in RSA		Vegetation in LSA		Actual Disturbed Vegetation[4]		
RWED ELC Unit[1]	Raptor[2]	Waterfowl[3]	Upland Bird	Grizzly Bear Female with Cubs	Grizzly Bear Male	Wolverine	Caribou Spring	Area (ha)	% of RSA	Area (ha)	% of LSA	Area (ha)	% of RSA	% of LSA
Heath Tundra	Moderate	Low	Moderate	High	Moderate	Low	High	68,837	18.4	841	27.0	33.6	<0.1	4.0
Heath/Bedrock	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	64,635	17.3	306	9.8	4.1	<0.1	1.3
Esker Complex	Low	Low	Nil	Moderate	Moderate	Moderate	Low	632	0.2	0	0.0	0.0	0.0	0.0
Heath/Boulder	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate	3,361	0.9	21	0.7	0.8	<0.1	3.8
Bedrock Association	Low	Nil	Low	Moderate	Moderate	Moderate	Moderate	11,134	3.0	11	0.4	1.2	<0.1	10.9
Boulder Association	Low	Nil	Low	Low	Moderate	Moderate	Moderate	1,613	0.4	11	0.4	0.3	<0.1	3.1
Lichen Veneer	Low	Low	Low	Moderate	Low	Low	High	3,249	0.9	42	1.3	3.9	0.1	9.3
Gravel Deposit/Bare Ground	Low	Nil/Low	Low	Moderate /Nil	Moderate/Nil	Moderate	Low/Moderate	10,093	2.7	126	4.0	2.9	<0.1	2.3
Tussock/Hummock	Moderate	Moderate	High	Moderate	High	High	Moderate	32,397	8.7	743	23.8	29.5	0.1	4.0
Riparian Tall Shrub	Moderate	Moderate	High	Moderate	High	Low	Low	10,658	2.8	117	3.8	1.5	0.1	1.3
Low Shrub	Moderate	Moderate	High	Moderate	Low	Nil	High	28,724	7.7	189	6.1	1.9	<0.1	1.0
Wetland (Sedge Wetland)	Moderate	High	High	Moderate	Low	High	Moderate	15,958	4.3	127	4.1	2.3	0.1	1.8
Water (Deep and Shallow)	Nil	High	Nil	Nil	Nil	Nil	Nil	118,478	31.7	557	17.9	0.7	<0.1	0.1
Unclassified	Low	High	Moderate	N/A	N/A	N/A	N/A	4,284	1.1	24	0.8	0.5	<0.1	2.1
Total								**374,052**	**100.0**	**3,116**	**100.0**	**83.0**	**<0.1**	**2.7**

[1] Classification system used in EIS predictions for habitat loss.
[2] Specific to raptors, all habitat within 4 km of known raptor nest sites is also rated as having High Suitability.
[3] Specific to waterbirds, all terrestrial habitats within 50 m of water is also rated as having High Suitability.
[4] Does not include proposed road around TIA or south dam, which were included under the original EIS prediction, but have not yet been constructed. Does not include Madrid. Values reflect all habitat lost to December 31, 2016.

Table 9.2-14. Area of Suitable Habitat Disturbed for Caribou

		Amount of Suitable[1] Habitat in RSA[2]		Actual Disturbed Suitable Habitat	
Species	Season	Total (ha)	% of RSA[2]	Total (ha)	% of RSA[3]
Caribou	Spring	251,290	67.2	82.3	0.03

[1] Suitable Habitat does not include Nil-rated habitat in study area.
[2] Calculations based on: RSA area of 374,052 ha for Caribou, Grizzly Bear and Wolverine;
[3] Calculations based on total amount of suitable habitat in RSA

Table 9.2-15. Pooled Habitat Classes from the Northern Land Cover Map Used for Analyses

Pooled Habitat class	Description
Bedrock-boulder	Sparse vegetation (2-10%), barren, and exposed bedrock
Tussock	Tussock graminoid tundra
Sedge Wetland	Wet sedge and wetlands
Tundra	Moist to dry non-tussock graminoid/dwarf shrub tundra, dry graminoid prostrate dwarf shrub tundra, and prostrate dwarf shrub
Low shrub	Low shrub (<40cm; >25% cover)
Tall shrub	Tall shrub (>40cm; >25% cover)
Water	Areas covered by standing water

Simulations conducted with the data indicated that there were sufficient observations of caribou to detect a ZOI should one occur. However, the study design did not include survey transects within 1.5 km of Windy camp, and so if a ZOI were to occur within 1.5 km of the camp, this design would not be able to detect it.

Results of Wildlife Camera Monitoring

From 2012 to the present, caribou have been monitored in the area surrounding the Doris Project using motion-triggered cameras. Over the years, 44 to 59 cameras were placed on the tundra between zero to over 20 km from the Doris Project, and downloaded twice per year. An analysis was conducted to determine if caribou were avoiding the Doris Project using data collected between August 2014 and August 2015 (ERM 2016a). Caribou event data recorded on motion-triggered photos were analyzed in R-3.1.3 (R Core Team 2015).

Generalized additive mixed models were used to test whether there were differences in the number of caribou events recorded per month by cameras set up in Treatment locations (< 1 km from the Doris Project) and Control locations (> 1 km). A binomial distribution was used to model the probability of at least one event in a month at each camera (Government of Nunavut 2015; KIA 2015a, 2015b). Smoothed covariate terms were included for northing and month, and effort was included as an offset term. Camera number was included as a categorical random effect to account for repeated measurements across cameras. Models were run using the *gamm()* function from the *mgcv* library. This analysis indicated that there was no difference in the probability of observing caribou within 1 km of the Doris Project compared to control areas at greater than 1 km ($\beta = 0.24$, $p = 0.69$, not significant).

The data were also tested to determine if there was a ZOI at a distance of greater than 1 km. Event data were analyzed using a binomial distribution to model the presence or absence of caribou at each camera in each month. The covariates included in the model were: month, the location of the camera (east-west position on the earth and north-south position on the earth), and the distance to existing infrastructure at the Doris Project. Camera effort was included as an offset term to adjust for differing effort across cameras by month. Models were produced in R (R Core Team 2015) using the *gam()* function from the *mgcv* library with a binomial distribution. An AIC analysis was used to compare the models.

Generally, the cameras recorded more caribou in summer and in the northern part of the RSA. To account for the general north-south orientation of the Doris Project infrastructure and to increase the power to detect a ZOI, the cameras were grouped into four groups:

1. the coast to the Doris airstrip;
2. the Airstrip to Doris site;
3. Doris site to the southern tip of Windy Lake; and
4. south of Windy Lake.

Across all four groups, the predicted probability of recording at least one caribou event at a camera in a given month tended to increase to a distance of approximately 5 km after which the predicted values appeared to decrease.

These data suggest that there may be a ZOI surrounding the Doris Project, with fewer caribou within approximately 5 km of the Doris Project. However, the number of caribou observed was very low, so these results should be interpreted with caution. Moreover, as the KIA and GN DOE commented in 2015, the study design had several limitations. In February 2016, TMAC met with the KIA and GN DOE and re-designed the camera monitoring program to address these limitations and the camera locations were

changed accordingly during summer 2016 and updated the camera program design in the 2016 WMMP Plan (ERM 2016c).

Direct Mortality

Any wildlife mortality, including caribou mortality that have been observed by onsite personnel were reported immediately to the ESR Department and in the annual WMMP report. Any mortality of large fauna is also reported directly to GN DOE and KIA, as necessary.

In the years that personnel have been at the Doris Project site (2006-2016), there have been no reports of vehicle and aircraft strikes to caribou at the Doris Project. The on-site speed limits for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to caribou. Caribou ramps have been placed on the road at crossing locations identified by Elders to facilitate crossing events.

There have been two reports of caribou injury resulting in mortality at the Doris Project. In mid-summer 2009, a caribou became entangled in geophysical survey wiring as it was being deployed. The animal died shortly after being found, and before attempts to free it could be made. This was communicated to the KIA and GN DOE. In mid-summer 2012, a male caribou was found with its antlers entangled in a rope that was tied between several traffic pylons marking off the core storage area on the camp pads. The rope was cut in an attempt to release the animal, but the pylon and rope did not come free. The caribou had broken its antlers in 4 places. After repeated attempts to free the animal, a Wildlife Officer from GN DOE instructed wildlife responders to dispatch the animal and salvage the meat, which was provided to the community. The caribou was located on the tundra approximately 5 km from camp and was harvested by Inuit workers, who also dressed the carcass. The meat was distributed in Cambridge Bay. The KIA was compensated according to Article 6 of the NLCA.

Due to these incidents, adaptive management measures were put in place to prevent future entanglements of caribou, including greater care when deploying geophysical survey equipment, ropes are no longer used between traffic markers. Camp hygiene is monitored on a regular basis by the ESR Department to ensure that the camps and other facilities are safe for wildlife.

Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Permitted Project (primarily the Doris Project). This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in caribou due to the existing Doris Project activities.

9.2.7 Characterization of Baseline Conditions for Muskox

9.2.7.1 Introduction

Muskox (*Ovibos moschatus*) are large herbivores and a key species in the tundra food chain. Muskox feed on shrubs in wet meadows in summer, and dig craters to find willows and grasses in winter. Muskox comprise an important food source for wolves and, to a lesser degree, grizzly bears (Gunn and Miller 1982; P. E. Reynolds, Wilson, and Klein 2002; Wiebe et al. 2009; Mech 2010). Muskox are valued by Inuit as a source of food, hides, horns, and wool, as well as for the commercial sale of meat. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing. Muskox are presently designated as Apparently Secure in Nunavut (CESCC 2016) and are managed and protected as a big game species under the *Nunavut Wildlife Act* (2003).

Inuit TK indicates that muskox are sparsely distributed within the RSA and are distributed across the Kent Peninsula particularly along the coasts and to the west side of Bathurst Inlet (Banci and Spicker 2016). According to TK, muskox have generally increased in the Elu Inlet area since the early 1900s. Muskox were traditionally hunted by the Inuit when caribou and seals were not available. Inuit did not hunt muskox during the summer months as the meat is not as good to eat during this season and the pelts are of poor quality. Besides meat, muskox provided bedding, dog mats, and the horns were made into a wide assortment of tools and crafts (Banci and Spicker 2016).

Population Trends and Conservation

The population of muskox in Nunavut and the Northwest Territories in 1997 was estimated at 140,000 animals, about 85% (119,000) of which occurred on the Arctic islands (Fournier and Gunn 1998). In 2001, muskox numbers in Canada were estimated as having increased to 166,000 animals (Gunn and Adamczewski 2003). Though population size has been estimated, there has been no large scale assessment of muskox population trends in Nunavut. The population size of muskox is thought to fluctuate in response to snow depth (i.e., food availability) and predator numbers (P. E. Reynolds, Wilson, and Klein 2002). Like caribou, muskox populations periodically have large-scale die-offs, which may be due to starvation following rain-on-snow events that form ice crusts too thick to dig through (Nagy, Gunn, and Wright 2009).

Muskox are found throughout the Kitikmeot region at relatively low densities (Gunn 1990; Dumond 2007). The Government of Nunavut currently defines 13 muskox management units (GN DOE 2015; Leclerc 2015b). The RSA occurs within muskox management unit MX-11, which is part of the central Kitikmeot population (GN DOE 2015). MX-11 extends from Kugluktuk to the central Queen Maud Gulf and from the coast to the NWT border. Population surveys have been conducted on the western half of MX-11, west of Bathurst Inlet, but not east of Bathurst inlet.

Prior to July 2013, there were 19 muskox management units in Nunavut (Dumond 2006); management zone MX-11 was formerly categorized into three management zones (MX-13, MX-14 and MX-19) and the RSA was located within western portion of the former MX-14 management zone (Leclerc 2015b).

Surveys were conducted for muskox in the western portion of the former MX-14 (now part of MX-11) management zone in 1986 and 2005 (Dumond 2007), west of Bathurst Inlet. The survey in 1986 was conducted west of Bathurst Inlet and reported 3,400 ± 460 animals (Gunn 1990). This number declined to 2,560 ± 460 animals during surveys in 2006 (Dumond 2007). In 2013, after consultation with the HTOs in Cambridge Bay and Kugluktuk, a muskox population survey was conducted surrounding Kugluktuk and 1,331 adult muskox were recorded on the 7,017 km^2 of transect area surveyed (Leclerc 2015b). Since there has been little overlap in the areas surveyed in MX-11, it is not possible to fully understand trends in muskox population dynamics within the entire management zone. No formal population surveys have been conducted east of Bathurst Inlet, where the Hope Bay Project is located.

The GN DOE recommends a total annual harvest (TAH) of 225 individuals from MX-11 (GN DOE 2015). On the West Kitikmeot mainland, Bathurst Inlet harvests of muskox for subsistence or sport hunts are between 20 and 30 animals annually (M. Dumond, GN DOE, personal comm.). Kugluktuk harvests of muskox are between 35 and 50 animals annually. Harvest statistics from Bathurst Inlet, and Kugluktuk include muskox hunts near Contwoyto Lake and Pellat Lake areas which are located over 300 km to the west of the Hope Bay Project.

Muskox populations may be affected by climate change in the future. Climatic shifts in winter weather have been known to affect muskox populations in Greenland (e.g., M. C. Forchhammer et al. 2002). Like caribou, climate change may result in large-scale die-offs of muskox due to starvation during

arctic winters when ice layers form too thick for muskox to crater through the ice with their hoofs (Nagy, Gunn, and Wright 2009; reviewed in Jenkins et al. 2011). Climate change in the last four decades also appears to have accelerated the development of parasitic lungworm (*Umingmakstrongylus pallikuukensis*) in Arctic muskox populations (Kutz et al. 2005). Additional effects of climate change include shifting vegetation communities. Some shifts in vegetation communities may be beneficial to muskox, particularly increases in shrubby vegetation which constitutes much of the muskox's seasonal diet (Gunn and Sutherland 1997; Larter and Nagy 2004; Kristensen et al. 2011).

Distribution and Migration Patterns

Muskox herds are larger in winter (average of 28 individuals) as compared to the summer (average of 12 individuals; Gunn and Fournier 2000), likely because suitable forage sites are limited by snow depth and as a defensive strategy against wolf predation (Heard 1992).

These animals have relatively small seasonal home ranges but can move relatively long distances, up to 140 km, between summer and winter ranges (P. E. Reynolds 1998; Gunn and Fournier 2000). In the winter, muskox home range size varies from 27 to 70 km^2 and in the summer the average home range size is 223 km^2 (P. E. Reynolds 1998). Reflecting their small home ranges, muskox are relatively sedentary in winter, moving on average 1 to 1.5 km/day. Muskox move about twice that distance in summer (average of 2.6 km/day), and movement rates are highest when plant biomass is greatest (P. E. Reynolds 1998). A high degree of fidelity to geographic areas observed in Nunavut populations may explain the observation that range contraction does not appear to be correlated with large scale population declines (Dumond 2007; Nagy, Gunn, and Wright 2009).

Habitat Use

Muskox generally calve between late March and late May before vegetation has greened. During the calving and post-calving periods, muskox show a high degree of selectivity for moist sedge meadows and upland areas with willows as the emergent leaves are more nutritious than later in the season (P. E. Reynolds, Wilson, and Klein 2002). Muskox are sensitive to disturbance during the calving season (Gunn 1984).

Survival and calf productivity of muskox is highly dependent on forage availability in winter (P. E. Reynolds, Wilson, and Klein 2002; Barboza and Reynolds 2004). To conserve energy, muskox reduce movements in winter, and thus, sites chosen for overwintering must contain adequate forage to support nutritional requirements. Key characteristics of overwintering sites that maintain the nutritional status of muskox are sites where sedges and grasses are abundant but where snow depth is low (Heard 1992; P. E. Reynolds, Wilson, and Klein 2002; Gustine et al. 2011). Typically these sites are lower elevation riparian corridors with windblown vegetated bluffs (P. E. Reynolds, Wilson, and Klein 2002).

9.2.7.2 Baseline Data for Muskox

Three forms of baseline studies were conducted for muskox in the RSA:

1. Aerial surveys conducted between 1996 and 2011;
2. Motion triggered camera studies in the RSA between 2012 and 2015; and
3. Habitat suitability modeling.

Incidental observations of muskox were also recorded during field studies in the RSA and by site personnel near infrastructure. These observations were used to supplement information on distribution of muskox within the RSA.

Aerial Surveys

Methods

From 1996 to 2011, observations of muskox were recorded during aerial surveys for caribou, following the same methods (Section 9.2.6.5); recording location, group size and composition (number of adults and calves). Surveys were divided into two seasonal periods:

- Spring through Autumn ("Summer"; June 1 to October 31); and
- Winter (November 1 to May 31).

Approximately ¾ of surveys (39 surveys) were conducted during the summer (spring through autumn) relative to winter (15 surveys), largely due to better weather for surveying during the spring, summer, and fall. Table 9.2.16 for survey dates and seasonal periods.

Density estimates for the RSA were calculated for each survey. Density estimates were not corrected for detection bias because muskox observability was deemed high within the 500 m survey strip on either side of the aircraft.

Results

In general, the muskox density in the RSA was low and variable in all survey years (Table 9.2-16; Figure 9.2-20). The density during all seasons averaged 0.049 ± 0.006 /km^2 and on several surveys no muskox were observed (Table 9.2-16). Across all years, density during the winter period was similar (0.042 ± 0.010 /km^2) to the summer period (spring through autumn; 0.051 ± 0.008 /km^2; t-test, p=0.22). These densities are similar to those reported in MX-07 on Victoria Island of 0.07 ± 0.03, but lower than those reported in MX-11 near Kugluktuk of 0.2 ± 0.12/ km^2 (Leclerc 2015b)

The distribution of muskox in the RSA varied between seasons. During the summer (spring to autumn) period, muskox were relatively evenly distributed in the RSA (Rescan 2010, 2011c, 2011f). During the winter, muskox were primarily observed along the coast in the northern portion of the RSA and south of Boston property (Rescan 2010, 2011c, 2011f). Muskox calves along with adults were spotted primarily in the spring through summer months and were evenly distributed in the study area when data from all years are combined (Rescan 2010). Calves averaged 3% of the muskox observed on survey across all years, but the detection of calves within individual years varied substantially, with no calves detected in 2000, from 2002 to 2004, and from 2009 to 2011, to roughly 11% of individuals counted as calves on surveys in 1996 (44 of 383 muskox, 11.5%) and 2007 (2 of 17 muskox; 11.8%).

Camera Monitoring

Methods

Muskox activity in the RSA was recorded using motion triggered wildlife cameras from September 2012 to September 2016. Camera methods followed those for caribou, as described in Section 9.2.6.2.

For muskox, camera monitoring data were used to:

1. Characterize muskox activity in the RSA;
2. Examine muskox use of areas within the RSA on a seasonal basis; and
3. Document the potential existing interaction with the Doris Project infrastructure.

Table 9.2-16. Aerial Survey Results for Muskox in the RSA, 1996 to 2011

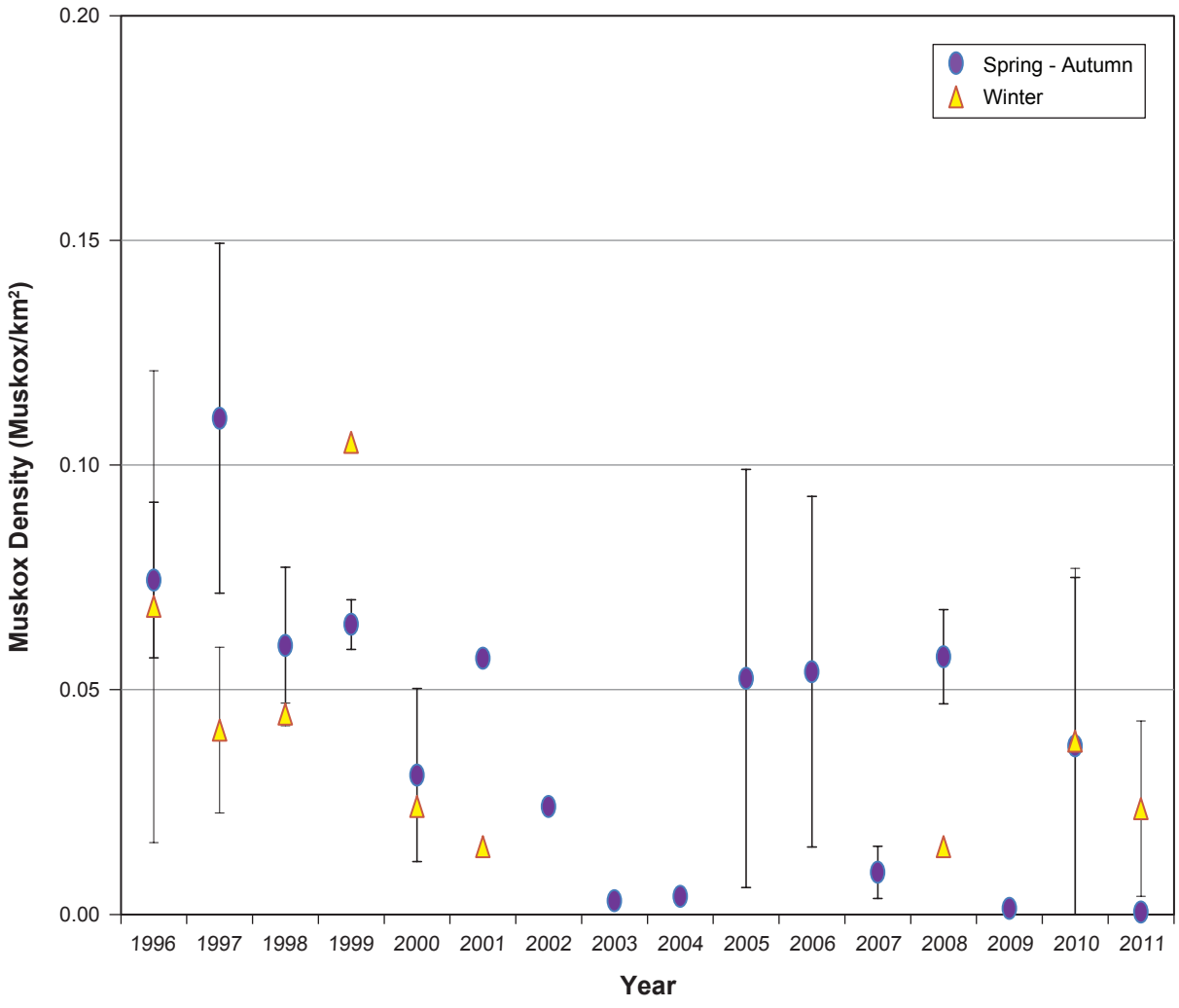
Year	Month	Date	Survey Category	Number of Transects Surveyed	Transect Length (km)	Transect Width (km)	Total Transect Area (km^2)	Total Number of Muskox Observed (on transect)	Estimated Muskox Density ($Ind./km^2$)
1996	May	31	Winter	22	30	1	584.5	71	0.121
	June	20, 21	Spring - Autumn	26	30	1	674.5	57	0.085
	July	3	Spring - Autumn	26	30	1	674.5	32	0.047
	July	19	Spring - Autumn	26	30	1	674.5	33	0.049
	July	23	Spring - Autumn	26	30	1	480	66	0.138
	Oct	18, 19	Spring - Autumn	26	30	1	300	16	0.053
	Nov	27, 28	Winter	26	30	1	674.5	11	0.016
1997	Feb	12, 13	Winter	26	30	1	674.5	52	0.077
	May	30	Winter	26	30	1	674.5	20	0.030
	June	21	Spring - Autumn	26	30	1	674.5	13	0.019
	July	14	Spring - Autumn	26	30	1	674.5	46	0.068
	July	23	Spring - Autumn	26	30	1	674.5	39	0.058
	Aug	18	Spring - Autumn	26	30	1	674.5	140	0.208
	Sept	11	Spring - Autumn	26	30	1	674.5	134	0.199
	Nov	28, 29	Winter	26	30	1	674.5	11	0.016
1998	Feb	28	Winter	26	30	1	674.5	32	0.047
	June	2	Spring - Autumn	26	30	1	674.5	53	0.079
	June	25	Spring - Autumn	26	30	1	674.5	35	0.052
	July	11	Spring - Autumn	26	30	1	674.5	78	0.116
	Aug	19, 20	Spring - Autumn	26	30	1	674.5	24	0.036
	Oct	15	Spring - Autumn	26	30	1	674.5	11	0.016
	Dec	2, 3	Winter	26	30	1	674.5	28	0.042
1999	Feb, Mar	28, 1	Winter	26	30	1	674.5	71	0.105
	June	20	Spring - Autumn	26	30	1	674.5	40	0.059
	July	11	Spring - Autumn	26	30	1	674.5	47	0.070
2000	May	18, 19	Winter	26	30	2	1349	32	0.024
	June	1, 2	Spring - Autumn	26	30	1	674.5	46	0.068
	June	11	Spring - Autumn	26	30	1	674.5	15	0.022
	July	20	Spring - Autumn	26	30	1	674.5	2	0.003

Year	Month	Date	Survey Category	Number of Transects Surveyed	Transect Length (km)	Transect Width (km)	Total Transect Area (km^2)	Total Number of Muskox Observed (on transect)	Estimated Muskox Density ($Ind./km^2$)
2001	May	23	Winter	23[1]	30	1	584.5	9	0.015
	June	9	Spring - Autumn	23[2]	30	1	652.5	37	0.057
2002	June	8, 9	Spring - Autumn	26	30	1	674.5	16	0.024
2003	June	8, 9, 10	Spring - Autumn	26	30	1	674.5	2	0.003
2004	June	11	Spring - Autumn	26	30	1	674.5	3	0.004
2005	June	26, 27, 29	Spring - Autumn	26	30	1	674.5	4	0.006
	Aug	10	Spring - Autumn	26	30	1	674.5	67	0.099
2006	June	14	Spring - Autumn	10	60	1	600	9	0.015
	July	6	Spring - Autumn	10	60	1	600	56	0.093
2007	June	17	Spring - Autumn	10	60	1	600	5	0.008
	June	29	Spring - Autumn	10	60	1	600	0	0.000
	Aug	3	Spring - Autumn	10	60	1	600	12	0.020
2008	May	15, 16	Winter	10	60	1	600	9	0.015
	June	29	Spring - Autumn	10	60	1	600	43	0.072
	July	6	Spring - Autumn	10	60	1	600	38	0.063
	Sept	15, 16	Spring - Autumn	10	60	1	600	22	0.037
2009	June	8, 9	Spring - Autumn	12	60	1	720	1	0.001
2010	April	5, 6	Winter	16	60	1	960	65	0.077
	May	11	Winter	16	60	1	960	0	0.000
	July	24, 25	Spring - Autumn	16	60	1	845[3]	63	0.075
	Sept	13, 14	Spring - Autumn	16	60	1	845[3]	0	0.000
2011	April	18, 19	Winter	16	60	1	960	36	0.043
	May	21, 22	Winter	16	60	1	960	3	0.004
	July	9, 10	Spring - Autumn	16	60	1	845[3]	0	0.000
	August	15, 16	Spring - Autumn	16	60	1	845[3]	1	0.001

[1] *The three southern transects were omitted*
[2] *The three northern transects were omitted*
[3] *Northern transects were not flown over open water.*

Figure 9.2-20

Muskox Densities in the Aerial Survey Area between 1996 and 2011



Note: Error bars represent standard error of the mean.

Results

A total of 44 to 59 cameras were deployed in the RSA between 2012 and 2016 and recorded muskox over a total period of 1,453days. In general, muskox events on photos from motion-triggered cameras were rare, with a total of only 24 events during those 1,453days (Table 9.2-17a). While cameras were deployed on the tundra in 2012, no muskox events were recorded by motion-triggered cameras until the winter of 2013/2014 (Table 9.2-17a).

Table 9.2-17a. Muskox Detection Summary across All Cameras, September 2012 to September 2016

Survey Period	Camera Location	No. Events[1]	No. Events/Camera/Day[1]	No. Ind. Recorded on Events[1, 2]
1 (2012-2013)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
2 (2013)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
3 (2013-2014)	On-site	0	0	0
	Off-site	4	0.0005	12
	All Cameras	**4**	**0.0003**	**12**
4 (2014)	On-site	7	0.0034	58
	Off-site	7	0.0028	10
	All Cameras	**14**	**0.0030**	**68**
5 (2014-2015)	On-site	0	0	0
	Off-site	3	0.0003	4
	All Cameras	**3**	**0.0002**	**4**
6 (2015)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
7 (2015-2016)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
8 (2016)	Zone 1	0	0	0
	Zone 2	3	0.0012	7
	Zone 3	0	0	0
	All Cameras	**3**	**0.0006**	**7**

[1] *Event data are not corrected for camera effort or for darkness factor.*
[2] *the number of individuals does not represent total number of individuals recorded across all events, as multiple events can be of the same individual/group utilizing the area surrounding the wildlife camera.*

Small and large groups of muskox individuals were recorded on motion-triggered images. Single individuals were recorded on 10 of 24 events (42%). Groups of two to five individuals were recorded on 11 events (46%), and the remaining three events consisted of observations of nine to twenty individuals. All events of large groups (9 to 20 individuals) were recorded at a single camera (Camera 1b) during the summer period of 2014. It is important to note that the total individuals recorded across events do not necessarily represent detections of unique individuals, as it is possible that the same individual(s) was

recorded in multiple events. Further, events may not have recorded all individuals in a group; even if they were present they may have been out of camera view.

Seasonal Differences

Few seasonal trends for muskox are apparent from the camera data, as events were recorded sporadically over time. Detections appear to be more consistently recorded during the spring and summer (Weeks 23-29, roughly June and July) although very few events were recorded during these periods (1 – 7 events per week number when corrected for the darkness factor; Table 9.2-17b).

Table 9.2-17b. Muskox Detection Summary across All Cameras by Week Number, June 2013 to September 2016

Month (Approx)	Week Number	No. Events (Raw)	No. Events (Corrected)[1]	Event Recording Rate (Events/100 Camera Days)[2]
January	1	1	1.26	0.59
	2	0	0	0
	3	0	0	0
	4	0	0	0
	5	0	0	0
February	6	0	0	0
	7	0	0	0
	8	0	0	0
	9	0	0	0
March	10	0	0	0
	11	0	0	0
	12	0	0	0
	13	0	0	0
April	14	2	2.2	0.30
	15	0	0	0
	16	0	0	0
	17	0	0	0
May	18	0	0	0
	19	0	0	0
	20	2	2.08	0.26
	21	0	0	0
	22	0	0	0
June	23	1	1	0.11
	24	3	3	0.34
	25	2	2	0.17
	26	0	0	0
July	27	0	0	0
	28	5	7.21	0.48
	29	1	1.03	0.07
	30	0	0	0

Month (Approx)	Week Number	No. Events (Raw)	No. Events (Corrected)[1]	Event Recording Rate (Events/100 Camera Days)[2]
August	31	0	0	0
	32	3	3.27	0.22
	33	0	0	0
	34	0	0	0
September	35	0	0	0
	36	0	0	0
	37	0	0	0
	38	0	0	0
	39	0	0	0
October	40	0	0	0
	41	0	0	0
	42	0	0	0
	43	0	0	0
November	44	0	0	0
	45	0	0	0
	46	0	0	0
	47	0	0	0
December	48	0	0	0
	49	0	0	0
	50	2	2.6	1.11
	51	0	0	0
	52	0	0	0
	53	0	0	0

[1] *Corrected for darkness factor.*
[2] *Event recording rate calculated using the events corrected for the darkness factor.*

Incidental Observations

Methods

Methods for incidental observations of muskox followed those for caribou and are discussed in Section 9.2.6.2, and were recorded when:

1. observed by personnel near the Doris Project Site from 2009 and 2016 and recorded in the Wildlife Sighting Log; and
2. observed by field environmental personnel (wildlife biologists and other environmental personnel) recorded spatially or temporally outside of targeted VEC studies when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016.

Results

Incidental Observations of Muskox by Site Personnel

Incidental observations of muskox were recorded by site personnel in the Wildlife Sightings Log during all years, 2009-2016 (Table 9.2-18). Across years, muskox were observed in the RSA during most months

of the year (Table 9.2-18). Many observations of muskox were in large groups of 12-65 animals (48%) while 21% were in small groups of 3-9 animals, with lone individuals or pairs making up the remaining 31% (Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Table 9.2-18. Muskox Doris Observations from the Wildlife Sightings Log Standardized by Number of Personnel on Site, 2009 to 2016

		Number of Observations*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
Year	Month	No. Individuals	No. Records		No. Individuals	No. Records
2009	Jan	0	0	69	0	0
	Feb	0	0	84	0	0
	Mar	0	0	94	0	0
	Apr	0	0	102	0	0
	May	0	0	102	0	0
	Jun	0	0	103	0	0
	Jul	24	4	113	0.21	0.04
	Aug	0	0	109	0	0
	Sep	0	0	98	0	0
	Oct	0	0	66	0	0
	Nov	0	0	16	0	0
	Dec	0	0	14	0	0
2010	Jan	0	0	83	0	0
	Feb	0	0	106	0	0
	Mar	0	0	131	0	0
	Apr	4	2	172	0.02	0.01
	May	6	1	182	0.03	0.01
	Jun	16	4	200	0.08	0.02
	Jul	9	2	220	0.04	0.01
	Aug	75	3	205	0.37	0.01
	Sep	0	0	484	0	0
	Oct	0	0	332	0	0
	Nov	0	0	147	0	0
	Dec	0	0	108	0	0
2011	Jan	0	0	214	0	0
	Feb	20	1	250	0.08	0.00
	Mar	23	2	265	0.09	0.01
	Apr	3	1	278	0.01	0.00
	May	28	3	274	0.10	0.01
	Jun	14	3	280	0.05	0.01
	Jul	19	1	284	0.07	0.00
	Aug	52	2	277	0.19	0.01
	Sep	0	0	277	0	0
	Oct	0	0	270	0	0
	Nov	1	1	252	0.00	0.00

Year	Month	Number of Observations*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
		No. Individuals	No. Records		No. Individuals	No. Records
2012	Jan	1	1	183	0.01	0.01
	Feb	1	1	193	0.01	0.01
	Mar	0	0	180	0	0
	Apr	0	0	127	0	0
	May	3	3	90	0.03	0.03
	Jun	7	3	103	0.07	0.03
	Jul	0	0	90	0	0
	Aug	74	2	93	0.80	0.02
2013	Mar	0	0	3	0	0
	Apr	27	1	13	2.06	0.08
	May	0	0	20	0	0
	Jun	3	1	44	0.07	0.02
	Jul	20	2	61	0.33	0.03
	Aug	0	0	59	0	0
	Sep	0	0	54	0	0
	Oct	0	0	49	0	0
	Nov	0	0	19	0	0
	Dec	0	0	8	0	0
2014	Jan	0	0	7	0	0
	Feb	0	0	7	0	0
	Mar	0	0	8	0	0
	Apr	0	0	14	0	0
	May	0	0	63	0	0
	Jun	75	4	71	1.05	0.06
	Jul	0	0	77	0	0
	Aug	0	0	79	0	0
	Sept	0	0	73	0	0
	Oct	0	0	79	0	0
	Nov	0	0	44	0	0
	Dec	0	0	7	0	0
2015	Jan	2	1	13	0.15	0.07
	Feb	2	1	16	0.12	0.06
	Mar	0	0	30	0	0
	Apr	0	0	28	0	0
	May	0	0	32	0	0
	Jun	0	0	41	0	0
	Jul	0	0	46	0	0
	Aug	0	0	84	0	0
	Sep	0	0	105	0	0
	Oct	0	0	114	0	0

Year	Month	Number of Observations*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
		No. Individuals	No. Records		No. Individuals	No. Records
	Nov	0	0	93	0	0
	Dec	40	1	89	0.45	0.01
2016	Jan	85	2	60	1.41	0.03
	Feb	0	0	73	0	0
	Mar	0	0	78	0	0
	Apr	0	0	93	0	0
	May	0	0	110	0	0
	Jun	0	0	123	0	0
	Jul	0	0	123	0	0
	Aug	0	0	129	0	0
	Sep	60	1	144	0.42	0.01
	Oct	30	1	158	0.19	0.01
	Nov	100	4	172	0.58	0.02
	Dec	105	3	169	0.62	0.02

** Whether or not wildlife are recorded can vary by factors other than number of personnel on site, e.g., the type of animal, multiple reporting of same individuals by different observers, work activities (indoor vs outdoor; site-based vs field-based), number of daylight hours, visibility, novelty of the sighting, observer reporting enthusiasm, ability to identify animal, etc.*

***Personnel were on site in all months between 2009 and December 2016 except October – December 2012. Personnel totals do not include personnel at Boston Site.*

In several cases, muskox were observed to have established residence on or near the Doris site. Recent examples of this behaviours are from June, 2014 where a group of muskox with calves took up residence adjacent to the Doris Site for a period of a few weeks and winter 2016 where a large group (20-50 individuals) were spotted sporadically near the Doris Site through November and December. As explained in the caribou section 9.2.6.2, incidental observations by site staff may include multiple reports of the same individual(s), and for this and numerous other reasons outlined previously, incidental data cannot be used for reliable density or abundance estimation.

Incidental Observations of Muskox by Field Personnel

Field personnel reported muskox observations in the RSA during all years, 2006-2015. No muskox were reported by field personnel in 2016, however wildlife biologists were at site for less time in 2016 relative to other years. No general trends were detected in these observations (Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Habitat Suitability Modeling

Methods

Habitat suitability modeling within the LSA and RSA was conducted for muskox. Details on habitat suitability modeling methodology is discussed in Section 9.2.6.5 and detailed in Appendix V4-9A. Habitat suitability for muskox was assessed for late winter/early spring (April to June) and summer/fall (August through September). The life requisites assigned to late winter/early spring habitat were living and reproducing, while the only life requisite assigned to fall habitat was living (Table 9.2-19).

Table 9.2-19. Seasonal Life Requisites of Muskox

Season	Months	Life Requisite	Habitat Preference
Late Winter and Early Spring	April – June	Living and Reproducing	Sedge, esker, riparian shrub, heath tundra
Summer and Fall (Rutting)	August – September	Living	Wetlands, riparian communities, valleys/lowlands

Results

Habitat suitability modeling based on ecosystem mapping data indicated that the majority of the LSA was rated as moderate value for late winter/early spring (53.1%) habitat and high value (61.7%) during the summer and fall (Table 9.2-20). The smaller quantity of high value habitat in the LSA in late winter/early spring (13%) is a product of muskox's' selection for specific forage sites that have limited snow depth and early developing forage; these habitats are not as prevalent in the LSA as compared to regions east and west of the Belt (Figure 9.2-21).

Table 9.2-20. Area and Percentage of Seasonal Habitat within the Local Study Area and Regional Study Area for Muskox

		Local Study Area[1]		Regional Study Area[2]	
Season	Suitability Rating	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Late Winter and Early Spring	High	7,327.5	13.0%	102,612.5	20.9%
	Moderate	29,901.9	53.1%	9,517.3	1.9%
	Low	11,962.1	21.3%	148,810.9	30.3%
	Nil	7,085.5	12.6%	226,039.5	46%
Summer and Fall (Rutting)	High	34,729.1	61.7%	41,810.1	8.5%
	Moderate	10,982.1	19.5%	279,496.9	56.8%
	Low	4,157.9	7.4%	107,949.8	21.9%
	Nil	6,407.9	11.4%	57,723.7	11.7%

[1] *LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the Terrestrial Ecosystem Mapping data (see Section 9.2.3-10).*
[2] *RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.10). A total of 4,843.7 ha were categorized as unclassified likely due to coverage of the imagery by cloud cover.*

Habitat suitability modeling based on the WKSS ecosystem classification indicated that approximately 21% of the RSA contains high value later winter and early spring habitat, with the majority classified as low (30%) or nil (46%; Table 9.2-20). High value winter and early spring muskox habitat was located primarily in the west and northeast side of the RSA (Figure 9.2-21). Over half of the RSA (56.8%) was rated moderate value as summer/fall habitat for muskox and only 8.5% of the RSA was classified as high value summer/fall habitat for muskox (Table 9.2-20), primarily located east of the Boston Development Area (Figure 9.2-22).

9.2.7.3 The Doris Project

Between 1996 and 2004, exploration occurred in the Hope Bay Belt, based out of the Windy Lake camp. In 2006, a project certificate was issued for the Doris Project. Construction began in 2009, but was put into care and maintenance following changes in market conditions in 2010, and was re-opened for additional construction and resource exploration in 2015.

The WMMP for the Doris Project included monitoring of muskox for avoidance of the Doris Project site and any direct mortality due to collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Surveying and monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance phases since 2006, as part of the ongoing WMMP. This section summarizes the results of these monitoring activities for muskox.

Sensory Disturbance

In the years that personnel have been at the Doris Project site (2006 to 2016), one muskox disturbance event has occurred at the Doris Project. The incident was noted due to abnormal behaviour elicited by a muskox herd, requiring use of deterrents. On June 11, 2014 a herd with several calves spent several days foraging and resting in an area adjacent to the Doris helipad and the main Doris road. The ESR Department was concerned that the noise of a starting helicopter would cause the muskox group to stampede and injure the young (ERM 2015b). The Cambridge Bay Wildlife Officer was contacted and asked for advice and the muskox were deterred following this advice.

The response included forming a line of people that walked slowly towards the group of muskox from a direction that encouraged them to move away and to higher ground (their preference is to be on high ground). The muskox continued movement, stopping occasionally to circle. When the muskoxen ceased movement, advances from the line of people ceased to avoid use of defensive behaviour or charging by muskoxen. Noise (clapping/calling or the air horn) was used to encourage movement. No further incidents occurred, and the muskoxen moved off-site.

Aerial surveys were conducted for caribou between 1996 and 2010. The number of muskox recorded during aerial surveys was too low to estimate avoidance of the Doris Project site by calculating a zone of influence.

A wildlife camera monitoring program was implemented in 2012 with the objective of monitoring the distribution of VEC species in the Program study area (to determine a ZOI) and to monitor for potential interactions between VEC species and the area immediately surrounding Doris Project infrastructure. As part of this program, muskox interactions with Doris Project infrastructure have also been assessed to determine potential effects of sensory disturbance on muskox. Detections of muskox by wildlife camera were rare (21 events since 2012). These data did not indicate a trend towards fewer muskox near the Doris Project, but there were too few detections for a comprehensive statistical analysis.

Direct Mortality

Any wildlife mortality observed by onsite personnel are reported immediately to the ESR Department and in the annual WMMP report. Mortality of VECs or larger fauna, or mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE and KIA, as necessary.

In the years that personnel have been at the Doris Project site (2006-2016), there have been no reports of any muskox morality of any sort, including from vehicle and aircraft strikes. The on-site speed limits for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to muskox (Jalkotzy, Ross, and Nasserden 1997). These results indicate that there has been no effect of direct mortality on muskox due to the Doris Project (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Figure 9.2-21
Muskox Winter / Early Spring Habitat Suitability in the Local Study Area and Regional Study Area

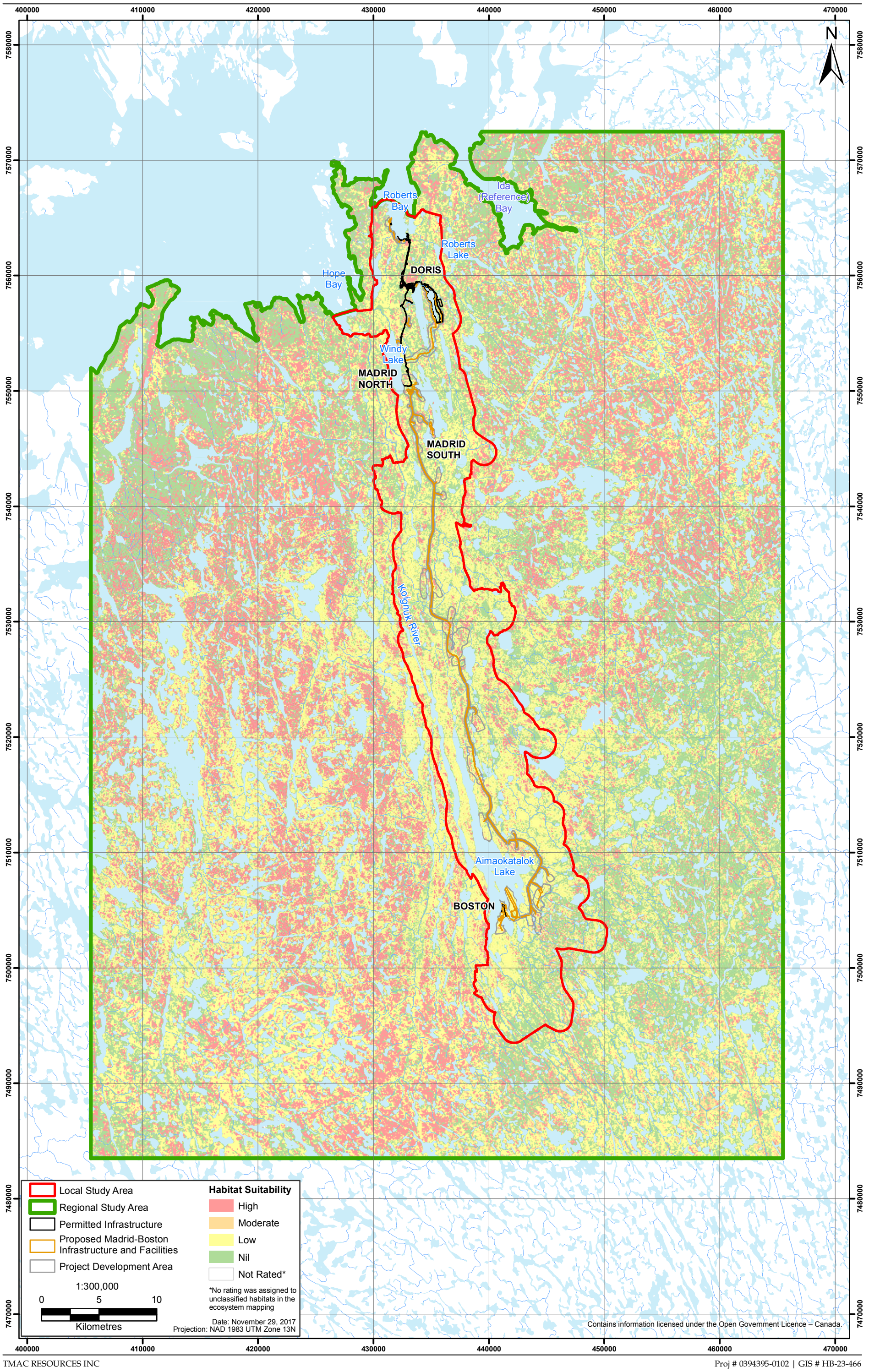
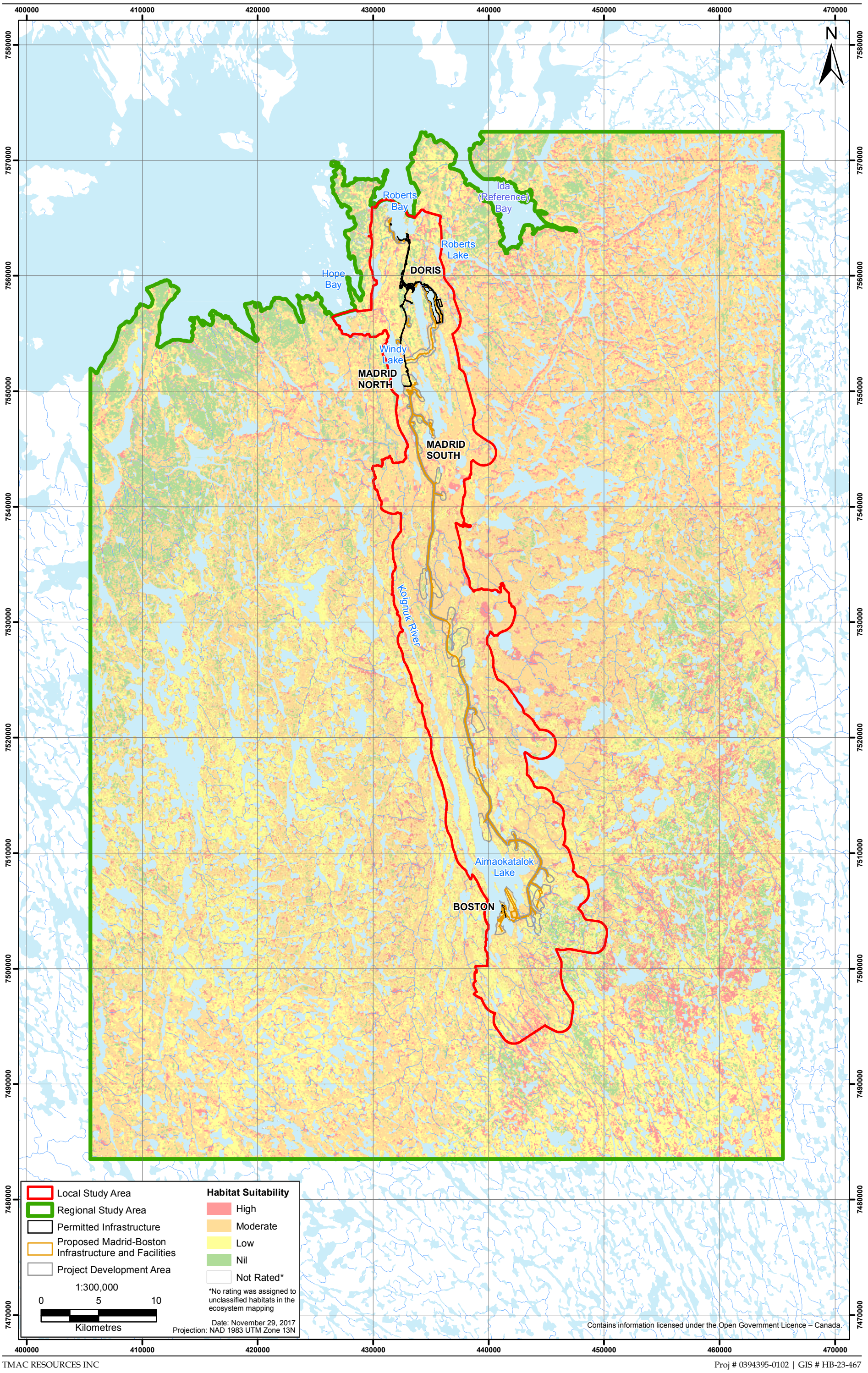


Figure 9.2-22
Muskox Summer / Fall (Rutting) Habitat Suitability in the Local Study Area and Regional Study Area



Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on muskox due to Doris Project activities.

9.2.8 Characterization of Baseline Conditions for Grizzly Bear

9.2.8.1 Introduction

Barren-ground grizzly bears (*Ursus arctos horribilis*) inhabit the northern extent of the grizzly bear range in North America. Barren-ground populations of grizzly bears are designated as a species of Special Concern by COSEWIC, but are not listed under *SARA* (COSEWIC 2012c). In Nunavut, the grizzly bear is listed with a range rank of Vulnerable to Apparently Secure(GNWT ENR 2006; CESCC 2016).

Grizzly bears are respected by Inuit and many legends and stories exist about them (Banci and Spicker 2016). Traditionally, grizzly bears were hunted for meat and fat typically in spring or fall before denning (Banci and Spicker 2016).

Population Trends and Conservation

In the Canadian Arctic, the most recent analysis of population trends for grizzly bears indicated a stable or slightly increasing population (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). There is no official estimate on grizzly bear population sizes for the West Kitikmeot region of Nunavut where the Hope Bay Project is located; however, a rough estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which includes the RSA (which is 4,918 km^2) (Ross 2002). In 2011, an estimate of 1,530 – 2,000 individuals was produced for Nunavut (COSEWIC 2012c).

Grizzly bears are long lived animals characterized by low reproductive rates due to a late age of maturity, small litter sizes, and long intervals between litters (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). These life history traits generally limit the resilience of grizzly bear populations to human disturbance (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). The stability of grizzly bear populations in the Arctic may be dependent on several factors including mortality due to hunting and human-related activities, low reproductive productivity, and general health of individuals. Productivity and general health of grizzly bears may in turn be influenced by access to high value habitat and nutritional sources, exposure to contaminants, and climate change.

Barren-ground grizzly bear populations may be at risk of decline if annual harvests and human activity are increased (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). There are currently no total allowable harvest (TAH) guidelines for subsistence harvesting of grizzly bear in Nunavut (GN DOE 2012). In 2007, the GN DOE recommended a TAH of six grizzly bears, including problem kills, from the Bathurst Inlet population (GN DOE 2007). Grizzly bears may be harvested in a ratio of two males to one female, but harvest is not recommended for females accompanied by cubs given poor survival rates of orphaned cubs (GN DOE 2005). Based on reported harvest in the Kitikmeot Region from 2000-2012, the number of grizzly bears harvested was roughly stable from 2000-2008 with on average of 15 bears harvested, with a slight decrease at the end of the reporting period in 2009 (8 bears), 2010 (4 bears), 2011 (4 bears), and 2012 (10 bears) (GN DOE 2012). This result is reflected by Inuit TK, which indicated that use of grizzly bears for meat, fat, and pelts appears to have decreased recently decades (Banci and Spicker 2016). The GN DOE indicates that the level of harvested is within recommended limits as

suggested by McLoughlin and Messier (2001), who indicated that removal of 15 bears within the Kitikmeot region would be sustainable. GN DOE (2012) concluded that the level of harvest seems to be sustainable and also that the population in the Kitikmeot Region appears to be relatively stable or slightly increasing. During the caribou workshops in 2016 and 2017, Elders and harvesters commented that predator numbers (wolves and bears) have been increasing over time.

Climate change may affect populations of barren-ground grizzly bears. One of the most important changes in the Arctic as a result of recent warming trends, is an increase in the biomass of shrub species, such as birch, willow, and alder (Myers-Smith et al. 2011; Tremblay, Lévesque, and Boudreau 2012; Frost et al. 2013), which will have important implications for the structure and function of Arctic ecosystems. The increase in plant cover may provide additional nutritional resources for ungulates and other species on which grizzly bears prey. However, it is unclear how climate change may interact with other human-related activities such as industrial development, changes in contaminant exposures and the viability of barren-ground populations of grizzly bears (Parmesan, Root, and Willig 2000; Parmesan 2006).

Distribution and Movement Patterns

Grizzly bears are distributed across the tundra in the Canadian Arctic. Barren-ground grizzly bears have large home ranges and exist at low densities compared to other grizzly bear populations in more productive southern ecosystems (McLoughlin 2000). Average home range sizes derived from satellite collar data varied from 2,100 km^2 for females to 7,245 km^2 for males, and home ranges of individuals overlapped more than those reported in southern latitudes (McLoughlin, Ferguson, and Messier 2000; McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003). Density estimates of grizzly bears in Northwestern Nunavut are approximately 4 bears per 1,000 km^2 (Ross 2002). Recent studies using mark-re-capture techniques in northwestern Nunavut near Kugluktuk indicate that the density may be slightly higher, with an estimated 5 bears per 1,000 km^2 (Dumond, Boulanger, and Paetkau 2015).

Traditional knowledge indicates that grizzly bears are found throughout the RSA (Banci and Spicker 2016). Traditional knowledge also indicates that major grizzly bear movements occur within the RSA in association with major river systems, watersheds and coastal areas (Thorpe et al. 2001; Banci and Spicker 2015, 2016).

Inuit TK indicates that grizzly bears in the Hope Bay Project area build their dens in slopes of river banks and around the coast. Most of the denning habitat indicated by TK occurs just south of the Elu Peninsula, as well as areas close to the Perry River and Omingmaktok (Banci and Spicker 2016).

9.2.8.2 Baseline Data for Grizzly Bears

Five baseline studies were conducted to document the activity of grizzly bears in the RSA:

1. population-estimation using DNA mark-recapture protocols;
2. motion triggered camera monitoring;
3. carnivore den surveys;
4. habitat plot surveys; and
5. habitat suitability modelling.

In addition, observations of grizzly bears were reported incidentally by field staff during other studies conducted in the RSA and by Hope Bay Project personnel. Grizzly bears were detected in the RSA between 1996 and 2015.

DNA Mark-Recapture

Methods

DNA fingerprinting using hair has been used extensively to estimate bear populations through mark and recapture techniques (Woods et al. 1999; Mowat and Strobeck 2000; K. G. Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger, McLellan, et al. 2004; Proctor et al. 2005). Roots of mammalian hair contain sufficient DNA for analysis (Higuchi et al. 1988) and bears frequently leave hair on rub trees, in beds, and at foraging sites (Taberlet et al. 1993). Bears are readily attracted by scent lures, permitting methods to obtain hair samples from free-ranging bears using systematic sampling regimes necessary for many ecological studies, such as animal censuses (Woods et al. 1999).

In mark-recapture studies, an initial population sample is "marked", which corresponds to the bears detected in the first round of hair sampling. The population is then resampled one or more times (Woods et al. 1999). The ratio of newly captured animals to recaptures is used to compute a population estimate (G. C. White et al. 1982). The benefits of this method are that 'marking' of bears through live capture or other invasive methods is unnecessary, individuals can be identified with a small risk of error, and hair capture sites are faster to set up and are checked less often than live-capture sites (Woods et al. 1999; Mowat and Strobeck 2000; K. G. Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger, McLellan, et al. 2004).

Bears traverse in and out of the study area over the period of the study which violates the assumption of geographic closure in most studies that use mark-recapture or related methods (S. D. Miller et al. 1997). In these cases, abundance estimates are derived from mark-recapture analysis that calculate a "super-population" based on detection frequencies, under the model assumptions that movement is random across grid boundaries (Kendall 1999). In the context of mark-recapture DNA studies, the super-population is defined as the number of animals that inhabit the sampling grid and surrounding area (as opposed to the grid alone; Boulanger, McLellan, et al. 2004). The population estimate is only the number of animals estimated to be on the study area during the sampling period, and is not intended as a true population estimate or for the calculation of population density. Under a trend monitoring objective, however, an absolute abundance or density estimate is not necessary, and the assumptions of population closure can be relaxed (Apps 2010).

A DNA based mark-recapture program for grizzly bears was conducted in 2010 and 2011 using scent-baited hair capture stations arranged in a grid of cells surrounding the Hope Bay Project (Rescan 2012a). In 2010, the study area consisted of 37 cells (10 km by 10 km, cells 1 - 37) surrounding the Doris Site (Figure 9.2-23). During the last two sampling periods in 2010, an additional 12 cells were added to incorporate the Boston area (cells 38 to 49; Figure 9.2-23), increasing the study area to approximately 5,000 km^2. In 2011, the study area increased to 6,500 km^2 (65 cells) to accommodate the potential future activities around the Boston area (Figure 9.2-24).

Each cell within the DNA grid contained a baited post to attract bears, which would investigate the post and leave hairs on barbed wire wrapped around the post. Posts were placed near to the center of each cell, in locations likely to intercept bears, based on experience and input from Inuit assistants. The posts were checked and re-baited six times during each summer. Individual bears were identified from their DNA in the sampled hairs and a super-population estimate was calculated from the proportion of bears that returned to the posts during the summer (Rescan 2012a). As a result of changes to the grid between years, the super-population estimate was calculated only for the original northern portion (37 cells) of the study area (Doris). Details of the methods, including model assumptions about mortality and emigration, are reported in the 2011 interim Grizzly Bear DNA Report (Appendix V4-9B) (Rescan 2011a) and the 2012 Final Grizzly Bear DNA Report (Appendix V4-9C; Rescan 2012a).

Results

A total of 411 hair samples were collected from the Doris sampling grid (37 cells) during the 2010 field program. DNA was successfully extracted from 163 (40%) of the 411 samples and assigned to 31 individuals; 17 males and 14 females (Rescan 2011a). In 2011, a combination of increased study area, improved bait, improved sampling locations and drier weather (which minimizes DNA degradation) led to a four-fold increase in samples collected (1,623 samples). Stricter sub-selection rules resulted in a lower proportion of samples analyzed by microsatellite genotyping. Of the samples submitted in 2011, 241 samples were successfully extracted and assigned to 39 individuals (17 males and 22 females), of which 18 were recaptures (7 males and 11 females) from 2010 (Rescan 2012a).

Within the entire study area, a total of 52 grizzly bears (27 males and 25 females) were identified over the two year program (Rescan 2012a). One grizzly bear from this study was also sampled at another development project 200 km southwest of the Hope Bay Project area (Rescan 2014). Within the Doris study area (37 cells) 41 grizzly bears were detected (2010 and 2011) and the super-population was estimated to be 45 bears (25 males, and 20 females) in 2010 and 31 bears (13 males and 18 females) in 2011. Population analyses based on the DNA based mark-recapture inventories reflect a more reliable indication of population status relative to incidental observations, which are a poor reflection of population status because a single individual or family unit may be recorded on multiple occasions, and only those animals that are close to mine infrastructure are likely to be observed.

Camera Monitoring

Methods

Grizzly bear activity in the RSA was monitored using motion triggered wildlife cameras from September 2012 to August 2015. Methodology regarding camera deployment locations and analyses are identical to those conducted for caribou and are described in Section 9.2.6.2.

For grizzly bear, camera monitoring data were used to:

1. Characterize grizzly bear use of the RSA;
2. Examine seasonal grizzly bear use of areas within the RSA; and
3. Document the potential existing interaction with Doris Project infrastructure

Results

Between September 2012 and September 2016, 44 to 59 cameras were deployed in the RSA, recording a total period of 1,453days. Cameras recorded 445 grizzly bear observations (Table 9.2-21a). It is important to note that the total individuals recorded across events do not necessarily represent unique individuals, as it is very likely that the same individual(s) were recorded in multiple events.

A detailed spatiotemporal statistical analysis of the August 2014 to August 2015 camera data was conducted in 2016 for the purpose of detecting a project-related effect of the Doris Project, and was reported in the 2015 WMMP Report (ERM 2016a). Analysis indicated that grizzly bear events declined with latitude, indicating that higher numbers of grizzly bears were recorded along the coast than further inland to the south. This finding is supported by the results of the grizzly bear DNA study that indicated the northern coast of Nunavut is a productive area for grizzly bears, with an estimated detection rate of 8 to 11 bears per 1,000 km^2 (Rescan 2012a). Coastal areas may support more grizzly bears for several reasons, including productive vegetation resources, seasonal access to caribou, fish resources in the streams along the Arctic coast. In addition, grizzly bears have been observed hunting seals on the sea ice during the spring (M. Dumond, GN-DOE, pers. Comm.).

Figure 9.2-23
Grizzly Bear DNA Survey Grid and Capture Frequency in 2010

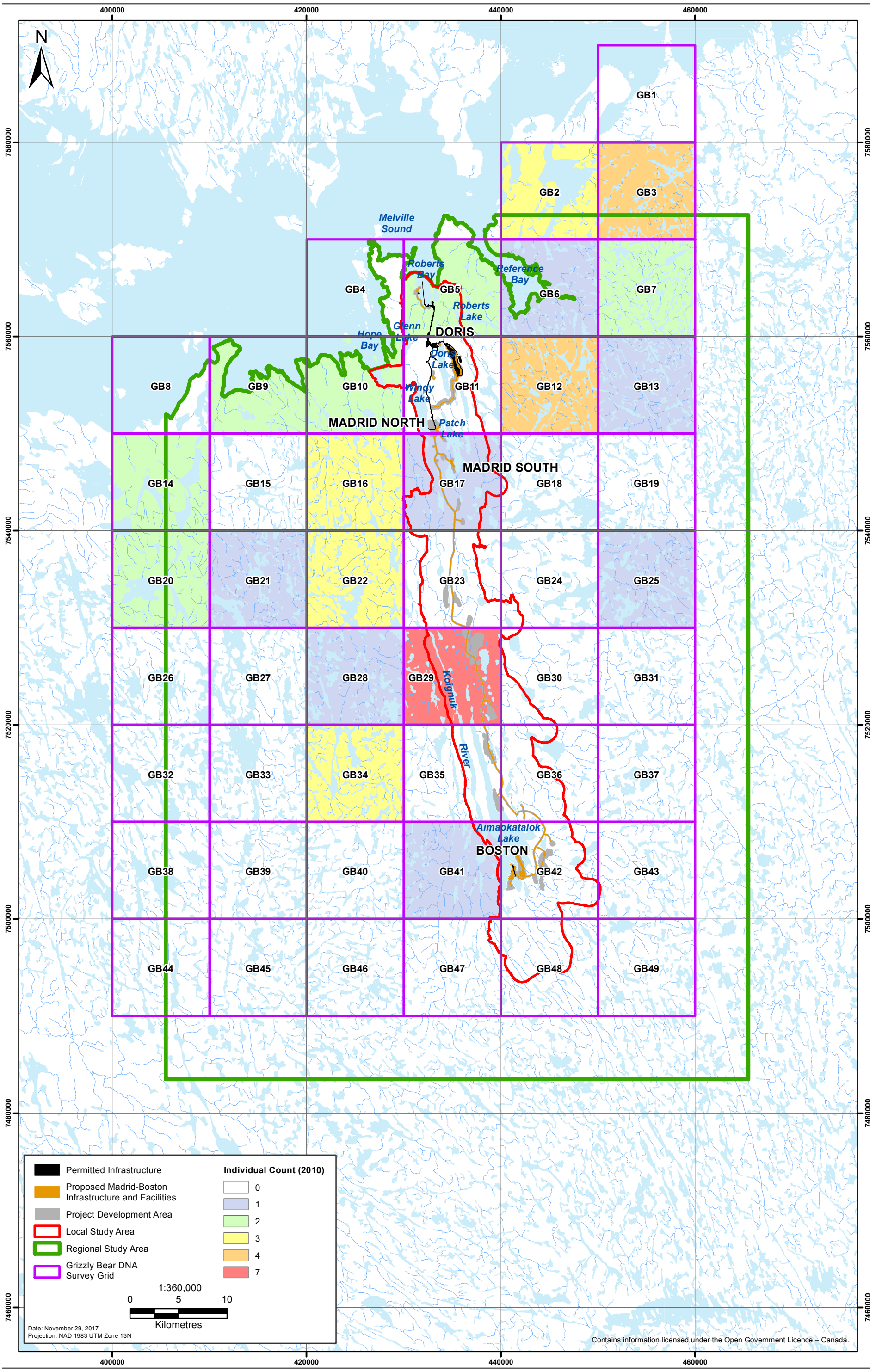


Figure 9.2-24
Grizzly Bear DNA Survey Grid and Capture Frequency in 2011

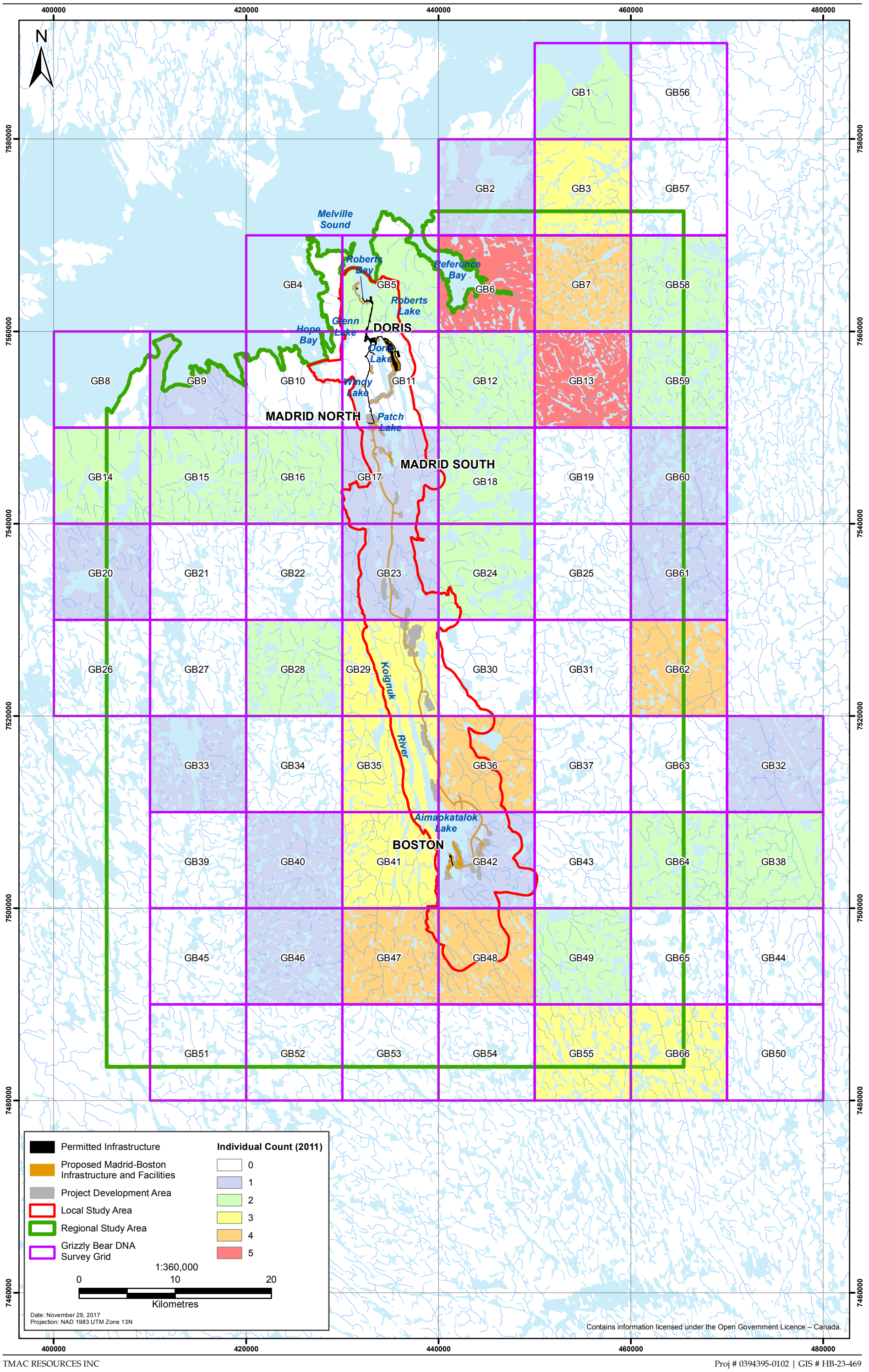


Table 9.2-21a. Grizzly Detection Summary across All Cameras, September 2012 to September 2016

Survey Period	Camera Location	No. Events (Raw)[1]	No. Events/Camera/Day[1]	No. Ind. Recorded on Events[1,2]
1 (2012-2013)	On-site	2	0.0002	3
	Off-site	6	0.0016	8
	All Cameras	**8**	**0.0007**	**11**
2 (2013)	On-site	36	0.0147	46
	Off-site	93	0.0288	139
	All Cameras	**129**	**0.0227**	**185**
3 (2013-2014)	On-site	0	0	0
	Off-site	18	0.0022	24
	All Cameras	**18**	**0.0013**	**24**
4 (2014)	On-site	37	0.018	38
	Off-site	49	0.019	51
	All Cameras	**86**	**0.019**	**89**
5 (2014-2015)	On-site	12	0.0018	12
	Off-site	23	0.0026	24
	All Cameras	**35**	**0.0023**	**36**
6 (2015)	On-site	17	0.0083	19
	Off-site	31	0.0136	36
	All Cameras	**48**	**0.0227**	**55**
7 (2015-2016)	On-site	**13**	0.002	16
	Off-site	**51**	0.005	54
	All Cameras	**64**	**0.004**	**70**
8 (2016)	Zone 1	25	0.013	29
	Zone 2	19	0.012	22
	Zone 3	13	0.007	15
	All Cameras	**57**	**0.011**	**66**

[1] *Event data are not corrected for camera effort or for darkness factor.*
[2] *The number of individuals does not represent total number of individuals recorded across all events, as multiple events can be of the same individual utilizing the area surrounding the wildlife camera.*

Seasonal Differences

The general time period when grizzly bear events were recorded across all cameras in all years and seasonal periods was mid-May (Week 19, earliest date May 10) through mid to late-October (Week 43, latest date October 25; Table 9.2-21b). Outside of October 25 to May 10, no grizzly bears were recorded in any year. These dates provide valuable local information on the times when grizzly bear enter and emerge from hibernation within the RSA. The event recording rate (events/100 camera days) peaked during the mid to late summer and early fall, with rates of roughly 2 events/100 camera days across Weeks 27-37 (roughly July through mid-September; Table 9.2-21b)

Table 9.2-21b. Grizzly Detection Summary across All Cameras by Week Number, June 2013 to September 2016

Month (Approx)	Week Number	No. Events (Raw)	No. Events (Corrected)[1]	Event Recording Rate (Events/100 Camera Days)[2]
January	1	0	0	0
	2	0	0	0
	3	0	0	0
	4	0	0	0
	5	0	0	0
February	6	0	0	0
	7	0	0	0
	8	0	0	0
	9	0	0	0
March	10	0	0	0
	11	0	0	0
	12	0	0	0
	13	0	0	0
April	14	0	0	0
	15	0	0	0
	16	0	0	0
	17	0	0	0
May	18	0	0	0
	19	4	4.16	0.52
	20	2	2.08	0.26
	21	7	7.28	0.87
	22	8	8.16	0.90
June	23	13	11	1.20
	24	15	14	1.56
	25	12	12	0.99
	26	18	17.03	1.14
July	27	25	25.75	1.71
	28	29	29.87	1.99
	29	32	32.96	2.24
	30	29	29.87	2.06
August	31	26	26.95	1.86
	32	29	31.61	2.16
	33	35	37.06	2.55
	34	29	29.43	2.00
September	35	24	26.46	1.76
	36	22	25.08	1.70
	37	30	34.2	2.36
	38	15	17.1	1.36
	39	23	26.22	2.40

Month (Approx)	Week Number	No. Events (Raw)	No. Events (Corrected)[1]	Event Recording Rate (Events/100 Camera Days)[2]
October	40	5	5.95	0.56
	41	6	7.14	0.68
	42	4	4.76	0.51
	43	3	3.57	0.42
November	44	0	0	0
	45	0	0	0
	46	0	0	0
	47	0	0	0
December	48	0	0	0
	49	0	0	0
	50	0	0	0
	51	0	0	0
	52	0	0	0
	53	0	0	0

[1] *Corrected for darkness factor.*
[2] *Event recording rate calculated using the events corrected for the darkness factor.*

Carnivore Den Surveys

Carnivore den surveys were conducted in 2014 in the area surrounding the Boston and the proposed all-weather road. Surveys were flown by helicopter at an altitude of 50 to 100 m above ground level and at speeds between 30 to 80 km/h. Additionally, all eskers within the LSA between Doris and Boston Site were flown by helicopter in 2010 to survey for active or carnivore dens.

Grizzly bear dens were not observed during carnivore den surveys conducted near Boston in 2014 (ERM, unpublished data). However, grizzly bear dens are often difficult to find as they can be shallowly dug into the tundra and show little evidence of their presence after the snow melts. Inuit TK indicates that grizzly bears in the Hope Bay Project area build their dens in slopes of river banks and around the coast. Most of the denning habitat indicated by TK occurs just south of the Elu Peninsula, as well as areas close to the Perry River and Omingmaktok (Banci and Spicker 2016).

Habitat Plot Survey

Methods

Vegetation plots were monitored from 2005 to 2008 to examine habitat use by grizzly bears in the RSA. Vegetation plots were randomly located within sedge wetland and riparian habitats, because these habitats are preferred foraging areas by grizzly bears (Gau et al. 2002; McLoughlin et al. 2002). Sedge wetland habitats were surveyed in the spring when newly growing shoots of sedges and grasses appear, and riparian plots were surveyed in late summer (Table 9.2-22). Habitat use was quantified as the proportion of vegetation plots used by grizzly bears during each year.

Each plot encompassed a 500 by 500 m area and included at least 20% cover of preferred vegetation types. Bear sign searches were initiated from the center point of each plot and were standardized to one hour in length. All bear sign, including beds, digs, tracks, scat, hair, and feeding sites, was recorded. Only fresh sign from bear activity that had occurred in the year of the survey (since den emergence) was included in the data reporting for any given year.

Table 9.2-22. Survey Dates for Grizzly Bear Habitat Use Plot Surveys, 2005 to 2008

Year	Sedge Wetland Plots		Riparian Plots	
	Survey Dates	Number of Plots	Survey Dates	Number of Plots
2006	June 15 to July 3	43	August 8 to 18	43
2007	June 19 to 26	43	August 3 to 8	43
2008	June 27 to July 4	42	July 24 to 31	43

Results

The presence of grizzly bear sign varied among the four survey years and ranged from 30 to 60% in sedge wetland habitats, and 49 and 75% in riparian shrub habitats (Table 9.2-23). The occurrence of bear sign in sedge wetlands was greatest in 2005 but within the 95% confidence limits of all other years. In general, the percentage of fresh sign per plot surveyed was comparable in riparian shrub habitats relative to sedge wetland habitats (Table 9.2-23). These surveys were discontinued after 2008 due to safety concerns for field technicians.

Table 9.2-23. Number of Wetland and Riparian Plots Containing Grizzly Bear Sign, 2005 to 2008

Habitat Type	Sedge Wetland				Riparian Shrub			
Year	2005	2006	2007	2008	2005	2006	2007	2008
Number of plots surveyed	10	43	43	42	4	43	43	43
Number of plots with sign	6	16	13	22	3	24	21	25
% plots with sign	60%	37%	30%	52%	75%	56%	49%	58%
95% confidence interval[1]	26-88%	23-54%	17-46%	41-66%	19-99%	40-70%	33-65%	41-71%

[1] *95% confidence interval based on the binomial distribution*

Incidental Observations

Methods

Methods for incidental collection of wildlife are identical to those for caribou and are discussed in Section 9.2.6.2. Incidental observations of grizzly bear were recorded when:

1. observed by site personnel near the Doris Project Site from 2009 and 2016 and recorded in the Wildlife Sighting Log for the Doris Project; and
2. observed by field personnel (wildlife biologists and other environmental personnel) recorded spatially or temporally outside of targeted VEC studies when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016.

Results

Incidental Observations of Grizzly Bear by Site Personnel

Grizzly bears were recorded in the wildlife sightings log in all years between 2009 and 2016 (Table 9.2-24). When all years are combined, grizzly bears have been observed by site personnel in all months between April and October. From 2009 to 2016, the majority of grizzly bears have been reported in July and August but are comparable amongst months when corrected for the number of personnel on site with spikes of observations detected in July and August of some years (e.g., 2009, and 2013; Table 9.2-24). Overall, observations of bears by on-site personnel in the wildlife sightings log peaked in 2009 and 2013. In 2009, multiple bears were attracted to the recently closed Windy camp,

leading Newmont (the operator at the time) to conduct a cleanup of the camp and revise the site waste management practices, after which bear presence dropped substantially. Most observations were of single bears, with infrequent observations of mothers with cubs (Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2016a, 2017a). As explained in the caribou section 9.2.6.2, incidental observations by site staff may include multiple reports of the same individual(s), and for this and numerous other reasons outlined previously, incidental data cannot be used for reliable density or abundance estimation.

Table 9.2-24. Grizzly Bear Observations from the Wildlife Sightings Log Standardized by Personnel on Site, 2009 to 2016

Year	Month	Number of Observations from Raw Data*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
		No. Individuals	No. Records		No. Individuals	No. Records
2009	Jan	0	0	69	0	0
	Feb	0	0	84	0	0
	Mar	0	0	94	0	0
	Apr	0	0	102	0	0
	May	11	5	102	0.11	0.05
	Jun	4	4	103	0.04	0.04
	Jul	18	10	113	0.16	0.09
	Aug	18	17	109	0.17	0.16
	Sep	6	6	98	0.06	0.06
	Oct	0	0	66	0	0
	Nov	0	0	16	0	0
	Dec	0	0	14	0	0
2010	Jan	0	0	83	0	0
	Feb	0	0	106	0	0
	Mar	0	0	131	0	0
	Apr	0	0	172	0	0
	May	6	6	182	0.03	0.03
	Jun	2	1	200	0.01	0.01
	Jul	7	7	220	0.03	0.03
	Aug	4	4	205	0.02	0.02
	Sep	7	5	484	0.01	0.01
	Oct	0	0	332	0	0
	Nov	0	0	147	0	0
	Dec	0	0	108	0	0
2011	Jan	0	0	214	0	0
	Feb	0	0	250	0	0
	Mar	0	0	265	0	0
	Apr	0	0	278	0	0
	May	3	3	274	0.01	0.01
	Jun	0	0	280	0	0
	Jul	3	1	284	0.01	0

Year	Month	Number of Observations from Raw Data*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
		No. Individuals	No. Records		No. Individuals	No. Records
	Aug	10	5	277	0.04	0.02
	Sep	3	1	277	0.01	0
	Oct	3	1	270	0.01	0
	Nov	0	0	252	0	0
2012	Jan	0	0	183	0	0
	Feb	0	0	193	0	0
	Mar	0	0	180	0	0
	Apr	1	1	127	0.01	0.01
	May	2	2	90	0.02	0.02
	Jun	1	1	103	0.01	0.01
	Jul	3	1	90	0.03	0.01
	Aug	6	2	93	0.06	0.02
2013	Mar	0	0	3	0	0
	Apr	0	0	13	0	0
	May	0	0	20	0	0
	Jun	0	0	44	0	0
	Jul	9	3	61	0.15	0.05
	Aug	8	3	59	0.14	0.05
	Sep	3	1	54	0.06	0.02
	Oct	1	1	49	0.02	0.02
	Nov	0	0	19	0	0
	Dec	0	0	8	0	0
2014	Jan	0	0	7	0	0
	Feb	0	0	7	0	0
	Mar	0	0	8	0	0
	Apr	0	0	14	0	0
	May	0	0	63	0	0
	Jun	2	2	71	0.03	0.03
	Jul	2	2	77	0.03	0.03
	Aug	1	1	79	0.01	0.01
	Sep	0	0	73	0	0
	Oct	1	1	79	0.01	0.01
	Nov	0	0	44	0	0
	Dec	0	0	7	0	0
2015	Jan	0	0	13	0	0
	Feb	0	0	16	0	0
	Mar	0	0	30	0	0
	Apr	0	0	28	0	0
	May	1	1	32	0.03	0.03
	Jun	3	3	41	0.07	0.07

Year	Month	Number of Observations from Raw Data*		Monthly Average of Personnel on Site**	Number of Observations per Personnel	
		No. Individuals	No. Records		No. Individuals	No. Records
	Jul	1	1	46	0.02	0.02
	Aug	17	11	84	0.2	0.13
	Sep	2	2	105	0.02	0.02
	Oct	0	0	114	0	0
	Nov	0	0	93	0	0
	Dec	0	0	89	0	0
2016	Jan	0	0	60	0	0
	Feb	0	0	73	0	0
	Mar	0	0	78	0	0
	Apr	0	0	93	0	0
	May	0	0	110	0	0
	Jun	0	0	123	0	0
	Jul	14	5	123	0.11	0.04
	Aug	10	4	129	0.08	0.03
	Sep	0	0	144	0	0
	Oct	3	3	158	0.02	0.02
	Nov	0	0	172	0	0
	Dec	0	0	169	0	0

** Whether or not wildlife are recorded can vary by factors other than number of personnel on site, e.g., the type of animal, multiple reporting of same individuals by different observers, work activities (indoor vs outdoor; site-based vs field-based), number of daylight hours, visibility, novelty of the sighting, observer reporting enthusiasm, ability to identify animal, etc.*

*** Personnel were on site in all months between 2009 and December 2016 except October to December 2012. Personnel totals do not include personnel at Boston Site.*

Incidental Observations of Grizzly Bear by Field Personnel

Field personnel observed bears incidentally in the RSA in all years 2006-2016 and observations ranged from one to three bears. No general trends were detected in these observations (Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Habitat Suitability Modeling

Methods

Habitat selection by grizzly bears mainly reflects spatial and temporal patterns in forage availability and abundance (McLoughlin et al. 2002). Grizzly bears target a variety of vegetation, but are strongly influenced by the availability of caribou, and in specific areas, Arctic char and lake trout. Habitat selection has been measured at two spatial scales; landscape and home range. At the landscape scale, grizzly bears select home ranges that have a higher proportion of eskers, tussock/hummock tundra, lichen veneer, birch seep, and riparian tall shrub habitat than surrounding areas. For the home range of an individual, habitat selection varies by season, sex and reproductive status (McLoughlin et al. 2002).

Research on the dietary patterns of barren-ground grizzly bears indicates that five time periods correlate with seasonal changes in resource selection (Table 9.2-25; Gau et al. 2002): spring, summer, late summer, fall and denning.

Table 9.2-25. Seasonal Periods for Grizzly Bear

Season	Start Date	End Date
Spring	May 14	June 20
Summer	June 21	July 31
Late Summer	August 1	September 9
Autumn	September 10	October 15
Denning	October 16	May 15

Note: Dates used in habitat suitability modeling by Johnson et al. (2005). Dates reflect shifts in grizzly bear diet throughout the season.

Spring: Grizzly bears show the greatest preference for esker habitat during the spring, perhaps because ground squirrel burrows are abundant and more easily accessible in spring (McLoughlin et al. 2002; C.J. Johnson et al. 2005). Male grizzly bears also show a preference for tussock/hummock tundra, while females without cubs show a preference for riparian tall shrub habitat (McLoughlin et al. 2002; C.J. Johnson et al. 2005).

Summer: Female grizzly bears (with and without cubs) show preference for eskers and riparian tall shrub habitat (McLoughlin et al. 2002). Females with young also prefer heath tundra. Males continue to show preference for tussock/hummock tundra in the summer (McLoughlin et al. 2002).

Late Summer: Grizzly bears prefer eskers and riparian tall shrub habitat (McLoughlin et al. 2002; C.J. Johnson et al. 2005). These habitats provide an abundance of fresh berries and caribou. Differences in habitat use among males, females with cubs and females without cubs are pronounced in late summer. Females with cubs select heath bedrock and tussock/hummock tundra, while males and females without cubs avoid these habitats preferring eskers (McLoughlin et al. 2002).

Autumn: Important grizzly bear habitat in autumn includes riparian tall shrub, lichen veneers and heath tundra habitats. Habitat selection is strongly influenced by the occurrence of caribou during fall (C.J. Johnson et al. 2005). However, females with cubs select bedrock habitat which is avoided by males and avoid riparian tall shrub habitat. Females without young continue to prefer eskers in autumn (McLoughlin et al. 2002).

Denning: Dens have been found in a wide variety of habitat types. In the West Kitikmeot region, research indicates that most grizzly bear dens found were located in heath tundra and heath boulder habitats, with the majority of remaining dens located in riparian tall shrub and birch seep habitats (McLoughlin et al. 2002). Although eskers accounted for only seven of 56 den sites in this study, this habitat type was selected more than expected, given its low availability in the central Arctic (McLoughlin et al. 2002). Grizzly bear den sites most commonly face south (H. V. Reynolds, Curatalo, and Quimby 1976; Rescan 1997; McLoughlin et al. 2002), likely for the benefit of insulation as the accumulation of an insulating layer of snow resulting from the prevailing northerly winds. The substrates of den sites are typically well-drained and contain a large amount of sand and coarse materials, including cobblestones and boulders. The structural integrity of den sites is maintained through root mats from dwarf birch and other shrubby vegetation located in the ceilings of dens. Often grizzly bear dens in the Arctic do not last long; by mid-summer, most will partially or completely collapse (McLoughlin, Cluff, and Messier 2002). Thus, it appears that bears usually dig new dens each year.

Grizzly bears are omnivorous and opportunistic feeders that select habitat largely based on seasonal availability of forage (McLellan et al. 1999; Wellwood 2003). Habitat suitability ratings (HSR) focused on living requisites for spring, summer, and fall seasons based on an assessment of forage capacity in

each respective ecosystem unit (Table 9.2-26). Early summer and late summer habitat types were combined for the analysis of habitat availability in the LSA and RSA. Vegetation phenology was used to rate ecosystem units for target forage species for a given season (e.g., blueberries are absent in the spring, ripen during the summer, and die off during the fall). Prey sources, mainly Arctic ground squirrel (*Spermophilus parryii*), that are strongly associated with specific ecosystem units were included in the ecosystem unit HSRs.

Table 9.2-26. Seasonal Life Requisites of Grizzly Bear

Season	Date	Life Requisite	Habitat Preference
Spring	May – June	Living	Esker, crowberry, blueberry, sedge, riparian shrub, caribou, ground squirrel
Summer	June - September	Living	Esker, blueberry, sedge, riparian shrub, ground squirrel
Fall	September - October	Living	Esker, blueberry, sedge, riparian shrub, caribou, ground squirrel, streams that provide fish
Winter	October - May	Denning	Esker, major river corridors

Further details of the distribution, movement, habitat, and demographics of grizzly bears in the RSA and how they relate to the suitability modelling assumptions are provided in Appendix V4-9A (Rescan 2011h).

Results

Foraging Habitat

Habitat suitability modeling for grizzly bears based on EM mapping within the LSA indicated that the majority of the LSA provides low (53.9%) and moderate (39.9%) value as spring habitat (Table 9.2-27). The low and moderate spring ratings are largely due to a lack of caribou calving grounds in the LSA. Higher value spring habitat, which comprises only 3.3% of the LSA in spring, primarily consists of eskers and ecosystem units that support overwintered berries or Arctic ground squirrel. Summer suitability of the LSA is more evenly distributed in quality, with moderate (39%) and high (29.5%) value habitat being most prevalent (Table 9.2-27) and related to the abundance of forage and post-calving caribou movements. Fall suitability of the LSA is similar to spring, with 57.4% considered moderate value and 15.5% rated as high value (Table 9.2-27). The reduction in available higher value fall habitat is related to reduced forage opportunities and a higher reliance on caribou and Arctic ground squirrel.

Table 9.2-27. Area and Percentage of Seasonal Habitat within the Local Study Area and Regional Study Area for Grizzly Bear

		Local Study Area[1]		Regional Study Area[2]	
Season	Suitability Rating	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Spring	High	1,846.4	3.3%	1,234.5	0.3%
	Moderate	22,440.3	39.9%	279,925.4	56.9%
	Low	30,325.8	53.9%	148,096.8	30.1%
	Nil	1,664.5	3.0%	57,723.5	11.7%
Summer	High	16,577.5	29.5%	27,575.9	5.6%
	Moderate	21,939.4	39.0%	194,438.6	39.5%
	Low	6,772.4	12.0%	207,242.2	42.1%
	Nil	10,987.7	19.5%	57,723.5	11.7%

Season	Suitability Rating	Local Study Area[1]		Regional Study Area[2]	
		Area (ha)	Percent (%)	Area (ha)	Percent (%)
Fall	High	8,731.5	15.5%	1,234.5	0.3%
	Moderate	32,276.0	57.4%	220,780.0	44.9%
	Low	5,616.9	10.0%	207,242.2	42.1%
	Nil	9,652.6	17.2%	57,723.5	11.7%
Denning	High	719.8	1.3%	5,853.0	1.2%
	Moderate	8,412.5	14.9%	80,877.8	16.4%
	Low	37,595.5	66.8%	305,791.6	62.2%
	Nil	9,549.2	17.0%	99,301.6	20.2%

[1] *LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the EM data (see Section 9.2.3.10) except for the denning habitat model (see Denning Habitat).*
[2] *RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.10) except for the denning habitat model (see Denning Habitat). A total of 4,843.7 ha of WKSS data in the RSA were categorized as unclassified likely due to coverage of the imagery by cloud cover.*

Other important grizzly bear habitat features in the LSA included a total of 606 hectares of buffered (100 meters on each side of the stream) streams and rivers that are known to have substantial seasonal migration movements of Arctic char and/or lake trout, including Roberts Creek and Koignuk River (Rescan 2011h). The total areas ranked as moderate and/or high value habitat during summer and fall habitat were adjusted upwards if they included creeks that supported Arctic char and/or lake trout (Table 9.2-27).

Within the RSA, habitat suitability modeling based on the WKSS ecosystem classification indicated that the majority of ecosystem units within the RSA provide low or moderate value habitat across all seasons (Table 9.2-27). Approximately 5.6% of the RSA was classified as high value summer habitat, and only 0.3% of the RSA contained high value spring and fall habitat for grizzly bears (Table 9.2-27). Small areas of high value grizzly bear spring (Figure 9.2-25) habitat was indicated southeast of Boston camp and this habitat category became more prevalent east and southeast of Boston in summer (Figure 9.2-26). High value fall habitat showed similar spatial patterns to spring (Figure 9.2-27).

Denning Habitat

A grizzly bear denning habitat model was produced during the review phase of the DEIS, and used landscape level data to identify eskers and river corridors that could provide high quality denning habitat for grizzly bear. Eskers habitat and watercourses were identified using publicly available CANVEC data from Natural Resources Canada (NRCan). Habitat areas within 100 m of these features were considered as having potential to support grizzly bear habitat. A 100 m buffer was used as a conservative measure to ensure that potential habitats are considered in the model based on the input data. For example, river banks vary from narrow, steep banks to wider, gently sloped banks and thus the habitat buffer ensures that habitat areas on gently sloped river banks are captured but likely overestimates some potential habitat given that some banks are steeper.

The areas within 100 m of esker and major river systems (i.e., river banks) were considered to be high value habitat for denning, based on the potential for these habitats to contain well-drained sandy areas that also may have appropriate structures for denning, such as presence of vegetation and root mats for structural integrity (See Methods). The Koignuk River in the western RSA and the Angimayak River in the eastern RSA are the major river systems. Approximately 1.3% of the LSA and 1.2% of the RSA was classified as high value denning habitat (Figure 9.2-28; Table 9.2-27).

Figure 9.2-25
Grizzly Bear Spring Habitat Suitability in the Local Study Area and Regional Study Area

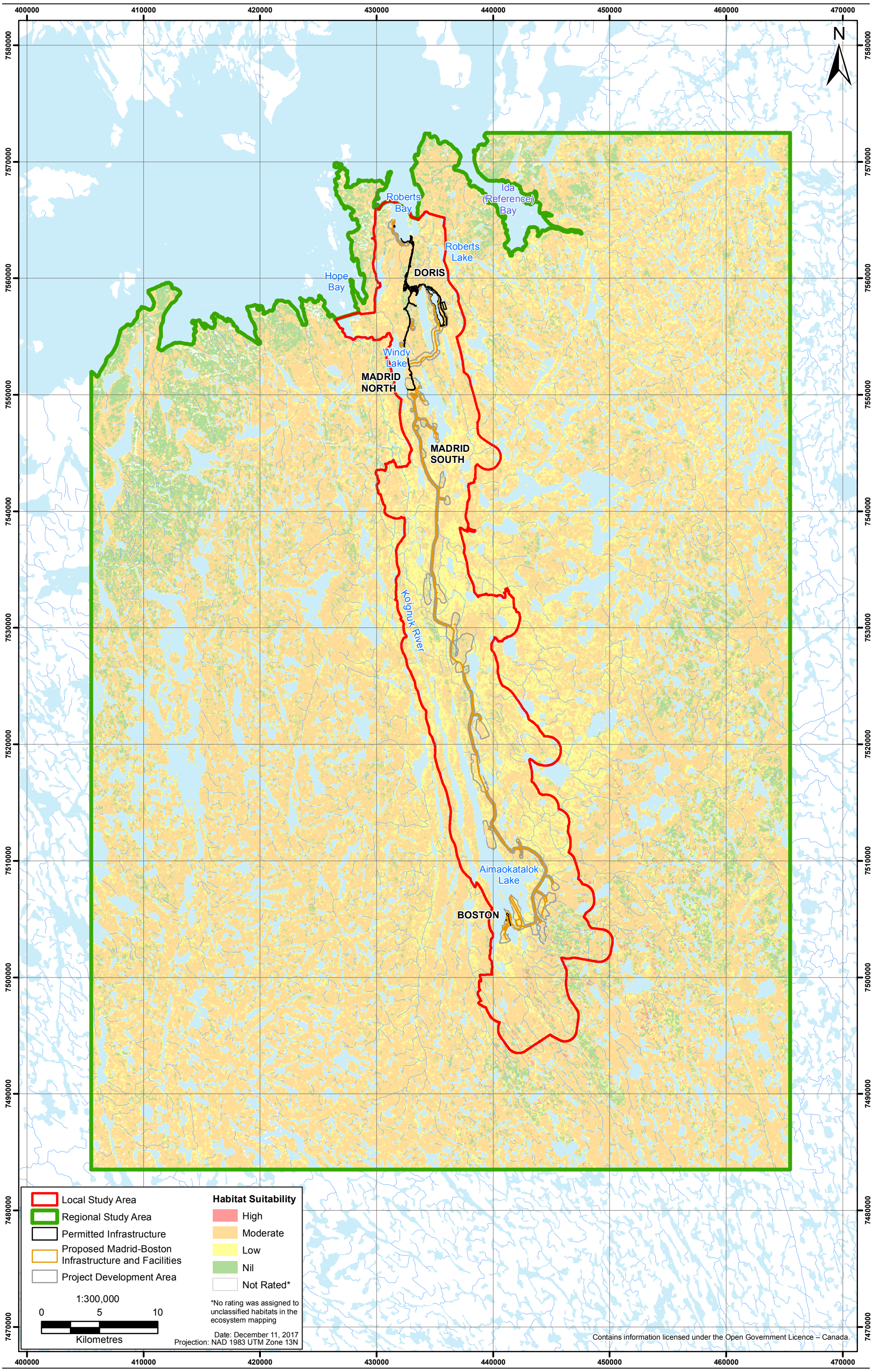


Figure 9.2-26
Grizzly Bear Summer Habitat Suitability in the Local Study Area and Regional Study Area

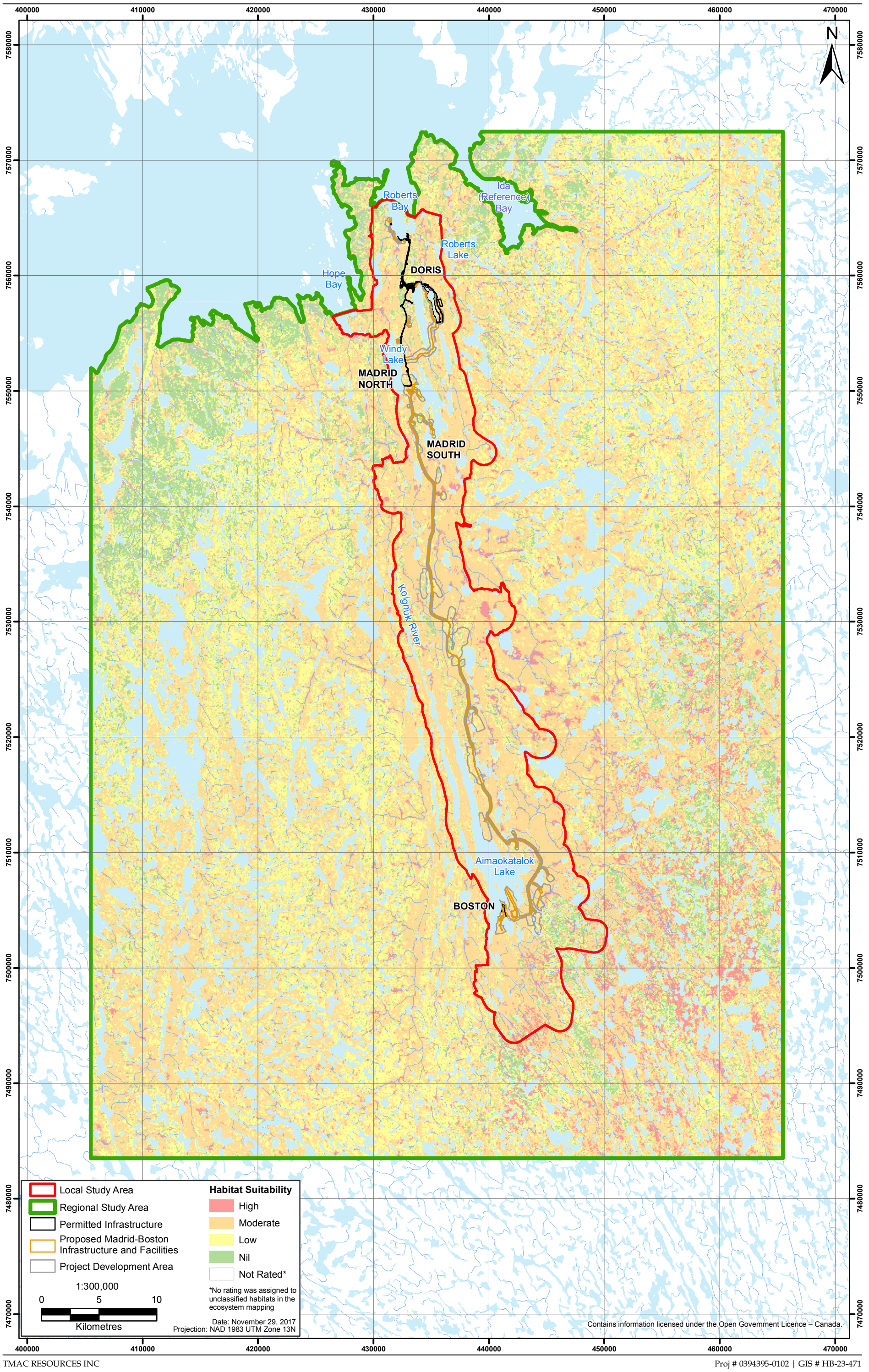


Figure 9.2-27
Grizzly Bear Fall Habitat Suitability in the Local Study Area and Regional Study Area

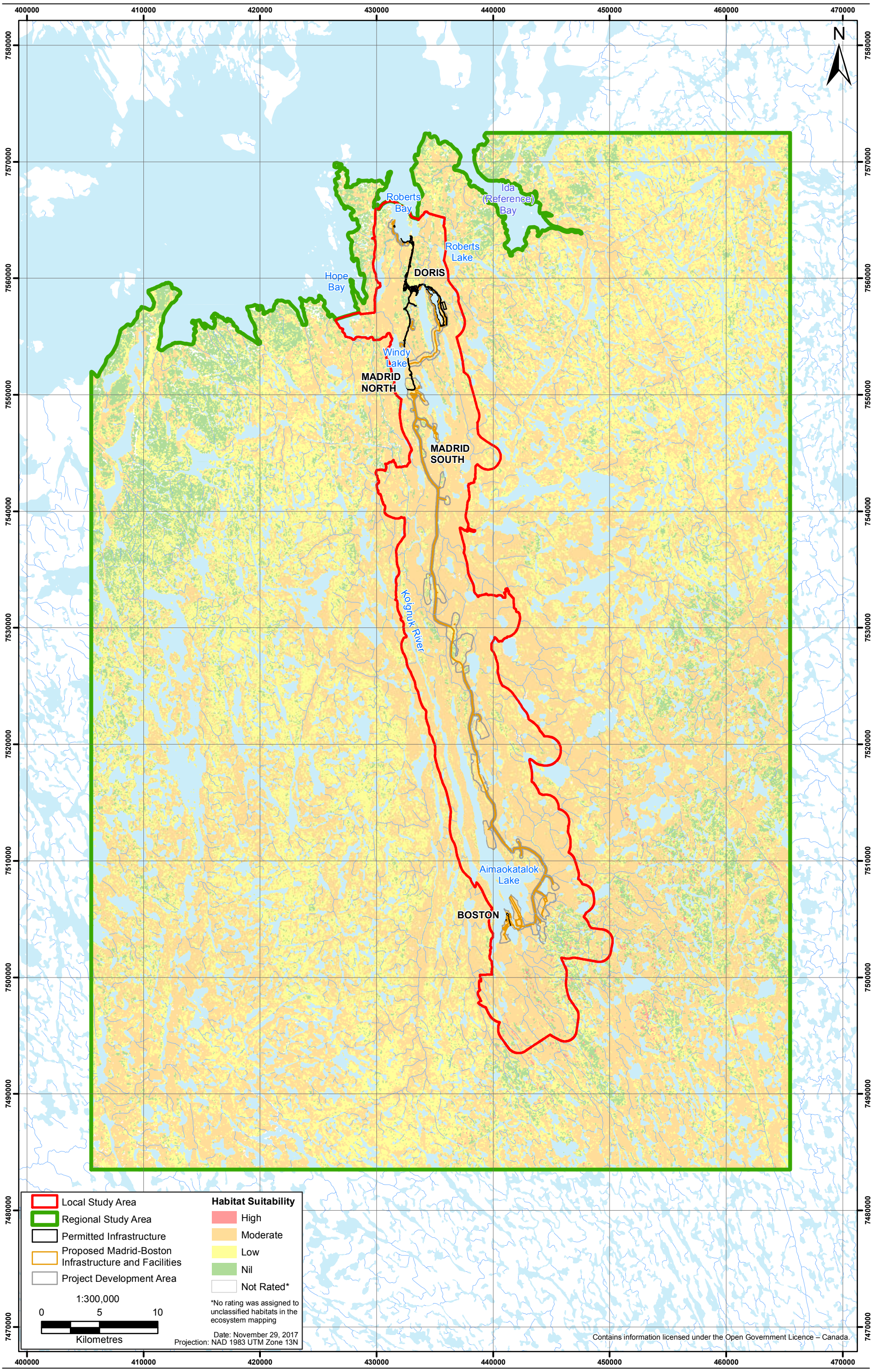
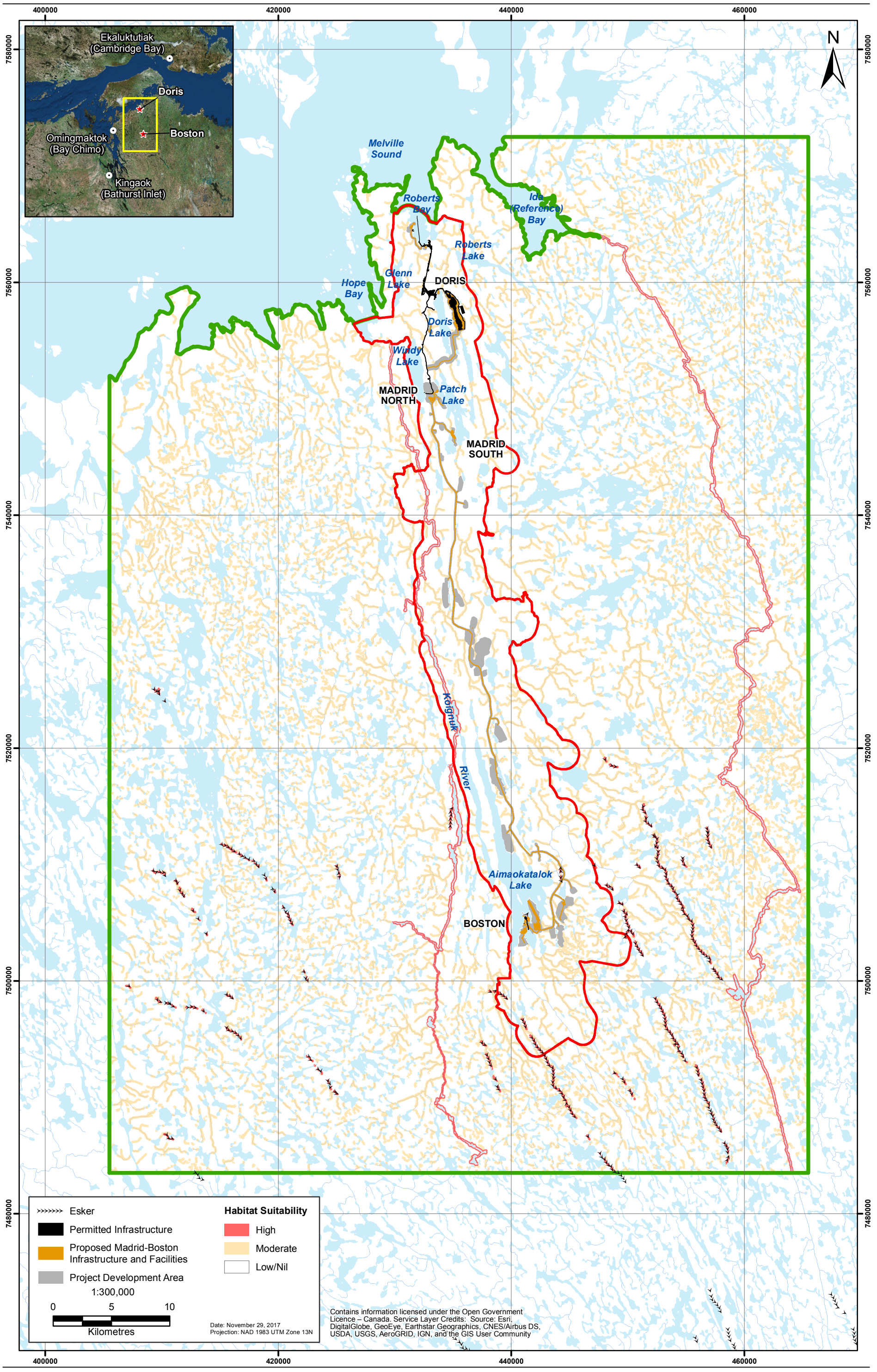


Figure 9.2-28
Grizzly Bear Denning Habitat Suitability in the Local Study Area and Regional Study Area



Smaller river systems and creeks may also have sandy banks, though are less likely have extensive areas of sandy materials the smaller the watercourse is. Thus, areas within 100 m of all smaller watercourse were identified as moderate value denning habitat. A total of 15% of LSA and 16% of the RSA was rated as moderate value denning habitat.

All remaining terrestrial habitat was classified as having low habitat value for grizzly bear denning and the area of water features (lakes, ponds, wetlands, and rivers) were classified has having no value (i.e., nil habitat). Low value habitats accounted for 67% of the LSA and 62% of the RSA, and nil rated habitat covered 17% of the LSA and 20% of the RSA (Figure 9.2-28; Table 9.2-27).

9.2.8.3 The Doris Project

Between 1996 and 2004, exploration occurred in the Hope Bay Belt. In 2006, a project certificate was issued for the Doris Project and construction began in 2009, but was put into care and maintenance following changes in market conditions in 2010, and was re-opened for additional construction and resource exploration in 2015.

The WMMP for the Doris Project included monitoring of grizzly bear for habitat loss (measured as the area of the Doris Project footprint), possible sensory disturbance (avoidance of the Doris Project), attraction to the Doris Project, and possible direct mortality through collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance phases since 2006. This section summarizes the results of these monitoring activities for grizzly bear.

Habitat Loss

Habitat lost within the Doris Project footprint has been measured since 2009 (see Section 9.2.6.3 for further details on the evaluation of habitat loss for the Doris Project for VECs). The footprint was measured in 2016 as 83.0 ha, or 2.7% of the LSA from the 2006 FEIS for the Doris Project (ERM 2017a). The majority of habitat loss occurred in habitat types rated as moderate or high for males or females with cubs: heath tundra (33.6 ha) and tussock/hummock (29.5ha), or low and moderate for males or females with cubs: heath bedrock (4.1 ha; Table 9.2-13). Of the 83.0 ha of habitat lost, 79.4 ha of habitat lost was classified as suitable grizzly bear habitat for both males and females with cubs. This represents an actual loss of 0.03% of the total suitable habitat identified for grizzly bear males and females with cubs within the RSA from the 2006 FEIS for the Doris Project (Table 9.2-28).

Table 9.2-28. Area of Suitable Habitat Disturbed for Grizzly Bear

		Amount of Suitable[1] Habitat in RSA[2]		Actual Disturbed Suitable Habitat	
Species	Season	Total (ha)	% of RSA[2]	Total (ha)	% of RSA[3]
Grizzly Bear	Male	248,955	66.6	79.4	0.03
	Female with Cubs	248,955	66.6	79.4	0.03

[1] *Suitable Habitat does not include Nil-rated habitat in study area.*
[2] *Calculations based on RSA area of 374,052 ha for Caribou, Grizzly Bear and Wolverine.*
[3] *Calculations based on total amount of suitable habitat in RSA.*

Sensory Disturbance

The WMMP evaluates the potential for grizzly bears to be disturbed by Doris Project activities and avoid the Doris Project site. Since 2012, this program has included using wildlife, motion-triggered cameras. The objective of the motion-triggered cameras program is to monitor for wildlife interactions with Doris Project infrastructure, comparing observations near Doris Project infrastructure to observations in control

areas at a greater distance from the Doris Project. This monitoring protocol provides a basic measure of whether a ZOI is present.

Generalized additive mixed models were used to test whether there were differences in the number of grizzly bear events recorded per month by cameras set up in Treatment locations (< 1 km from the Doris Project) and Control locations (> 1 km). This analysis followed the same procedure as described for caribou in Section 9.2.6.3 (ERM 2016a). This analysis indicated that the probability of observing grizzly bear within 1 km of the Doris Project was lower than compared to control areas at greater than 1 km (β = -1.67, $p < 0.001$, significant). However, a detailed spatiotemporal statistical analysis for Doris indicated that the camera data may be confounded in its ability to determine effects related to Doris due to the correlation of bear density with distance to the coast; the cameras near to Doris infrastructure were nearer to the coast than most of those cameras further from Doris infrastructure (ERM 2016a). Hence, it cannot be concluded that grizzly bears are avoiding the Doris site.

In general, grizzly bear events were recorded at both on-site and off-site cameras during all survey periods except at on-site cameras during the winter period of 2013/2014. These data indicate that despite the presence of infrastructure for the Doris Project, grizzly bears still use the site and can move east-west along the shoreline.

Since the wildlife camera data were collected, a re-design of the camera program was requested to address a variety of comments from regulators including the KIA and GN DOE on their placement and use. In February 2016, TMAC met with the KIA and GN DOE and re-designed the camera monitoring program to address these limitations and the camera locations were changed accordingly during summer 2016 and are described, in detail, in the 2016 WMMP report (ERM 2017a). The redesigned camera program will increase the robustness of spatial and temporal analysis of grizzly bear detections by wildlife camera, and will better evaluate ZOI-type effects of sensory disturbance. Caution should therefore be applied to interpreting camera results to-date for the effects of sensory disturbance on grizzly bear (ERM 2016c).

Attraction to the Doris Project

The WMMP evaluates if grizzly bears are attracted to camps. Attraction to the Doris Project and human-bear interactions have been monitored on an annual basis and reported in the annual WMMP report in order to maximize wildlife and human safety, and identify any possible effects the Doris Project may have on grizzly bears.

In the years that personnel have been at the Doris Project site (2006 - 2016), the number of grizzly bear incidents and interactions were generally low (range one to seven incidents per year), with the exception of 2009 (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). During 2009 there was a spike in grizzly bear activity and observations near infrastructure. The main source of attractants was identified as improper garbage disposal at the Windy camp, following the hurried closure of Windy camp in late 2008. During the summer of 2009, frequent bear activity was reported at the vacated Windy camp in the late winter (May) and throughout the Roberts Bay-Airstrip-Doris Site areas during summer. Bears were deterred from these areas with the use of bear bangers, rubber and beanbag bullets, propane cannons, sirens, and helicopters. The Cambridge Bay Conservation Officers were kept informed of repeat events and the GN DOE Conservation Officer and Doris Project environment and social responsibility (ESR) staff assisted with deterring bears from Windy camp by snowmobile.

Efforts to remove attractants from Windy camp began in 2009. Potential attractants were identified, sorted and removed for incineration or secure storage until shipment off site. As additional preventative

measures, a wildlife-attractant-conscious waste management plan was drafted and implemented in 2009. Camp personnel were briefed on wildlife attractant management practices. A Bearwise representative, was also brought to site twice in 2009, and in each of the five subsequent years to audit site bear safety conditions, provide recommendations for improvement, assess various bear fencing options, and to provide bear responder training to separate cross-shifts of on-site staff.

Following 2009, the number of reports of bears fell sharply, but remained above pre-2009 levels during 2010 and 2011. This decline was likely a consequence of improved waste management practices. For instance, in 2010 grizzly bears were observed by camp personnel near footprint areas on 36 occasions. On 11 of these occasions a wildlife response team member investigated the sightings. Noise deterrents (bear bangers, honking of vehicles' horns) were used on four occasions to deter bears, and on two occasions helicopters were used. In the other cases no actions were taken apart from monitoring the behaviour of the bears and their direction of movement.

By 2012, the annual Bearwise report concluded that conditions have greatly improved on site largely due to the proper closure of Boston camp, ongoing decommissioning of Windy camp, and Doris Project-wide improvements to waste management practices. Since 2013, bear activity in the Doris Project area has been minimal, likely due to continued good waste management practices (Table 9.2-24). Only one bear incident was reported in 2014, when a bear was observed in close proximity to an exploration drill during August. Following established procedures for close grizzly proximity to a worksite, a helicopter was used to successfully divert the animal away from areas where personnel were working. All of the interactions since 2013 were successfully resolved by using bear deterrents, removing personnel from the area, "pushing" the bear with a vehicle or helicopter, or waiting for the grizzly bear to leave the area before resuming work.

These results indicate that there has been an effect of attraction on grizzly bears due to the Doris Project. Following improvements in landfill waste management procedures and a successful site-wide training and education program, the effects of attraction specific to grizzly bears have been minimized (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). In 2009, the Doris Project reported several grizzly bear interactions that triggered the development and implementation of new waste and wildlife attractant management procedures. These procedures included identifying, sorting, and removing all wildlife attractants, and instructing site personnel on proper wildlife attractant management practices. These measures continue to be used and are effective in reducing bear presence at the Doris Project.

Direct Mortality

Any wildlife mortality, including grizzly bear that have been observed by onsite personnel were reported immediately to the ESR Department and reported in the annual WMMP report. Mortality of large fauna, or mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE and KIA, as necessary.

Since 2006, there have been no incidents of grizzly bears being involved in vehicle or aircraft strikes. The on-site speed limit for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to grizzly bear.

Grizzly bears were prevalent at the Doris Project in 2009, following attractants and improper garbage disposal at Windy camp. Bears were deterred from the Doris Project site successfully using non-lethal means (e.g., bear bangers, helicopters) during 2009 and thereafter. However, in 2016 a juvenile bear, likely the newly independent yearling of a female grizzly that frequents the fish fence on Roberts Creek, was observed repeatedly at the Doris site (ERM 2017a). Camp cleanliness and waste

management procedures were reviewed and the bear deterred, but it became clear that the bear was habituated and posed a safety risk to Doris Project personnel. After conferring with the KIA and the Cambridge Bay DOE conservation officer, the bear was destroyed and the meat delivered to the Cambridge Bay Wellness Center food bank.

Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on grizzly bear due to Doris Project activities.

9.2.9 Characterization of Baseline Conditions for Wolverine and Furbearers

9.2.9.1 Introduction

Furbearers are any small or medium-sized predators that can be trapped or hunted for their fur. Of these, the wolverine (*Gulo gulo*) is sensitive to disturbances and as such was chosen as a representative species. Wolverine are members of the mustelid family, which includes weasels, badgers, and marten. Like other mustelids, wolverines are carnivorous, and are both scavengers and predators on a wide range of prey (COSEWIC 2014b). Very large home ranges, low population densities and lack of hibernation are characteristics of this solitary species (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). Recent advances in camera trapping and DNA analysis have resulted in new information on population dynamics, including more rigorous and potentially higher estimates of population densities (Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011). The wolverine is ranked as Vulnerable in Nunavut (CESCC 2016), and the Canadian population as a whole was designated as Special Concern (COSEWIC 2014b).

Inuit have generally regarded wolverines as pests because they cause damage to caches, destroy property, and steal food (Banci and Spicker 2016). Wolverine pelts were used as fur mats when hunting seals, otherwise wolverines were historically seldom hunted. Their status as pests has changed because the value of their pelts has increased, leading to a dramatic increase in trapping and hunting of wolverines by Inuit (Banci and Spicker 2016). The use of wolverine fur as trim on parkas is a relatively recent custom, and very important to the Inuit (Banci and Spicker 2016). Inuit TK indicates that wolverines use the RSA (Banci and Spicker 2016). Data from wolverine harvests indicate that Bathurst Inlet is a main site for wolverine hunting in the West Kitikmeot (Mulders 2000).

For furbearers other than wolverine, grey wolf were chosen as the representative species for the EIS. The grey wolf (*Canis lupis*) is the largest member of the Canis genus and is widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. Three subspecies of grey wolf occur in Nunavut — all of which may be found within the wildlife RSA (Chambers et al. 2012); the northern timber wolf (*Canis lupis occidentalis*), the plains wolf (*Canis lupis nubilus*), and the Arctic wolf (*Canis lupis arctos*). The northern timber wolf and plains wolf subspecies are listed as "Not at Risk" by COSEWIC, while the Arctic wolf subspecies is listed as "Data Deficient" (COSEWIC 2012a). The grey wolf is listed as Secure in Nunavut (CESCC 2016). For this purposes of this EIS, wolves are discussed at the species, rather than subspecies, level except where indicated.

Prior to the fur trade, wolf pelts were used by Inuit for trim on clothing, pups used for breeding with their sled dogs, and the meat was either thrown away or fed to dogs (Banci and Spicker 2016). After the inception of the fur trade, wolves became even more highly valued and continue to be highly valued by the Inuit as the pelts from these animals are sold at high prices.

Population Trends and Conservation

Wolverine

Wolverine populations in the central Arctic appear to fluctuate, although for the most part they are believed to be stable or even increasing in some areas of Northwest Territories and Nunavut (COSEWIC 2014b). The total population size of wolverines in Nunavut is estimated to be 2,000 to 2,500 individuals (Slough 2007; COSEWIC 2014b).

Due primarily to low reproductive rates and low population densities, wolverines are susceptible to population declines (Slough 2007; Inman et al. 2012). Food availability, especially during winter, is thought to be the main factor limiting reproduction and influencing the population dynamics of wolverines (Persson 2005). There are five different wolverine management areas in Nunavut; the wolverine population in the RSA occurs within the W/01-KT management area, and is considered to be an abundant, breeding population (GN DOE 2007).

The GN DOE recommends an annual Total Allowable Harvest (TAH) of 160 wolverines for the W/01-KT management area (GN DOE 2007). In addition, recommendations that wolverine not be trapped after April 15 or shot after April 30 until October 31 minimizes the potential effects of harvest of young wolverines (GN DOE 2005).

Potential direct effects of climate change on wolverine include increasing temperatures which may cause an earlier onset of the spring melt. This could have a negative effect on den sites for wolverines because dens are located in areas that retain snow in the spring (Magoun and Copeland 1998; McKelvey et al. 2011).

Potential indirect effects include changes to caribou populations and competition for resources with other predators (e.g., grizzly bear, wolves, foxes, etc.). Wolverine and in particular the Arctic grey wolf depend on caribou for sustenance, thus negative effects on the caribou herds can have potential negative implications for either or both species. The timing of caribou migrations, size of the herd, and routes followed could be affected by earlier and/or warmer spring/summer seasons (Section 9.2.6.2). Post and Stenseth (1999) reported that several ungulate populations have declined following warmer winters and Hinzman et al. (2005) suggest a warming climate will likely have a negative population effect on the health of caribou due to overheating and increased mosquito harassment.

Grey Wolf

In Nunavut and parts of the Northwest Territories, wolf populations were thought to be stable or increasing within their range as of 1995 (Hayes and Gunson 1995). There are no recent estimates of population trends of wolves for Nunavut. However, wolf den surveys between the treeline and Contwoyto Lake (west of the RSA) from 1996 to 2009 show declines in the number of active dens in late August since 2006. Adamczewski et al. (2009) reports the decline in the number of active dens is due to high levels of pup mortality. Wolf reproductive success and population trends are largely regulated by the availability of caribou (Frame, Cluff, and Hik 2008), and reproductive success has been shown to decrease with increasing distance between dens and migration routes of caribou (Frame, Cluff, and Hik 2008). As the availability of den sites is limited due to snow cover in early spring (April) when wolves are seeking den sites to raise pups, wolves must travel back and forth to den sites each day to hunt caribou along their migration routes and summering grounds until early fall (Cluff, Walton, and Paquet 2002). The grey wolf population in the RSA is likely tied to the health and availability of the Beverly caribou herd because this is the closest herd to the RSA during the summer months.

Distribution and Migration Patterns

Wolverine

Wolverine are found throughout the Arctic and boreal forests of North America and Eurasia (Copeland and Whitman 2003). In North America, the geographic range of the wolverine extends from Alaska throughout most of northern and western Canada, including the West Kitikmeot region of Nunavut (Pulliainen 1968; Slough 2007; COSEWIC 2014b).

Although wolverine density is low overall, it is thought to vary across the Canadian Arctic, with higher numbers in the Yukon (5.65-10.75/1,000 km^2; Banci and Harestead 1990; Golden et al. 2007) and Northwest Territories (17.2/1,000 km^2; Mulders, Boulanger, and Paetkau 2007), moderate density in western Nunavut (including the Kitikmeot region; 4.8-6.5/1,000 km^2 Poole unpubl. data 2013 in COSEWIC 2014b), and low in eastern Nunavut and on Arctic islands (Slough 2007; COSEWIC 2014b). Population densities of wolverine on the tundra are approximately 1.25 to 25 individuals per 1,000 km^2, depending on habitat and the availability of prey (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). Robust estimates of population density using wildlife cameras and DNA analysis have confirmed previous estimates of low densities derived from winter track counts in Northwest Territories and Nunavut (10 -15 wolverines per 1,000 km^2; Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011).

Wolverines are non-migratory. They occupy home ranges that can shift in location and vary in size over their lifetime. Home ranges of male wolverine are on average at least four times larger than female home ranges (Mulders, Boulanger, and Paetkau 2007; Persson, Wedholm, and Segerstrom 2010), ranging from 100 km^2 for an adult female to over 600 km^2 for an adult male (Copeland and Whitman 2003). Male home ranges overlap those of several females, in accordance with a polygynous (multiple females per male) mating system, but adult male-male and female-female home ranges rarely overlap due to territorial behaviour (Persson, Wedholm, and Segerstrom 2010).

Grey Wolf

The grey wolf is widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. Densities of grey wolf on the tundra are tied to caribou distributions, however, due to their habitat requirements and timing of pupping they tend to be more concentrated near the treeline, with lower densities further north (Heard and Williams 1992; Cluff, Walton, and Paquet 2002). According to Inuit TK, wolves were found wherever there were caribou. Inuit generally hunted the two species at the same time (Banci and Spicker 2016).

Annual home range sizes average 63,000 ± 13,000 km^2 for males and 45,000 ± 7,500 km^2 for females (Walton et al. 2001). The annual home ranges of wolves on the tundra are much larger than those of wolves in more southern latitudes because their main prey are the migratory caribou, which they follow (Walton et al. 2001; Cluff, Walton, and Paquet 2002). During the spring, wolves follow the caribou herds north and select den sites near the treeline, south of the calving grounds (Heard and Williams 1992). This strategy likely optimizes the availability of caribou during summer and alternative food resources for rearing pups (Walton et al. 2001).

Habitat Use

Wolverine

Wolverine habitat selection is largely driven by the requirements for denning. Wolverines usually choose den sites within rocky boulder fields in snowdrifts where a deep insulating layer of snow will be maintained throughout the denning period (February to April). Dens and den sites are often used for consecutive years (Lee and Niptanatiak 1996; Magoun and Copeland 1998). Typically, wolverine dens

are built under at least 1 to 5 m of snow and consist of long, complex snow tunnels that lead down to boulder fields, rock overhangs, or large cracks in rocks (Magoun and Copeland 1998; Inman et al. 2012; May et al. 2012). Proximity to habitat that provides small mammal prey for kits may also be an important factor in den site selection.

Food caching is an important survival strategy for wolverine, especially in winter, and may drive reproductive rate (Magoun 1987; Mulders 2000; Thorpe et al. 2001; Inman et al. 2012). Characteristics of cache sites are structures that prevent access by other scavengers, and allow cold storage to prevent cached prey spoilage in spring and summer. Wolverines will use a variety of habitats while searching for food (Mulders 2000; Thorpe et al. 2001; COSEWIC 2014b) but are often associated with rocky boulder fields which provide good sites for caching food (C.J. Johnson et al. 2005; Inman et al. 2012).

Wolverine foraging strategies switch from mostly scavenging and caching during winter, to hunting for birds and small mammals during summer (Inman et al. 2012). During the summer, wolverine occurrence is strongly related to the presence of sedge habitat, possibly because of the abundance of small mammals (C.J. Johnson et al. 2005).

Grey Wolf

Migratory wolves winter below the treeline and arrive at denning sites on the tundra in late April and give birth shortly thereafter (Walton et al. 2001). Less is known of the denning ecology of tundra-wintering wolves, but the timing of denning is likely similar. Wolves are territorial during denning and migratory wolves in the Kitikmeot region show strong fidelity to den sites (Walton et al. 2001).

Traditional Knowledge indicates that wolves make their dens where it is easier to dig, such as eskers and sandy glacial deposits along riverbanks (Banci and Spicker 2016). Esker habitats are granular and sandy, likely facilitating soil excavation and water drainage for dens in a landscape dominated by bedrock, boulders, standing water, and permafrost (McLoughlin et al. 2004). Eskers comprise 1 to 2% of Nunavut landscape (McLoughlin et al. 2004) and are a determining factor in locations of dens (McLoughlin et al. 2004).

Pups are weaned in the den and the immediate area surrounding the den. Pups are often moved from natal den sites to rendezvous sites, which, similar to natal dens, are re-used in consecutive years (Frame, Cluff, and Hik 2007). Wolves leave the den site when the young are able to travel with adults, usually in September or October (Walton et al. 2001). Pups are usually cared for cooperatively at communal dens (Frame et al. 2004).

9.2.9.2 Baseline Data for Wolverine and Furbearers

Five baseline studies were conducted to document the activity of wolverine and furbearers in the RSA:

1. population estimation surveys using DNA mark-recapture techniques;
2. motion triggered camera monitoring;
3. snow track surveys;
4. carnivore den surveys; and
5. habitat suitability modeling.

In addition, incidental observations of wolverine and furbearers were recorded during other studies conducted in the RSA and by site personnel.

DNA Mark-Recapture

The application of DNA mark-recapture studies is discussed in Section 9.2.8.2. Similar to grizzly bears, DNA mark-recapture studies on wolverine can be used to determine a super-population estimate of wolverine in a given area (Mulders, Boulanger, and Paetkau 2007; Fisher et al. 2009).

Methods

A wolverine DNA study was conducted in 2010 and 2011 for the Hope Bay Project (Rescan 2011f). The wolverine study area was 925 km^2 in the northern part of the RSA (Figure 9.2-29). The survey grid consisted of 37 cells, each 5 km × 5 km. A baited hair-snagging post wrapped in barbed wire was deployed within each cell. A long-distance scent lure was used to attract wolverine and a piece of fish was used as an incentive for wolverines to climb the posts. There were three sampling sessions in mid to late winter of each year, timed approximately 10 days apart. Individual wolverine were identified from DNA in the sampled hairs. Details of the methods are reported in the 2011 Wildlife Mitigation and Monitoring Program Report (Rescan 2011f).

Results

A total of 42 wolverine hair samples were collected during the 2010 field program. DNA was successfully extracted from seven samples and assigned to five individuals (four males and one female). In 2011, 23 hair samples were collected and DNA was successfully extracted from 10 samples and assigned to six individuals (four males, and two females). None of the individuals identified in 2011 were the same individuals identified in 2010. Overall, a total of 8 males and 3 females were detected in the study area in 2010 and 2011. Sample sizes and capture rates were too small to calculate a super-population estimate.

The low detection rates during the DNA study likely reflect low densities of wolverine in the RSA. Note that because DNA studies do not assume a closed population in the study area, that true density estimates cannot be calculated, however relative density estimates can be compared between similar studies. The wolverine DNA study reported 5.4-6.4 wolverine per 1,000 km^2. Other studies in Nunavut also reported low numbers of wolverines, including only 23 individuals (15 individuals in a grid of 1,692 km^2 and seven in a grid of 1,800 km^2) at Back River for relative densities of 8.8 and 3.8 wolverine per 1,000 km^2 (Rescan 2014).

In contrast, studies conducted by Boulanger and Mulders (2007) further to the south closer to the treeline reported higher relative densities, including: a) 38 wolverine in the 2,556 km^2 Daring Lake study (14.8/1,000 km^2), b) 24 wolverine in the 1,269 km^2 Diavik study (18.9/1,000 km^2), and c) 21 in the 1,062 km^2 Ekati study (19.7/1,000 km^2).

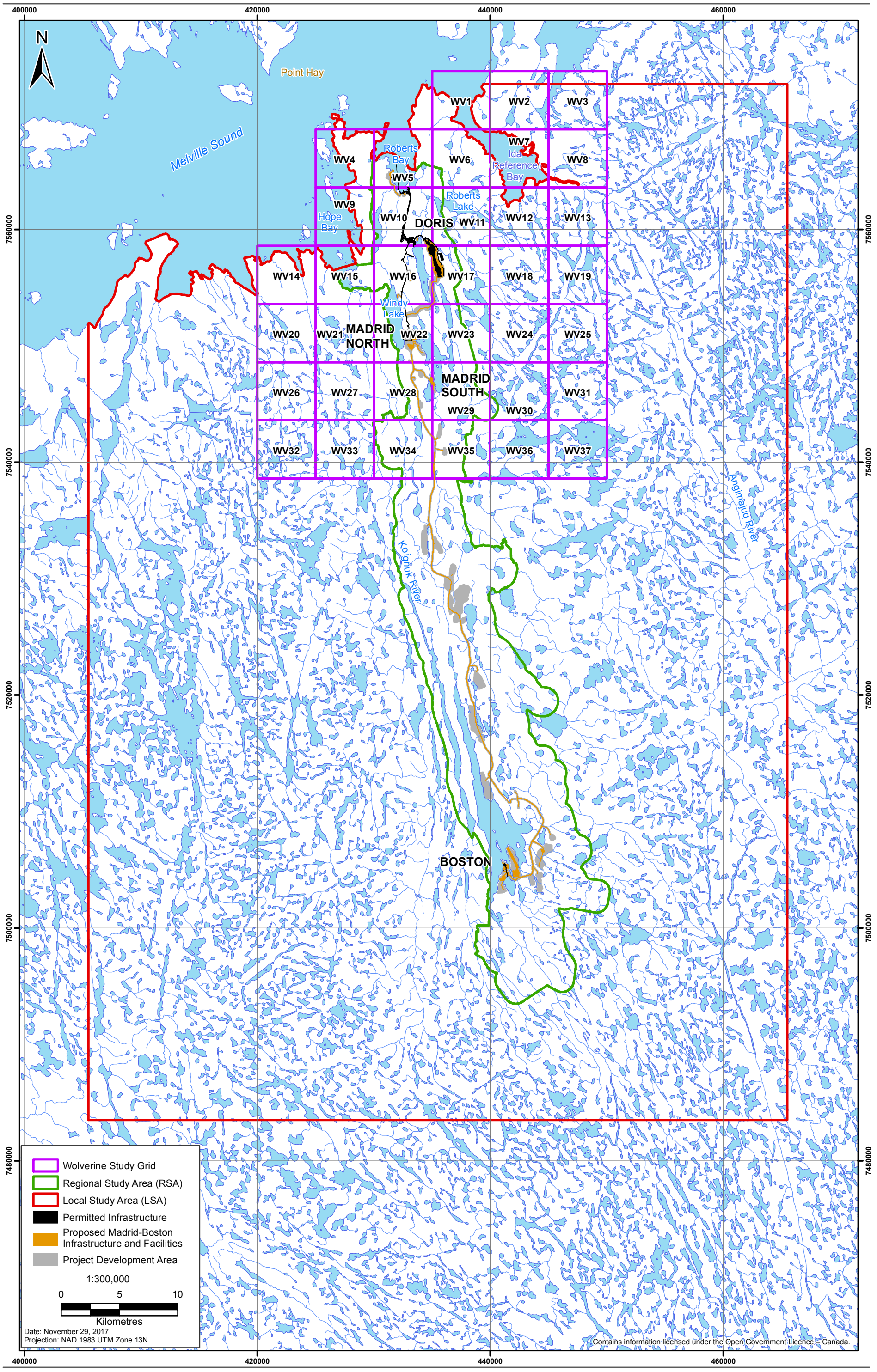
The lower numbers of wolverine reported in Nunavut may reflect fewer caribou available, compared to closer to treeline. The RSA only marginally overlaps a portion of the summer range of the Beverly caribou herd, and to some extent the winter range and northern migration route of the Dolphin and Union caribou herd. While wolverine can exploit a diverse diet, caribou has been found to be the primary food item in the central Arctic year round (Mulders 2000).

Camera Monitoring

Methods

Wolverine and grey wolf activity in the RSA was recorded using motion triggered wildlife cameras from September 2012 to September 2016. Camera methodology was identical to those for caribou and are described in Section 9.2.6.2.

Figure 9.2-29
Wolverine DNA Study Grid, 2010-2011



For wolverine and grey wolf camera monitoring information was used to:

1. Characterize wolverine and furbearer activity in the RSA;
2. Examine seasonal use of areas within the RSA; and
3. Document the potential interaction with existing Doris Project infrastructure.

Results

A total of 44 to 59 cameras were deployed in the RSA between September 2012 and September 2016, for a total observation time of 1,453 camera-days. In general, wolverine and grey wolf events on photos from motion-triggered cameras were rare, with a total of only 67 wolverine and 180 grey wolf events during those 1,453 days (Tables 9.2-29a and 9.2-29b).

Table 9.2-29a. Summary of Wolverine Detection Summary across All Cameras, September 2012 - September 2016

Survey Period	Camera Location	No. of Events (Raw)[1]	No. of Events/camera/day[1]	No. of Ind. Recorded On Events[1,2]
1 (2012-2013)	On-site	1	0.0001	1
	Off-site	1	0.0003	1
	All Cameras	**2**	**0.0002**	**2**
2 (2013)	On-site	0	0	0
	Off-site	11	0.0034	12
	All Cameras	**11**	**0.0019**	**12**
3 (2013-2014)	On-site	0	0	0
	Off-site	27	0.0033	28
	All Cameras	**27**	**0.0019**	**28**
4 (2014)	On-site	0	0	0
	Off-site	6	0.0024	6
	All Cameras	**6**	**0.0013**	**6**
5 (2014-2015)	On-site	1	0.0001	1
	Off-site	5	0.0006	5
	All Cameras	**6**	**0.0004**	**6**
6 (2015)	On-site	0	0	0
	Off-site	0	0	0
	All Cameras	**0**	**0**	**0**
7 (2015-2016)	On-site	1	0.0001	1
	Off-site	13	0.0014	17
	All Cameras	**14**	**0.0008**	**18**
8 (2016)	Zone 1	0	0	0
	Zone 2	0	0	0
	Zone 3	1	0.0006	1
	All Cameras	**1**	**0.0002**	**1**

[1] *Event data are not corrected for camera effort or for darkness factor.*
[2] *The number of individuals does not represent total number of individuals recorded across all events, as multiple events can be of the same individual utilizing the area surrounding the wildlife camera.*

Table 9.2-29b. Summary of Grey Wolf Detection Summary across All Cameras, September 2012 - September 2016

Survey Period	Camera Location	No. of Events (Raw)[1]	No. of Events/camera/day[1]	No. of Ind. Recorded On Events[1,2]
1 (2012-2013)	On-site	1	0.0001	1
	Off-site	12	0.0032	13
	All Cameras	**13**	**0.0011**	**14**
2 (2013)	On-site	14	0.0057	19
	Off-site	77	0.0238	77
	All Cameras	**91**	**0.0160**	**96**
3 (2013-2014)	On-site	3	0.0005	3
	Off-site	6	0.0007	7
	All Cameras	**9**	**0.0006**	**10**
4 (2014)	On-site	4	0.0020	4
	Off-site	16	0.0063	17
	All Cameras	**20**	**0.0044**	**21**
5 (2014-2015)	On-site	11	0.0016	13
	Off-site	4	0.0005	4
	All Cameras	**15**	**0.0010**	**17**
6 (2015)	On-site	3	0.0015	3
	Off-site	4	0.0018	4
	All Cameras	**7**	**0.0016**	**7**
7 (2015-2016)	On-site	11	0.0013	12
	Off-site	9	0.0009	9
	All Cameras	**20**	**0.0011**	**21**
8 (2016)	Zone 1	1	0.0005	1
	Zone 2	4	0.0025	9
	Zone 3	0	0	0
	All Cameras	**5**	**0.0009**	**10**

[1] *Event data are not corrected for camera effort or for darkness factor.*
[2] *The number of individuals does not represent total number of individuals recorded across all events, as multiple events can be of the same individual utilizing the area surrounding the wildlife camera.*

Most observations of furbearers were of single individuals; 93% of wolverine events and 96% of wolf events. It is important to note that the total individuals recorded across events do not necessarily represent detections of unique individuals, as it is likely that the same individual(s) was recorded across multiple events. Observations also do not necessarily capture all individuals in a group; only those within the field of view of the camera.

Seasonal Differences

Few seasonal trends in wolverine detection events were apparent in the camera data. In general, the event recording rates were low throughout the year (~0.5 events/100 camera days or less). Periods of consistent detections across weeks were recorded, for Weeks 13-25 (late March through mid-June) and Weeks 37-45 (mid-September through mid-November) (1-5 events; Table 9.2-30). During the winter period, wolverine detections were only recorded during the early winter (e.g., November) and late winter (March – April), with no detections from December through February.

Table 9.2-30. Summary of Wolverine and Grey Wolf Detections across All Cameras by Week Number, June 2013 to September 2016

Month (Approx.)	Week Number	No. of Events (Raw)		No. of Events (Corrected)[1]		Event Recording Rate (Events/100 Camera Days)[2]	
		Wolverine	Grey Wolf	Wolverine	Grey Wolf	Wolverine	Grey Wolf
January	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
	3	0	0	0	0	0	0
	4	0	2	0	3.78	0	4.11
	5	0	2	0	2.4	0	1.89
February	6	0	0	0	0	0	0
	7	0	0	0	0	0	0
	8	0	0	0	0	0	0
	9	0	0	0	0	0	0
March	10	1	0	1.15	0	0.26	0
	11	0	0	0	0	0	0
	12	0	2	0	2.3	0	0.33
	13	3	1	3.45	1.15	0.47	0.16
April	14	3	1	3.3	1.1	0.45	0.15
	15	4	1	4.4	1.1	0.57	0.14
	16	3	1	3.3	1.1	0.41	0.14
	17	2	0	2.2	0	0.27	0
May	18	2	0	2.2	0	0.29	0
	19	5	3	5.2	3.12	0.65	0.39
	20	2	4	2.08	4.16	0.26	0.52
	21	4	2	4.16	2.08	0.50	0.25
	22	1	3	1.04	3.04	0.11	0.33
June	23	2	5	2	5	0.22	0.54
	24	2	0	2	0	0.22	0
	25	1	2	1	2	0.08	0.17
	26	0	5	0	5	0	0.33
July	27	0	2	0	2.06	0	0.14
	28	1	2	1.03	2.06	0.07	0.14
	29	0	8	0	8.24	0	0.56
	30	1	8	1.03	8.24	0.07	0.57
August	31	0	9	0	9.69	0	0.67
	32	4	21	4.36	22.89	0.30	1.56
	33	4	30	4.36	33.79	0.30	2.33
	34	0	10	0	10.9	0	0.74
September	35	0	9	0	9.91	0	0.66
	36	0	6	0	6.84	0	0.46
	37	3	9	3.42	10.26	0.24	0.71
	38	3	9	3.42	10.26	0.27	0.81
	39	3	3	3.42	3.42	0.31	0.31

Month (Approx.)	Week Number	No. of Events (Raw)		No. of Events (Corrected)[1]		Event Recording Rate (Events/100 Camera Days)[2]	
		Wolverine	Grey Wolf	Wolverine	Grey Wolf	Wolverine	Grey Wolf
October	40	5	6	5.95	7.14	0.56	0.68
	41	1	0	1.19	0	0.11	0
	42	1	0	1.19	0	0.13	0
	43	1	0	1.19	0	0.14	0
November	44	1	0	1.19	0	0.17	0
	45	2	0	2.48	0	0.39	0
	46	0	0	0	0	0	0
	47	0	0	0	0	0	0
December	48	0	1	0	1.24	0	0.64
	49	0	0	0	0	0	0
	50	0	0	0	0	0	0
	51	0	0	0	0	0	0
	52	0	0	0	0	0	0
	53	0	0	0	0	0	0

[1] *Corrected for darkness factor.*
[2] *Event recording rate calculated using the events corrected for the darkness factor.*

Grey wolf activity (as recorded by wildlife camera) was fairly consistently recorded from Week 12 through Week 40, which corresponds roughly to mid-March through the end of September); during this period, events were recorded across all week numbers except 17, 18, and 24 (Table 9.2-30). The event recording rate recorded across the period from Weeks 12–40 was generally 1 event/100 camera day or less, except for a peak of 1.56 events/100 camera days and at 2.33 events/100 camera days on Weeks 32 and 33, respectively, corresponding to roughly mid to late August (Table 9.2-30). There were two other times when grey wolf events were recorded, Weeks 4-5 (late January) and Week 48 (early December).

Snow Track Surveys

Methods

Snow track surveys were conducted in the RSA from 2006 to 2008 as part of monitoring for Doris to provide an index of wolverine activity in the study area. With the assistance of Inuit hunters from Kugluktuk, survey plots 4 km^2 in size were located in areas that contained higher value habitat for wolverine (i.e., heath tundra – boulder associations, shoreline, and wetland habitats; Johnson C. J. and Boyce 2004).

A single 4 km transect line was surveyed in each plot. Transects were surveyed by two observers on snowmobile in late winter (Table 9.2-31). Snowmobiles were spaced approximately 25 m apart to either side of the transect line and driven at less than 15 km/hr. Wolverine tracks were documented by handheld GPS. The direction of travel, age of track, and snow and weather conditions was also recorded. A total of 27 to 49 transects were surveyed annually and covered northern areas of the RSA and areas surrounding Boston.

A detailed description of the survey methods and data analyses is provided in the 2006, 2007 and 2008 baseline studies for the Doris Project (Golder 2007, 2008a, 2009).

Table 9.2-31. Survey Dates for Snow Track Surveys Conducted in the RSA between 2006 and 2008

Year	Survey Dates	Number of Transects Surveyed
2006	May 2 to May 5	41
2007	April 24 to May 3	49
2008	May 15 to May 22	27

Results

The highest number of tracks was observed in 2007 due to greater coverage (Table 9.2-32); however, the proportion of transects with tracks was highest in 2008 (Table 9.2-32). After correcting for survey distance and days since threshold wind or snowfall (where tracks may become covered and undetected), the tracks/kilometre/day (TKD) index was similar among years. The majority of tracks observed during the study were from individual wolverine. One pair of tracks was observed in 2007. Overall, the distribution of tracks was widespread, but wolverine activity was highest near the coast in the north end of the RSA (Golder 2007, 2008a, 2009).

Table 9.2-32. Summary of Snow-tracking Transects Containing Wolverine Tracks, 2006 to 2008

	2006	2007	2008
Distance Surveyed (km)	164	196	104
Number of Transects Surveyed	41	49	27
Number of Tracks Observed	24	39	31
Number of Transects with Tracks	12	17	17
% Transects with Tracks	29%	35%	63%
TKD[1] ± 2SE	0.08 ± 0.06	0.17 ±0.13	0.19 ± 0.11

[1]*Mean number of tracks per km surveyed per days since last weather threshold*

Carnivore Den Surveys

Carnivore den surveys were conducted in 2014 in the area surrounding the Boston site and the proposed all-weather road. Surveys were flown by helicopter at an altitude of 50 to 100 m above ground level and at speeds between 30 to 80 km/h. The areas surveyed included eskers, riverbanks, and other landscape features which offered well drained soils and some vertical relief.

No wolf, wolverine or fox dens were observed during this dedicated carnivore den survey. However, several wolf and wolverine dens were identified by incidental observations (see Section on Incidental Observations; Figure 9.2-30).

Incidental Observations

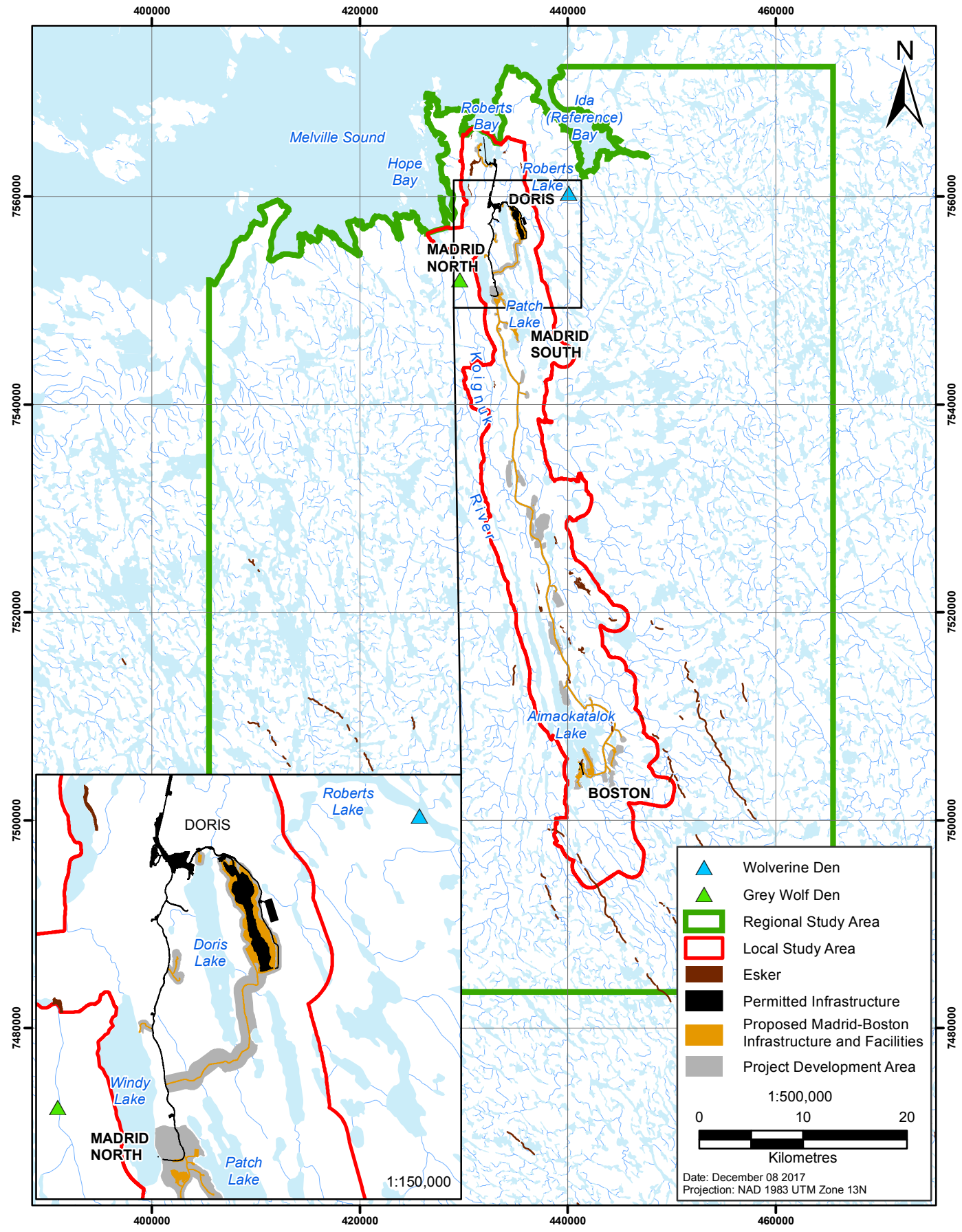
Methods

Methods for incidental collection of wildlife are identical to those for caribou and are discussed in Section 9.2.6.2. Incidental observations of wolverine and furbearers were recorded when:

1. observed by Doris mine personnel from 2009 and 2016 and recorded in the Wildlife Sighting Log for the Doris Project; and
2. observed by field personnel (wildlife biologists and other environmental personnel) recorded spatially or temporally outside of targeted VEC studies when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016.

Figure 9.2-30

Wolverine and Grey Wolf Den Locations in the Regional Study Area



Results

Incidental Observations of Wolverine and Grey Wolves by Site Personnel

Wolverine and grey wolves were recorded in the wildlife sightings log in all years between 2009 and 2016 (Tables 9.2-33 and 9.2-34). When data are combined, wolverine were observed during most months of the year except July, September and October (Table 9.2-33) and grey wolves were detected in all months except November and December (Table 9.2-34). Among years, wolverine were more commonly detected between February and May relative to the summer months, likely due to their high visibility against the snow and longer time in search of food (Table 9.2-33).

Table 9.2-33. Wolverine Observations from the Wildlife Sightings Standardized by Personnel on Site, 2009 to 2016

		No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
Year	Month	No. of Individuals	No. of Records		No. of Individuals	No. of Records
2009	Jan	0	0	69	0	0
	Feb	1	1	84	0.012	0.012
	Mar	0	0	94	0	0
	Apr	0	0	102	0	0
	May	1	1	102	0.01	0.01
	Jun	0	0	103	0	0
	Jul	0	0	113	0	0
	Aug	1	1	109	0.009	0.009
	Sep	0	0	98	0	0
	Oct	0	0	66	0	0
	Nov	0	0	16	0	0
	Dec	0	0	14	0	0
2010	Jan	0	0	83	0	0
	Feb	0	0	106	0	0
	Mar	1	1	131	0.008	0.008
	Apr	1	1	172	0.006	0.006
	May	0	0	182	0	0
	Jun	0	0	200	0	0
	Jul	0	0	220	0	0
	Aug	0	0	205	0	0
	Sept	0	0	484	0	0
	Oct	0	0	332	0	0
	Nov	0	0	147	0	0
	Dec	0	0	108	0	0
2011	Jan	1	1	214	0.005	0.005
	Feb	2	2	250	0.008	0.008
	Mar	0	0	265	0	0
	Apr	2	2	278	0.007	0.007
	May	3	3	274	0.011	0.011
	Jun	1	1	280	0.004	0.004
	Jul	0	0	284	0	0

Year	Month	No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
		No. of Individuals	No. of Records		No. of Individuals	No. of Records
	Aug	2	2	277	0.007	0.007
	Sep	0	0	277	0	0
	Oct	0	0	270	0	0
	Nov	1	1	252	0.004	0.004
	Dec	1	1	Unknown	-	-
2012	Jan	0	0	183	0	0
	Feb	2	2	193	0.01	0.01
	Mar	1	1	180	0.006	0.006
	Apr	2	2	127	0.016	0.016
	May	3	3	90	0.033	0.033
	Jun	0	0	103	0	0
	Jul	0	0	90	0	0
	Aug	0	0	93	0	0
2013	Mar	0	0	3	0	0
	Apr	0	0	13	0	0
	May	2	2	20	0.099	0.099
	Jun	0	0	44	0	0
	Jul	0	0	61	0	0
	Aug	0	0	59	0	0
	Sep	0	0	54	0	0
	Oct	0	0	49	0	0
	Nov	2	2	19	0.105	0.105
	Dec	0	0	8	0	0
2014	Jan	0	0	7	0	0
	Feb	1	1	7	0.143	0.143
	Mar	0	0	8	0	0
	Apr	0	0	14	0	0
	May	1	1	63	0.016	0.016
	Jun	0	0	71	0	0
	Jul	0	0	77	0	0
	Aug	0	0	79	0	0
	Sep	0	0	73	0	0
	Oct	0	0	79	0	0
	Nov	0	0	44	0	0
	Dec	0	0	7	0	0
2015	Jan	1	1	13	0.075	0.075
	Feb	1	1	16	0.062	0.062
	Mar	1	1	30	0.033	0.033
	Apr	0	0	28	0	0
	May	2	2	32	0.063	0.063
	Jun	0	0	41	0	0
	Jul	1	1	46	0.022	0.022

Year	Month	No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
		No. of Individuals	No. of Records		No. of Individuals	No. of Records
	Aug	1	1	84	0.012	0.012
	Sep	0	0	105	0	0
	Oct	2	1	114	0.018	0.009
	Nov	0	0	93	0	0
	Dec	1	1	89	0.011	0.011
2016	Jan	0	0	60	0	0
	Feb	1	1	73	0.01	0.01
	Mar	2	2	78	0.03	0.03
	Apr	0	0	93	0	0
	May	0	0	110	0	0
	Jun	0	0	123	0	0
	Jul	0	0	123	0	0
	Aug	0	0	129	0	0
	Sep	0	0	144	0	0
	Oct	0	0	158	0	0
	Nov	1	1	172	0.01	0.01
	Dec	0	0	169	0	0

**Whether or not wildlife are recorded can vary by factors other than number of personnel on site, e.g.; the type of animal, multiple reporting of same individuals by different observers, work activities (indoor vs outdoor; site-based vs field-based), number of daylight hours, visibility, novelty of the sighting, observer reporting enthusiasm, ability to identify animal, etc. **Personnel were on site in all months between 2009 and December 2016 except October – December 2012. Personnel totals do not include personnel at Boston Site.*

Table 9.2-34. Grey Wolf Observations from the Wildlife Sightings Standardized by Personnel on Site, 2009 to 2016

Year	Month	No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
		No. of Individuals	No. of Records		No. of Individuals	No. of Records
2009	Jan	0	0	69	0	0
	Feb	2	1	84	0.02	0.01
	Mar	1	1	94	0.01	0.01
	Apr	4	1	102	0.04	0.01
	May	8	3	102	0.08	0.03
	Jun	1	1	103	0.01	0.01
	Jul	4	5	113	0.04	0.04
	Aug	23	13	109	0.21	0.12
	Sep	12	6	98	0.12	0.06
	Oct	0	0	66	0	0
	Nov	0	0	16	0	0
	Dec	0	0	14	0	0
2010	Jan	0	0	83	0	0
	Feb	1	1	106	0.01	0.01
	Mar	0	0	131	0	0

Year	Month	No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
		No. of Individuals	No. of Records		No. of Individuals	No. of Records
	Apr	1	1	172	0.01	0.01
	May	1	1	182	0.01	0.01
	Jun	2	1	200	0.01	0.01
	Jul	3	2	220	0.01	0.01
	Aug	6	6	205	0.03	0.03
	Sep	4	1	484	0.01	0.00
	Oct	0	0	332	0	0
	Nov	0	0	147	0	0
	Dec	0	0	108	0	0
2011	Jan	0	0	214	0	0
	Feb	0	0	250	0	0
	Mar	1	1	265	0.00	0.00
	Apr	1	1	278	0.00	0.00
	May	0	0	274	0	0
	Jun	2	2	280	0.01	0.01
	Jul	0	0	284	0	0
	Aug	3	3	277	0.01	0.01
	Sep	3	3	277	0.01	0.01
	Oct	1	1	270	0.00	0.00
	Nov	0	0	252	0	0
2012	Jan	0	0	183	0	0
	Feb	0	0	193	0	0
	Mar	1	1	180	0.01	0.01
	Apr	0	0	127	0	0
	May	3	2	90	0.03	0.02
	Jun	0	0	103	0	0
	Jul	8	2	90	0.09	0.02
	Aug	0	0	93	0	0
2013	Mar	0	0	3	0	0
	Apr	0	0	13	0	0
	May	0	0	20	0	0
	Jun	0	0	44	0	0
	Jul	2	2	61	0.03	0.03
	Aug	4	4	59	0.07	0.07
	Sep	13	6	54	0.24	0.11
	Oct	0	0	49	0	0
	Nov	0	0	19	0	0
	Dec	0	0	8	0	0
2014	Jan	0	0	7	0	0
	Feb	0	0	7	0	0
	Mar	0	0	8	0	0
	Apr	0	0	14	0	0

Year	Month	No. of Observations from Raw Data*		Monthly Average of Personnel on Site**	No. of Observations per Personnel	
		No. of Individuals	No. of Records		No. of Individuals	No. of Records
	May	3	3	63	0.05	0.05
	Jun	4	2	71	0.06	0.03
	Jul	5	3	77	0.06	0.04
	Aug	3	3	79	0.04	0.04
	Sep	2	2	73	0.03	0.03
	Oct	0	0	79	0	0
	Nov	0	0	44	0	0
	Dec	0	0	7	0	0
2015	Jan	0	0	13	0	0
	Feb	1	1	16	0.06	0.06
	Mar	0	0	30	0	0
	Apr	0	0	28	0	0
	May	1	1	32	0.03	0.03
	Jun	0	0	41	0	0
	Jul	3	2	46	0.07	0.04
	Aug	0	0	84	0	0
	Sep	0	0	105	0	0
	Oct	3	1	114	0.03	0.01
	Nov	0	0	93	0	0
	Dec	0	0	89	0	0
2016	Jan	1	2	60	0.02	0.03
	Feb	2	1	73	0.03	0.01
	Mar	2	2	78	0.03	0.03
	Apr	0	0	93	0	0
	May	0	0	110	0	0
	Jun	3	2	123	0.02	0.02
	Jul	6	5	123	0.05	0.04
	Aug	2	2	129	0.02	0.02
	Sep	15	9	144	0.01	0.06
	Oct	0	0	158	0	0
	Nov	0	0	172	0	0
	Dec	0	0	169	0	0

**Whether or not wildlife are recorded can vary by factors other than number of personnel on site, e.g.; the type of animal, multiple reporting of same individuals by different observers, work activities (indoor vs outdoor; site-based vs field-based), number of daylight hours, visibility, novelty of the sighting, observer reporting enthusiasm, ability to identify animal, etc.*

***Personnel were on site in all months between 2009 and December 2016 except October – December 2012. Personnel totals do not include personnel at Boston Site.*

Peaks in grey wolf detections were recorded in August and September of some years (e.g., 2009, 2013 and 2016; Table 9.2-34). Most observations of wolverine and grey wolves recorded by mine site personnel were of individuals, although on one occasion, a pair of wolverines were detected (October 2015; ERM 2016a) and on several occasions, small groups of grey wolves (2 to 7 individuals) were observed together (Rescan 2010, 2011c, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Incidental Observations of Wolverine and Furbearers by Field Personnel

During baseline and monitoring studies conducted in the RSA between 2006 and 2016, incidental observations of wolverine were recorded in all years except 2014 and 2015, and grey wolves were recorded in all years. Other furbearer species that have been recorded incidentally in the RSA during baseline studies conducted between 2006 and 2016 include arctic fox and red fox and least weasel. In addition to incidental observations of furbearers within the RSA, a possible wolverine den was detected incidentally in 2006 on the south side of Roberts Lake, and in 2007, a wolf den with eight wolf pups was observed incidentally along the Koignuk River bank (Figure 9.2-30).

Habitat Suitability Modeling

Methods

Habitat suitability modeling was conducted in the LSA and RSA for wolverine and grey wolf. Methods are discussed in Section 9.2.6.5 and Appendix V4-9A.

Wolverine

Habitat suitability modeling for wolverine focused on identifying suitable denning habitat during the late winter (Table 9.2-35), as the availability of adequate security cover (i.e., dens) for kits in winter can affect wolverine productivity (Banci 1994; Persson 2005). Wolverine use two types of dens for reproduction: natal dens, where the young are born, and maternal dens, where the mother may move the kits if the conditions at the natal den are no longer suitable (Magoun and Copeland 1998). The peak period for birthing is February to mid-March (Magoun and Copeland 1998; Inman et al. 2012) which is earlier than other carnivore species (e.g., wolves, and foxes).

Table 9.2-35. Seasonal Life Requisites of Wolverine Denning

Season	Date	Life Requisite	Habitat Preference
Denning	February to early May	Living and Reproducing	Landscape features that provide deep, persistent snow packs.

Grey Wolf

The life requisites rated for habitat suitability for the grey wolf are living and reproducing during spring (denning) period (Table 9.2-36). The highest value habitats for wolf denning is considered to be esker habitat, and prey sources near den sites are also considered to be important. Wolves breed once per year, typically during March or April. After a nine-week gestation period, litters remain in dens for up to two weeks. Throughout the late spring and early summer pups remain close to dens, while adults hunt nearby. By late summer to early fall, the maturing juveniles join the pack as it follows caribou and begin to participate in hunting activities. Hence, the highest ratings were assigned to esker habitats, and moderate to nil ratings were assigned to habitats in relation to the ability of that habitat to provide prey sources (e.g., caribou and muskox).

Table 9.2-36. Seasonal Life Requisites of Grey Wolf

Season	Date	Life Requisite	Habitat Preference
Denning	May - July	Living and Reproducing	Eskers, nearby prey sources

Results

Wolverine

Habitat suitability modeling indicated that approximately 19% of the LSA was suitable for denning, while the remainder of the LSA was classified as "Not Suitable" (Table 9.2-37). Suitable habitat is defined as terrain that could accumulate snow to maintain denning habitat over the early spring season.

Table 9.2-37. Area and Percentage of Seasonal Habitat within the Wildlife Local Study Area and Regional Study Area for Wolverine

		Local Study Area[1]		Regional Study Area[2]	
Season	**Suitability Rating**	**Area (ha)**	**Percent (%)**	**Area (ha)**	**Percent (%)**
Denning	Suitable	10,666.8	18.9%	173,359.9	35.2%
	Not Suitable	45,673.2	81.1%	313,620.3	63.8%

[1] LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the EM data (see Section 9.2.3.3).
[2] RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.). A total of 4,843.7 ha were categorized as unclassified likely due to coverage of the imagery by cloud cover.

Habitat suitability modeling in the RSA indicated that 35.2% of the RSA was classified as suitable denning habitat for wolverine with the remainder classified as Not Suitable (Table 9.2-37). Suitable denning habitat was generally dispersed throughout the RSA, although larger proportions of suitable wolverine denning habitat were located within the LSA and in areas east and west of the LSA (Figure 9.2-31a).

Grey Wolf

The results of the suitability mapping indicate that high value denning habitat is rare in the LSA (0.7%), (Table 9.2-38). The limited amount of high value denning habitat in the LSA is consistent with studies in the Canadian Arctic, which indicate that esker habitat comprises approximately 1-2% of the landscape (McLoughlin et al. 2004). The rarity of suitable denning habitat is likely a limiting factor for the expansion of northern populations of wolves (McLoughlin et al. 2004) (Table 9.2-38).

Table 9.2-38. Area and Percentage of Seasonal Habitat within the Wildlife Local Study Area and Regional Study Area for Grey Wolf

		Local Study Area[1]		Regional Study Area[2]	
Season	**Suitability Rating**	**Area (ha)**	**Percent (%)**	**Area (ha)**	**Percent (%)**
Spring (Denning)	High	395.3	0.7%	1,234.5	0.3%
	Moderate	19,112.0	34.0%	14,234.2	2.9%
	Low	33,329.1	59.2%	11,490.7	2.3%
	Nil	3,440.6	6.1%	460,020.9	93.5%

[1] LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the TEM data (see Section 9.2.3.3).
[2] RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.3). A total of 4,843.7 ha were categorized as unclassified likely due to coverage of the imagery by cloud cover.

Within the RSA, habitat suitability modeling indicated that the RSA is very limited in the amount of denning habitat available for grey wolves. Only 0.3% of the RSA was classified as high value denning habitat (Table 9.2-38). In addition, small amounts of the RSA were classified as moderate and low grey wolf denning habitat, 2.9% and 2.3%, respectively (Table 9.2-38). The majority of the high value denning habitat for grey wolf is south east of Boston camp (Figure 9.2-31b).

9.2.9.3 The Doris Project

The Doris Project was issued a project certificate in 2006 and is principal component of the Existing and Approved Projects. As part of the WMMP plan, monitoring of furbearers (focused on wolverine) included habitat loss due to construction of the Doris Project, possible sensory disturbance and avoidance of the Doris Project site, attraction to the Doris Project and any direct mortality due to collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Surveying and monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance phases since 2006, as part of the ongoing WMMP. This section summarizes the results of these monitoring activities for furbearers.

Habitat Loss

Habitat lost within the Doris Project footprint has been measured since construction started in 2009 (see Section 9.2.6.3 for further details on the evaluation of habitat loss for the Doris Project for VECs). The Doris Project infrastructure was measured in 2016 as 83.0 ha, or 2.7% of the LSA from the 2006 FEIS for the Doris Project (ERM 2017a). The majority of habitat loss for wolverine occurred in habitat types rated as low or moderate: heath tundra (33.6 ha) and tussock/hummock (29.5 ha) (Table 9.2-14). Of the 83.0 ha of habitat lost, 80.4ha of habitat lost was classified as suitable wolverine habitat (Table 9.2-13). This represents an actual loss of 0.04% of the total suitable habitat identified for wolverine within the RSA from the 2006 FEIS for the Doris Project (Table 9.2-39).

Table 9.2-39. Area of Suitable Habitat Disturbed for Wolverine

		Amount of Suitable[1] Habitat in RSA[2]		Actual Disturbed Suitable Habitat	
Species	**Season**	**Total (ha)**	**% of RSA[2]**	**Total (ha)**	**% of RSA[3]**
Wolverine	N/A	226,850	60.4	80.4	0.04

1 Suitable Habitat does not include Nil-rated habitat in study area.
2 Calculations based on: RSA area of 374,052 ha for Caribou, Grizzly Bear and Wolverine.
3 Calculations based on total amount of suitable habitat in RSA.

Sensory Disturbance

The WMMP evaluates the potential for sensory disturbance to cause wolverine to avoid the Doris Project site. The distribution of wolverine was monitored in 2005 and 2006 using snow track surveys near the Doris Project sites and at a greater distance (control) sites, and since 2012, using motion-triggered cameras. This monitoring protocol provides a basic measure of whether a ZOI is present.

Following a review of the snow data, it was determined that this method was not generating sufficient information and was discontinued in 2009. Similarly, the wildlife camera program indicated too few detections of wolverine to meaningfully compare whether wolverine were more frequently recorded at Treatment or Control cameras (ERM 2016a).

Since the wildlife camera data was collected, a re-design of the camera program was requested to address a variety of comments from regulators including the GN DOE and KIA on their placement and use. The redesigned camera program will increase the robustness of spatial and temporal analysis of wolverine and furbearer detections by wildlife cameras, and will better evaluate ZOI-type effects of sensory disturbance (ERM 2016c, 2017a).

Figure 9.2-31a
Wolverine Denning Habitat Suitability in the Local Study Area and Regional Study Area

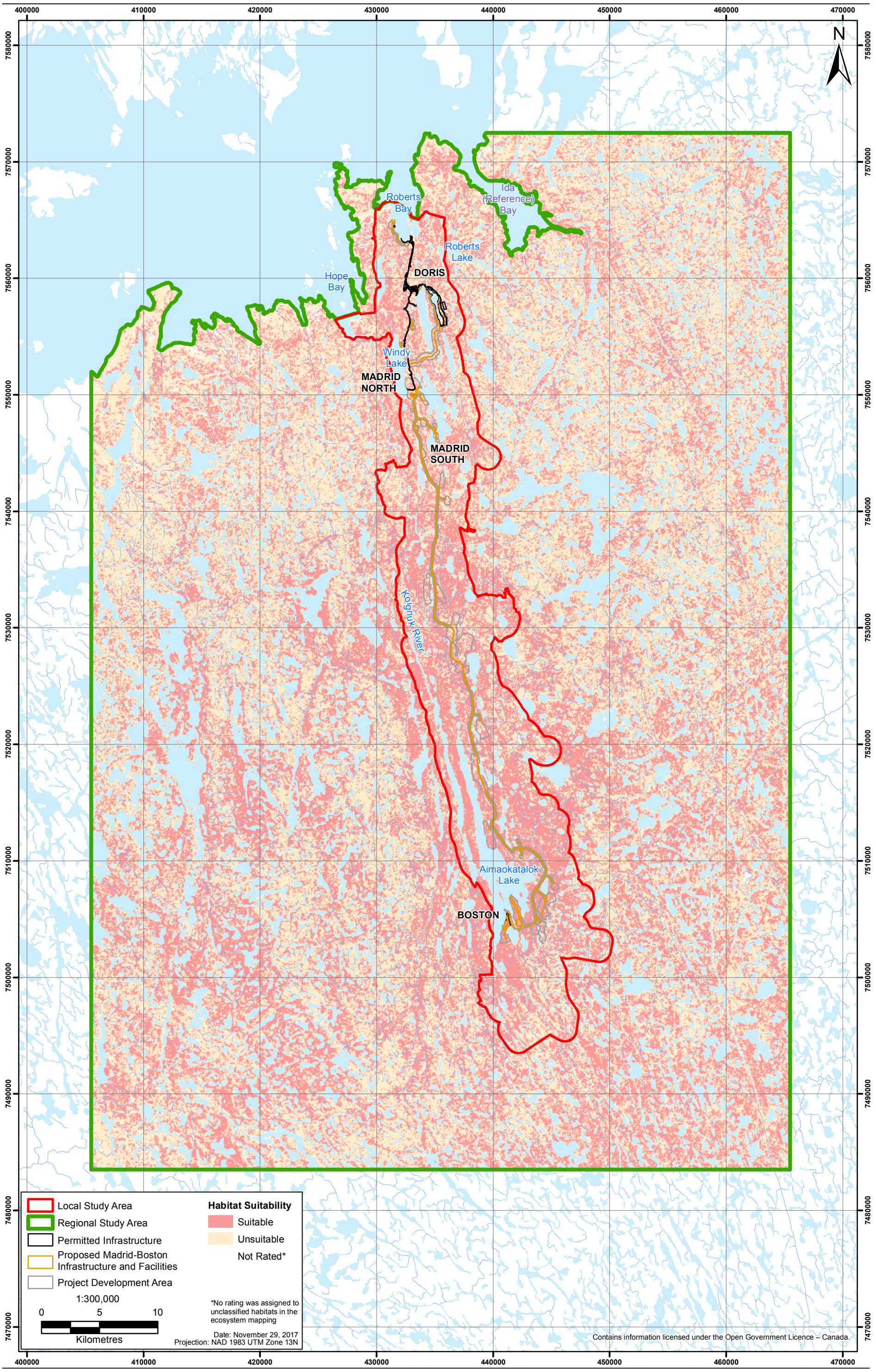
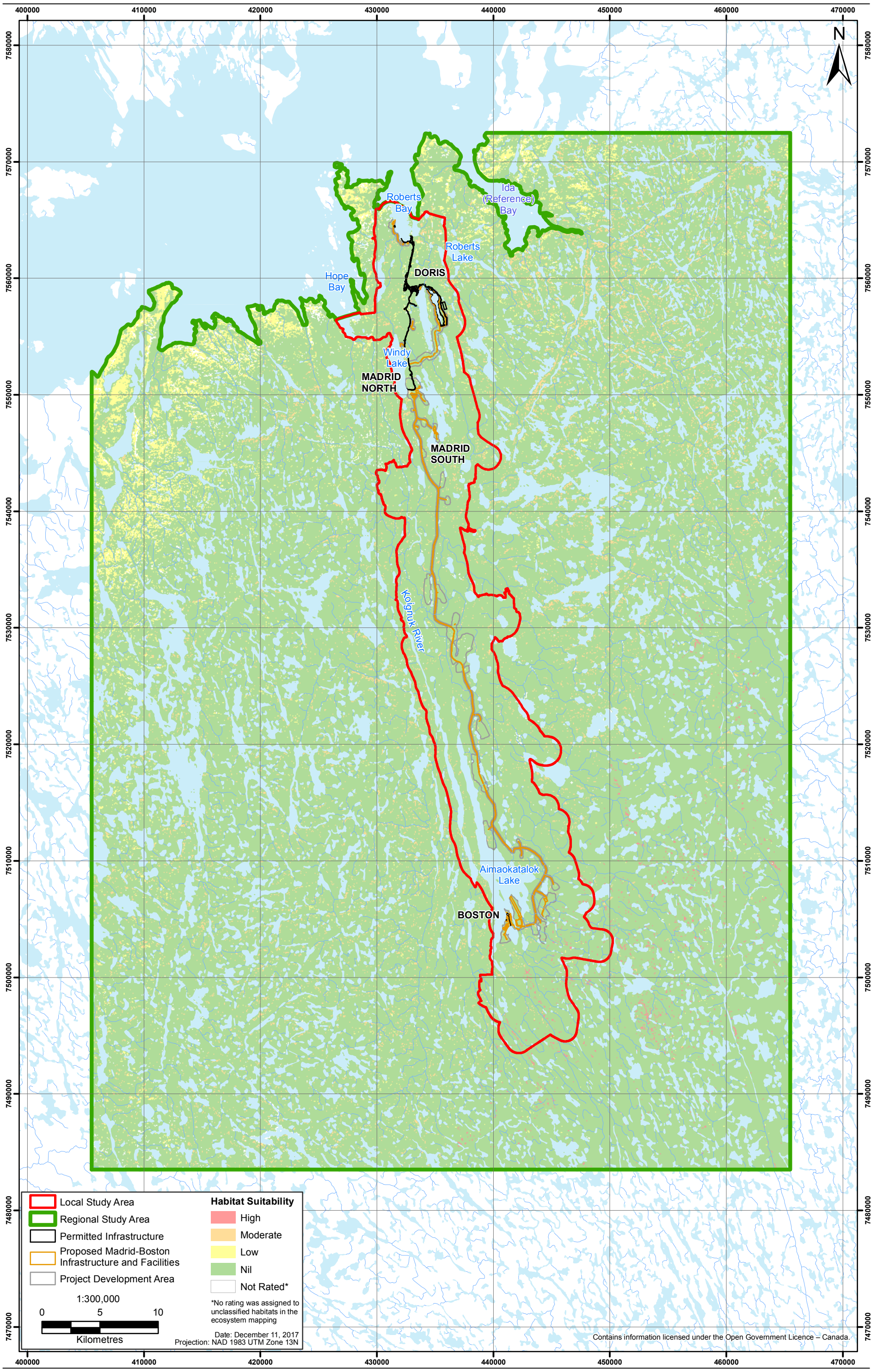


Figure 9.2-31b
Grey Wolf Spring (Denning) Habitat Suitability in the Local Study Area and Regional Study Area



Attraction to the Doris Project

The WMMP also evaluates if wolverine are attracted to infrastructure. Wildlife interactions were monitored and documented annually at the Doris Project since 2006, in order to maximize wildlife and human safety, and identify any possible effects the Doris Project may have on wildlife such as wolverine or furbearers. The majority of attraction events since 2006 involved wolverines or furbearers being attracted to landfill or other facilities due to improper waste management practices or denning opportunities (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). For example, in 2009, improperly disposed garbage attracted wolves to Windy camp, with near-daily wolf sightings in late summer (August)(Rescan 2010). In November 2010, daily sightings of one to three wolverines were recorded at Roberts Bay or Doris Site by camp personnel (Rescan 2011c). Noise deterrents (bear bangers, shotgun screamers) were used on two occasions to deter wolverines, and on three occasions rubber bullets were used. In 2010, the waste management building at Roberts Bay was identified as the focus of the wolverines' attention, thus a skirting barrier was installed to prevent wolverines from getting under the building and prevent denning opportunities (Rescan 2011c). Staff at Doris Site evaluated the buildings for potential and used entry points for wolverines. These entry points were repaired with suitable materials to prevent wolverine entry. Wolverines were recorded once more at the end of November and three times in December in the Roberts Bay area, but no further incidents were reported (Rescan 2011c).

One additional incident involved a red fox that denned successfully under the pumphouse facility in 2013 (ERM Rescan 2014a). More recently, in 2015 four Arctic fox were attracted to the Waste Management seacan containing grease that had leaked onto the floor of the seacan (ERM 2016a). Grease was cleaned and seacan will need to be moved where wildlife cannot access it (ERM 2016a). No incidents have resulted in wolverine or furbearers being dispatched (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

There were wildlife cameras that were placed in locations to monitor for attraction of carnivores and scavengers to Doris Project infrastructure. One camera (22a) was located at the Boulder Garden at the outflow of Roberts Lake in Roberts Creek to monitor wildlife activity around the stream, which is a natural fishing area for predators, and where a fish fence was placed for field studies conducted as part of the monitoring program for fish and aquatics (Volume 5, Section 6, Freshwater Fish). Two cameras (18b and 21b) were deployed to monitor wildlife activity at the Roberts Bay Waste Management Facility.

Wolverine activity was not recorded on any of these cameras. Eleven grey wolf events were recorded at Roberts Creek (22a) during the winter of 2012/2013 and during the summer of 2013 (68 events) and 2014 (6 events). Grey wolf events were not recorded at either of the two cameras located at the Roberts Bay Waste Management Facility from September 2012 and August 2015. These data indicate that the waste management facility is not acting as an attractant for either wolverine or grey wolf.

Direct Mortality

Any wildlife mortality, including wolverine or furbearers that have been observed by onsite personnel were reported immediately to the ESR Department and in the annual WMMP report. Mortality of VECs or larger fauna, or mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE and KIA, as necessary.

In the years that personnel have been at the Doris Project site (2006-2016), there have been no reports of wolverine or grey wolf morality of any sort, including from vehicle and aircraft strikes (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). In the same time period, three incidents of red fox mortality have occurred; none of these mortalities were vehicle or aircraft related incidents. One dead red fox was found in the Roberts Bay area during 2009

(Rescan 2010). This fox appeared to have died of natural causes and ESR personnel were instructed by the Cambridge Bay Conservation Officer to dispose of the fox through incineration (Rescan 2010). In 2014, a human-caused wildlife mortality (a mortality due to unknown causes) involved a red fox carcass that was found intact near the Doris Portal) (ERM 2015a). At the request of the GN DOE, the red fox carcass was shipped offsite to the GN DOE for necropsy; no results were provided. In 2014, site staff reported finding a deceased red fox inside the Doris portal switchgear station (ERM 2015a). The cause of the mortality was unknown and the carcass was intact. The KIA and GN DOE were notified April 15/14, and the fox was held at site in a freezer until it could be shipped offsite May 6/14 to GN DOE for necropsy (ERM 2015a). As of the date of this report, no results were provided.

Environmental Media Quality

The human health and ecological risk assessment (Volume 7, Section 2) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on furbearers due to Doris Project activities.

9.2.10 Characterization of Baseline Conditions for Raptors

9.2.10.1 Introduction

Four species of cliff-nesting raptors have the potential to breed in the RSA (Table 9.2-40): peregrine falcon (*Falco peregrinus tundrius*), gyrfalcon (*Falco rusticolus*), rough-legged hawk (*Buteo lagopus*), and golden eagle (*Aquila chrysaetos*). Common ravens (*Corvus corvax*), which are considered to be functional raptors, also have potential to breed in the RSA and are thus included in this assessment. Although no direct evidence of breeding has been documented in the Hope Bay Project area for bald eagle (*Haliaeetus leucocephalus*), nesting records of this species have been documented in nearby areas (Sabina 2015a) and the species has recorded in the Hope Bay Project area during the migration period. Golden eagle are listed as Vulnerable in Nunavut, while gyrfalcon and peregrine falcon are listed as Apparently Secure (CESCC 2016).The conservation status of rough-legged hawk in Nunavut is undetermined, as the species is determined to be unrankable in the latest report (2015), which means that there is not enough information to assign a rank or there is substantially conflicting information about status or trends in Nunavut (CESCC 2016); in 2010, the status of the species was Sensitive (CESCC 2016). Peregrine falcon, *tundrius* subspecies, is federally listed on Schedule 1 as a population of Special Concern under SARA (Government of Canada 2017).

Three ground-nesting raptor species: snowy owl (*Bubo scandiacus*), short-eared owl (*Asio flammeus*), and northern harrier (*Circus cyaneus*) also have the potential to breed within the RSA (Table 9.2-40). The short-eared owl is listed as Vulnerable in Nunavut and is listed on Schedule 1 as a species of Special Concern under *SARA* (CESCC 2016; Government of Canada 2017).

Table 9.2-40. Raptor Species Detected in the RSA and their Conservation Status

Common Name	Scientific Name	Conservation Status				
		Terr. Rank	COSEWIC	*SARA*	Global Rank	IUCN Red List[1]
Peregrine Falcon	*Falco peregrinus tundrius*	Apparently Secure	Special Concern	Schedule 1	G4T3	Least Concern
Gyrfalcon	*Falco rusticolus*	Apparently Secure	Not at Risk	-	G5	Least Concern
Rough-legged Hawk	*Buteo lagopus*	Unrankable/ Undetermined	Not at Risk	-	G5	Least Concern

Common Name	Scientific Name	Conservation Status				
		Terr. Rank	COSEWIC	*SARA*	Global Rank	IUCN Red List[1]
Golden Eagle	*Aquila chrysaetos*	Vulnerable	Not at Risk	-	G5	Least Concern
Common Raven	*Corvus corvax*	Secure	Not at Risk	-	G5	Least Concern
Bald Eagle	*Haliaeetus leucocephalus*	Unrankable/ Undetermined	Not at Risk	-	G5	Least Concern
Snowy Owl	*Bubo scandiacus*	Apparently Secure	Not at Risk	-	G5	Least Concern
Northern Harrier	*Circus cyaneus*	Unrankable/ Undetermined	Not at Risk	-	G5	Least Concern
Short-eared Owl	*Asio flammeus*	Vulnerable	Special Concern	Schedule 1	G5	Least Concern

Population Trends and Conservation

Raptors and their nests are protected under the *Nunavut Wildlife Act* (2003) and the *Canada Wildlife Act* (1985; on National Wildlife Refuges and Migratory Bird Sanctuaries). Though most raptors are long distance migrants, raptors are not protected under the *Canadian Migratory Bird Convention Act* (1994b).

The populations of several raptor species, including tundra peregrine (peregrine falcon) declined in the 1970s as a result of bio-accumulation of toxins like dichlorodiphenyltrichloroethane (DDT), which resulted in hatching failure caused by eggs with thin shells (Hickey and Anderson 1968). Since DDT and other organochlorine pesticides were banned in North America, peregrine falcon populations have recovered to pre-decline numbers of an estimated 1,500 to 2,000 pairs in the Canadian Arctic (COSEWIC 2007). However, the population is relatively small making tundra peregrines potentially vulnerable to natural and human disturbances.

Golden eagle populations are relatively stable in Canada and Alaska but declining elsewhere, whereas bald eagle populations appear to be increasing in the Arctic (Buehler 2000; Kochert and Steenhof 2002).

There is no evidence that the abundance of North American populations of gyrfalcons and rough-legged hawks have changed over the long-term (Bechard and Swem 2002; Booms, Cade, and Clum 2008). Populations of both species in the Canadian Arctic are known to fluctuate in response to weather, and to prey availability, particularly where these species specialize on prey that show strong cyclical trends in abundance (Gunn 2003; Barichello and Mossop 2011). Gyrfalcon reproductive productivity and population abundance are strongly tied to the three to four year abundance cycle of ptarmigan, which form the majority of their prey early in the breeding season (Barichello and Mossop 2011; Nielsen 2011). Similarly, the reproductive performance of rough-legged hawks at Bathurst Inlet was positively correlated with the abundance of lemmings (K. G. Poole and Bromley 1988a), whose populations cycle in abundance every three to four years (Krebs 1964).

Similar to the rough-legged hawk, Arctic populations of ground-nesting raptors (snowy owl, short-eared owl, and northern harrier) fluctuate cyclically in response to the abundance of lemmings and other small mammals (Parmelee 1992; Wiggins, Holt, and Leasure 2006). In addition to short-term cyclical fluctuations, the short-eared owl has shown a long-term, widespread decline in North America since the 1970s (COSEWIC 2008). Canadian populations of the short-eared owl appear to have decreased by 43% from 1966 to 1989 (GNWT ENR 2012), and by 23% between 1998 and 2008 (COSEWIC 2008). The snowy owl was designated as Not at Risk by COSEWIC in 1995 because this species is widespread and

there is no evidence of population declines. Approximately 30,000 pairs of snowy owls occurred in Canada in the early 1900s (Kirk, Hussell, and Dunn 1995).

Distribution and Migration Patterns

Raptors can be divided into two guilds based on migration and nesting patterns. The gyrfalcon, snowy owl, and common raven overwinter in the Arctic. Inuit TK includes observations of snowy owls and common ravens occurring in the Hope Bay Project area in winter (Banci and Spicker 2016). All other species migrate south in the fall and return in the spring to breed, although TK information suggests that some rough-legged hawk may also stay in winter (Banci and Spicker 2016).

During the breeding season, cliff-nesting raptors are distributed throughout the Arctic in areas where steep cliffs provide suitable habitat for breeding. Inuit TK has identified major nesting areas along the south coast of the Kent Peninsula, including the islands in Elu Inlet, near the mouths of major river systems including the Perry River, Tingmeak River, and Ellice River, Omingmaktok, and a large area on east Kiligiktokmik and also one area within the RSA near the coast (Banci and Spicker 2016).

Cliff-nesting migratory raptor species typically arrive on the tundra in May, and initiate egg-laying soon thereafter and then leave in October (K. G. Poole and Bromley 1988a). Since gyrfalcons and common ravens winter in the Arctic, both species initiate breeding earlier than the other raptor species, usually beginning in April, though clutch initiation has been observed as early as late March (K. G. Poole and Bromley 1988a; Barichello and Mossop 2011). Cliff-nesting raptors can make long distance movements from nests to search for food during the breeding season (e.g., up to approximately 50 km), but more typically forage within about 12 km from nest sites (Table 9.2-41).

Table 9.2-41. Average Home Range Size of Cliff-nesting Raptor Species

Species	Breeding Home Range (ha)	Maximum Breeding Home Range Radius (km)	Average Foraging Distance during Breeding (km)	Maximum Ranging Distance during Breeding (km)	Source
Golden Eagle	900 to 13,000	< 11	Few data	51	Kochert et al. (2002)
Rough-legged Hawk	Few data	Few data	Few data	Few data	-
Gyrfalcon	14,000 to 120,000	< 11	Few data	35	Booms, Cade, and Clum (2008)
Peregrine Falcon	35,000 to 150,000	< 12	5 (3 to 8)	43	C. M. White et al. (2002)

After breeding, gyrfalcon and common raven migrate from the breeding cliffs to wintering areas (Banci and Spicker 2016). Some gyrfalcon populations make short movements between breeding cliffs and wintering areas, while some populations migrate thousands of kilometers over the Arctic ocean to ensure access to abundant prey during winter (Burnham and Newton 2011).

Snowy and short-eared owls naturally occur at low densities, while northern harriers within the RSA represent individuals at the extreme northern limit of the species' range (Parmelee 1992; Wiggins, Holt, and Leasure 2006; K. G. Smith et al. 2011). Like migratory cliff-nesting raptors, the ground-nesting short-eared owl and northern harrier typically arrive on the tundra from southern latitudes in May, and leave before late October. Snowy owls are both migratory and resident species — some individuals migrate south for the winter, and some overwinter in the Arctic, especially in years when prey are abundant (Therrien, Gauthier, and Bety 2011). Recent satellite tracking has revealed that overwintering snowy owls migrate across the sea ice to access prey, such as seabirds using open water areas (Therrien, Gauthier, and Bety 2011).

Habitat Use

According to scientific research and Inuit TK, cliff-nesting raptors in the Arctic select sites on cliffs and rocky outcrops for nesting (K. G. Poole and Bromley 1988b; Banci and Spicker 2016). To provide protection from mammalian predators, nests are usually located on steep ledges at heights that make the ledges inaccessible from the bottom or top of the cliff. Overhang is an important habitat feature for gyrfalcons and common ravens, because they initiate breeding early in the year, when weather can limit breeding productivity (K. G. Poole and Bromley 1988a; Cade and Bird 2011). The availability of high quality cliff sites is likely an important determinant of breeding success, as indicated by the repeated occupancy of the same cliff sites by breeding raptors (Sinclair et al. 2003; Burnham, Burnham, and Newton 2009).

Nest are also selected based on prey abundance. For example, peregrine falcons often hunt from a perch location requiring 'look-outs' over areas such as wetlands with abundant small birds (C. M. White et al. 2002). The cliffs along Bathurst Inlet provide high quality raptor habitat as indicated by a high density of peregrine falcon nests (Northwest Territories and Nunavut Raptor Data Base (COSEWIC 2007). Common ravens use similar food and breeding resources as cliff-nesting raptors, and construct stick nests on cliffs that can be used later by raptor species for nesting (K. G. Poole and Bromley 1988a; K. G. Poole 2011).

During the breeding season, ground-nesting raptors are associated with wetland habitat, where their small mammal prey is more abundant. Observations of ground-nesting raptors using wetland habitats for foraging are described by Inuit within the Hope Bay Project area (Banci and Spicker 2016). Snowy owls choose dense, hummocky, dwarf shrub meadows for nesting (Parmelee 1992). Short-eared owls frequently choose a nesting site adjacent to wetlands where they hunt for small mammals (Wiggins, Holt, and Leasure 2006; COSEWIC 2008). The northern harrier nests near grassy wetlands (K. G. Smith et al. 2011).

9.2.10.2 Baseline Data for Raptors

Four baseline surveys were conducted to document the activity of raptors in the RSA:

1. aerial surveys to determine occupancy and productivity of cliff-nesting raptors nests (see Section 9.2.3.8);
2. stand watches during migration at wind tower locations.
3. ground-based surveys for upland birds and ground-nesting raptors.
4. habitat suitability modeling for cliff and ground-nesting raptors.

In addition, observations of raptors were reported incidentally by field staff during other studies conducted in the RSA and by TMAC personnel.

Aerial Surveys for Cliff-nesting Raptor Nests

With the exception of 2008, surveys were conducted from 2006 to 2015 to estimate the relative abundance, distribution, and productivity of cliff-nesting raptor species in the RSA (Golder 2007, 2008a; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a). Surveys conducted from 2006 to 2011 covered the majority of the RSA. From 2012 to 2015, the survey area was smaller and focussed on the area surrounding the Doris Project.

Two aerial surveys of nest sites were conducted annually; an occupancy survey to determine which of the previously known or new nest sites raptors have occupied and a productivity survey later in the

summer to determine which occupied nests have been successful at raising young. Surveys were conducted by flying along cliff faces in known or potential raptor territories.

The occupancy surveys were conducted in early to mid-June at historical and newly found nests. Nests were "occupied" if one adult bird, two birds together, or a nest containing eggs or young was observed. In some years (e.g., 2015), nests that contained recent evidence of use but no adults or eggs were observed were classified as "possible attempts". If no raptors were observed after two or more passes with the helicopter, the site was considered "unoccupied".

From 2006 to 2012, the occupancy rate was calculated as the number of nests occupied/surveyed. From 2013 to 2015, the occupancy rate was calculated as the number of occupied territories/raptor territories surveyed (see ERM Rescan 2014a; ERM 2015b; 2016a for more detailed descriptions on raptor nests vs. raptor territories). A nesting territory was defined as a physical area with multiple nest sites (typically a band of cliffs) where only one nest was occupied by a particular species per year (Steenhof and Newton 2007). These territories are biologically relevant because raptors of the same species will seldom nest in close proximity to each other, so the existence of one nest will exclude raptors from using nearby nesting sites.

A productivity survey was flown in late July or early August of each survey year to determine the success (at least one bird fledged) and productivity (total number of successful fledglings) of nests identified during the occupancy survey. From 2006 to 2012, nests were considered successful if young birds were observed at the site. No surveys were conducted in 2008. From 2013 to 2015, nests were considered successful if at least one young raptor fledged from the nest. The age of the nestling was approximated during the productivity surveys and it was assumed that young that were 80% of their fledging age would have likely fledged from that nest (Steenhof and Newton 2007). In addition, from 2013 to 2015, a successful nest was presumed for empty nests which had evidence that the breeding pair had successfully fledged young (e.g., prey remains, abundant faeces, etc.).

Additional nests found occupied during the productivity survey were recorded, but for consistency across all surveys, were not included in the calculations of nesting success and productivity since the status of the nest earlier in the season was unknown at these territories. These additional sites were surveyed during subsequent occupancy surveys in following years. Productivity was calculated as the number of young per occupied nest (2006 to 2012 surveys, except 2008) or territory (2013 to 2015 surveys).

Detailed rationale, methodology, data analyses and results for the raptor baseline surveys are provided in the baseline study reports and WMMP reports for the Doris Project (Golder 2007, 2008a; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a).

A total of 222 nests have been discovered and monitored in the RSA between 2006 to 2015, including 97 in the LSA (Table 9.2-42; Figure 9.2-32a and 9.2-32b). Many nests have been occupied over multiple years. Of the monitored cliff nests in the LSA, 16 occur within 1 km of proposed infrastructure – one near Boston, six near Madrid South, six near Madrid North, and three near Doris infrastructure. None of the nests within 1 km of infrastructure belonged to peregrine falcon; the majority belonged to rough-legged hawks (11 nests), followed by gyrfalcon (three nests) and common raven (two nests).

Figure 9.2-32a
Raptor Nest Site Locations in the Northern Portion of the Regional Study Area, 2006 to 2015

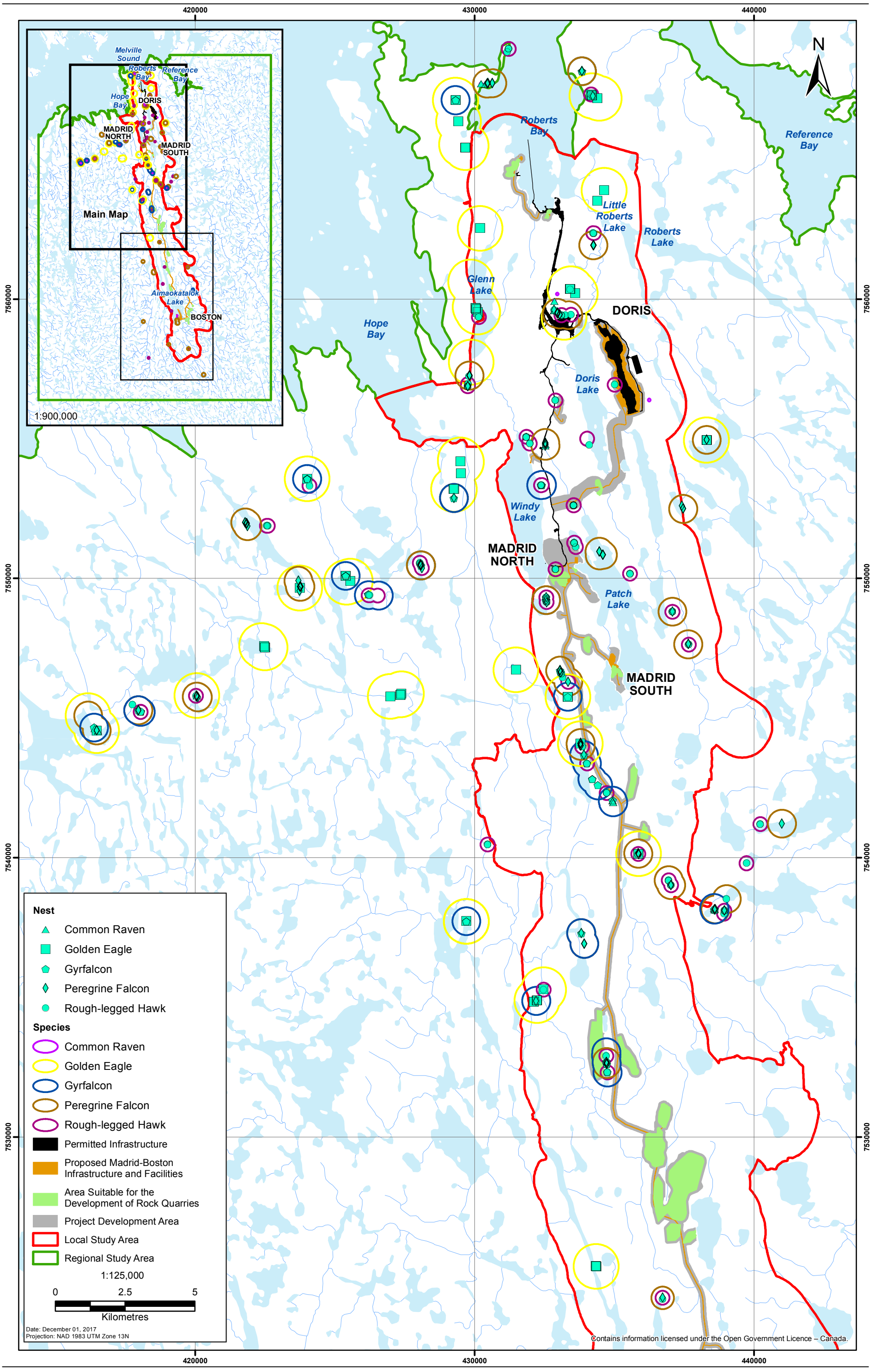


Figure 9.2-32b
Raptor Nest Site Locations in the Southern Portion of the Regional Study Area, 2006 to 2015

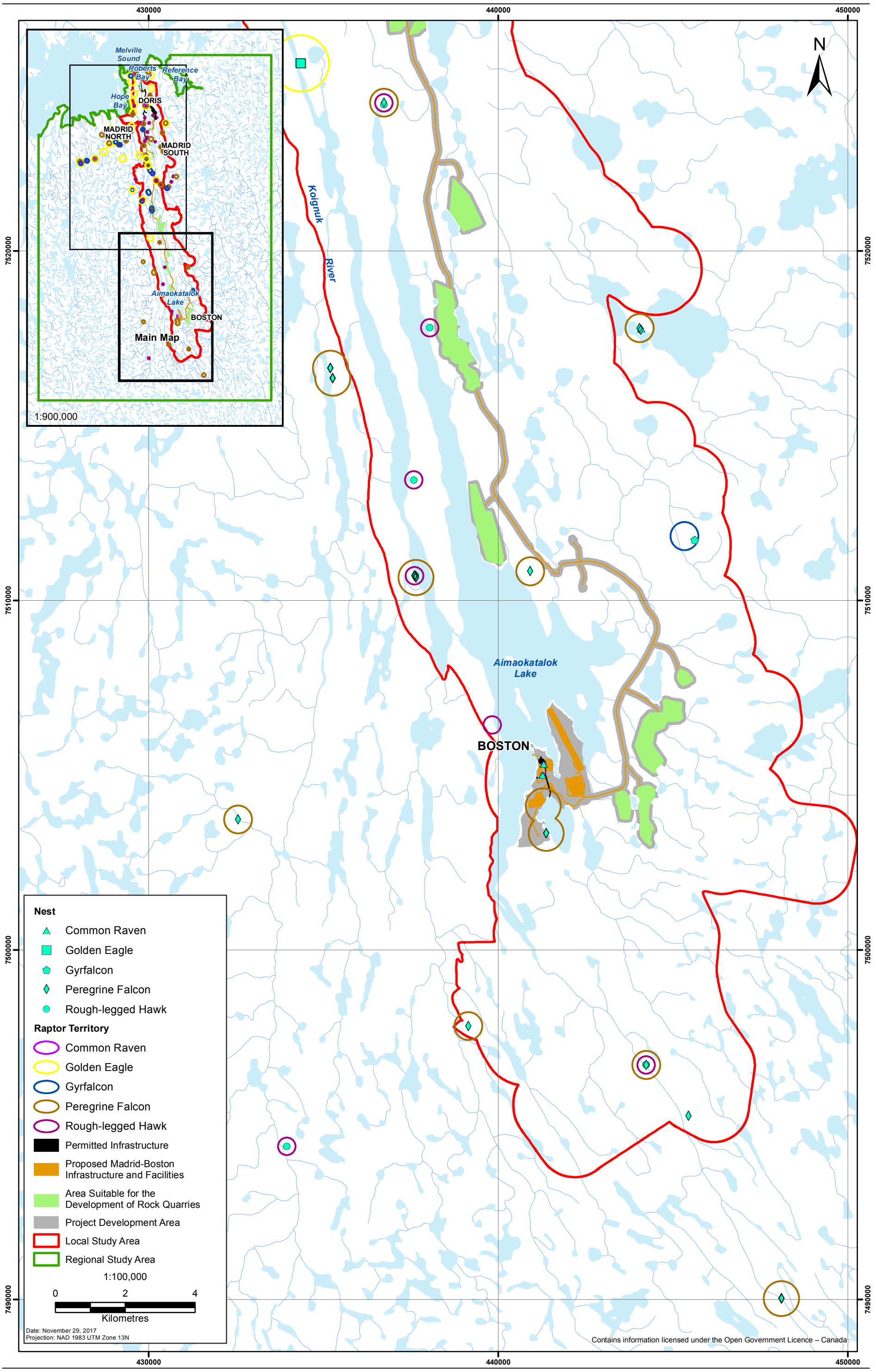


Table 9.2-42. Total Number of Cliff-nesting Raptor Nests Occupying Nest Sites and Territories in the RSA during Aerial Surveys Conducted from 2006 to 2015

Location	Species	2006	2007	2009	2010	2011	2012	2013	2014	2015	Total Number of Nests*
Local Study Area											
	Peregrine Falcon[1]	-	-	2	6	12	3	4	5	3	24
	Gyrfalcon	-	-	2	2	9	1	5	4	2	13
	Rough-legged Hawk	-	-	2	13	17	ND	16	15	3	41
	Golden Eagle	-	-	2	ND	5	2	3	3	2	11
	Common Raven	-	-	1	3	5	2	2	1	1	8
	Total	**-**	**-**	**9**	**24**	**48**	**8**	**35**	**28**	**11**	**97**
Regional Study Area[2]											
	Peregrine Falcon[1]	17	19	27	13	30	18	9	13	6	66
	Gyrfalcon	1	2	8	7	11	4	7	9	5	33
	Rough-legged Hawk	15	11	16	24	24	4	17	20	3	63
	Golden Eagle	1	6	11	6	16	8	6	9	6	45
	Common Raven	2	2	2	2	6	3	4	2	1	13
	Unknown Raptor	-	-	-	-	-	-	-	-	-	2
	Total	**34**	**40**	**64**	**52**	**92**	**37**	**43**	**53**	**21**	**222**

[1] SARA - listed Species of Conservation Concern
[2] Nest counts within the RSA include nests detected in the LSA
ND = Not detected
** Total includes nests and nesting sites within a territory (nests that were located within 100 m of one another) that were reused among years by the same species.*
Notes: Occupancy rates from 2006 to 2012 were calculated as the number of occupied nests per surveyed nests, and occupancy rates from 2013 to 2015 were calculated as the number of occupied territories per surveyed territories. No aerial surveys were conducted in 2016.

The distribution of raptor nest sites is associated with cliffs, which are most abundant and widely distributed in the northern portion of the RSA near the coast. To the south, cliffs and rocky dykes are less common, and are rare near Boston (Figures 9.2-32a and 9.2-32b). The peregrine falcon was the most frequently detected cliff-nesting raptor species within the wildlife RSA (Figures 9.2-32a and 9.2-32b, Table 9.2-42), and based on the relative frequency with which it occupied nest sites, the peregrine falcon was likely the most abundant cliff-nesting raptor species in the wildlife RSA. The rough-legged hawk was also commonly detected in the RSA (Table 9.2-42).

Occupancy

In 2006 through 2012, occupancy rates were based on the number of nests occupied per the number of nests surveyed in the RSA. In 2013 through 2015, surveys were conducted in a smaller area surrounding the Doris Project (Figure 9.2-6), and the occupancy rate was based on the number of territories occupied per the number of territories surveyed (a territory may contain more than one individual nest site within the overall territory). Given the change in methodology and study area, occupancy rates from 2006 to 2012 are not directly comparable to those from 2013 to 2015.

From 2006 through 2012, occupancy rate was highest in 2011 (54%) and lowest in 2012 (24%) (Table 9.2-43). From 2013 through 2015, the territory occupancy rate was highest in 2014 (50%) and lowest in 2015 (28%). Although occupancy rates are not directly comparable, the high occupancy rates recorded in 2011 (nest occupancy) and 2014 (territory occupancy) may be related to population cycles

that have been documented for many Arctic raptor species (Section 9.2.10.1, Population Trends and Conservation).

Table 9.2-43. Raptor Nest Site and Territory Occupancy, 2006 to 2015

	2006	2007	2009	2010	2011	2012	2013	2014	2015
Sites surveyed	105	112	197	196	170	152	101	105	76
Sites occupied[1]	34	40	64	52	92	37	43	53	21
Occupancy (%)	32%	35%	32%	27%	54%	24%	43%	50%	28%

Notes:
[1] Includes only nests and territories that were determined to be occupied during occupancy surveys and not additional occupied nests/territories found during productivity surveys.
Occupancy rates from 2006 to 2012 were calculated as the number of occupied nests per surveyed nests, and occupancy rates from 2013 to 2015 were calculated as the number of occupied territories per surveyed territories.

Productivity

Nest success is defined as the percentage of occupied nests that produced young, and the annual productivity rate is based on the total number of fledglings produced divided by the total number of occupied nests. As with the analysis of occupancy data, survey methodology and analysis differed between years (i.e., descriptive statistics from 2006 to 2012 are based on individual nest sites, while the statistics in 2013 to 2015 are based on nesting territories, not individual nests). Therefore, these data are not directly comparable across all years. From 2006 through 2012, nest success and productivity was highest in 2006 (Table 9.2-44). From 2013 through 2015, nest success and productivity was highest in 2013. Productivity varied across species, but was generally highest for common raven (Table 9.2-45).

Table 9.2-44. Raptor Nest Success and Productivity

	2006	2007	2009	2010	2011	2012	2013	2014	2015[2]
# Occupied Nesting Sites/Territories[1]	34	40	64	52	92	37	43	52	21 - 29
# Successful Nests/Territories	15	4	8	10	31	17	22	16	9
Nest Success[3] (%)	44%	10%	13%	19%	34%	27%	65%	31%	32%
# Young Produced[4]	27	6	17	56[5]	43	24[6]	58	31	7 – 9
Productivity Rate	0.79	0.10	0.20	0.60[5]	0.47	0.38[6]	1.70	0.60	0.30 - 0.40

[1] as recorded during Occupancy Survey in late May or early June. Represents the number of occupied nest sites found in 2006 through 2012, and the number of occupied territories found in 2013 to 2015. Due to changes in methodology and study area, nest success and productivity from 2006 to 2012 are not directly comparable to those from 2013 to 2015.
[2] A total of 21 occupied territories were recorded in 2015 and eight additional territories were found that were defined as possible attempts (not occupied by adults and/or eggs but where recent evidence of use was observed). Nest fate was determined for all 29 occupied and possible attempt territories, thus subsequent statistics are reported based on 29 territories.
[3] number of successful nests per occupied nesting sites (2006 to 2012) or per occupied territory (2013 to 2015). Does not include some nests occupied by peregrine falcon and rough-legged hawk in 2013 and peregrine falcon in 2014 and 2015 where young in nests had not reached 80% of their fledging age by the time of the survey.
[4] includes all chicks alive at productivity survey from 2006 to 2012 and all chicks that had reached 80% of their fledgling age from 2013 to 2015. From 2006 to 2012, numbers reported assumes 1 chick at successful nests with unknown number of chicks fledged (i.e., nests where young assumed to have fledged before the productivity survey)
[5] productivity rate excludes 25 peregrine falcon chicks ((Rescan 2011c)
[6] only 14 of these chicks are from nests identified at the occupancy survey and are used in productivity rate calculation

Table 9.2-45. Raptor Productivity Rates by Species

Species	2006	2007	2009	2010	2011	2012	2013[1]	2014[1]	2015[1]
Peregrine Falcon	0.71	0.11[2]	0.15[2]	1.92[2]	0.30	0.30	-	0.60	0.00
Gyrfalcon	1.50	0.00	0.13	0.57	0.82	0.50[3]	0.70	0.60	0.20 - 0.50
Golden Eagle	1.00	0.00	0.36	1.00	0.69	0.63	1.00	0.80	1.20
Rough-legged Hawk	0.88	0.18	0.25	0.63	0.33	0.00	2.10	0.50	0.00
Common Raven	n/a[4]	1.00	2.00	3.00	1.00	0.33[3]	3.00	1.00	-

[1] Based on nests at which a complete count of fledgling age chicks were made
[2] this is not indicative of the number of young that actually fledged, as young were at most two weeks old at time of survey
[3] broods were assumed to have fledged at least one chick at successful nests where the total number of fledged chicks was unknown
[4] Productivity rate not calculated for common raven in 2006
Notes: Due to changes in methodology and study area, nest success and productivity from 2006 to 2012 are not directly comparable to those from 2013 to 2015.

Migratory Standwatch Surveys

Methods

Standwatch surveys were completed in the Project area to establish the use of the area by diurnal migrants, including their altitude flying over the Project area in relation to proposed turbine height (passage migration counts). Methods followed those outlined in ECCC's Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (Environment Canada 2007a). Passage migration counts are recommended at proposed wind farms where migration is expected to be concentrated (e.g., large numbers of migrations are known to pass through the area, proposed wind turbines will be situated on a ridge top or within mountain passes, or data for similar areas elsewhere suggests migrants may be concentrated (Environment Canada 2007a); these conditions are not expected for birds migrating through the Project area since there are no topographic features that would concentrate movement through the area. Standwatch survey site locations were therefore selected to provide the clearest available views of the horizon to monitor for migrating birds. Figure 9.2-33a shows the locations of the migration survey sites in relation to the Project area.

Six days of standwatch surveys, totaling 36 hours, were conducted across two sites (D-1 and D-2) during the spring of 2017 in the Doris area of the Project. The study area was expanded in fall 2017 to include the Boston deposit part of the Project area, and six days of surveys, totaling 34.5 hours, were conducted at the Doris and Boston survey sites (D-1 and B-1). Spring surveys were completed between May 30 and June 5, 2017, and fall surveys were conducted between September 2 and 7, 2017. A summary of survey effort is provided in Table 9.2-46.

Table 9.2-46. Migratory Standwatch Survey Effort, 2017

Migratory Season	Survey Dates	Project Area	Survey Station	No. Surveys	Survey Effort (hrs)
Spring	May 31; Jun 1, 3, 5	Doris	D-1	4	24
	June 2, 4	Doris	D-2	2	12
Fall	Sep 2, 3, 4	Boston	B-1	3	16.5
	Sep 5, 6, 7	Doris	D-1	3	18
Total				**12**	**70.5**

Notes: migratory standwatch surveys were conducted concurrently for raptors, waterbirds, and upland birds VECs. Survey effort refers to all bird VECs.

Surveyors recorded all birds seen or heard within an unlimited radius. The maximum (horizontal) distance from the observer recorded at site D-1 was 4 km and the max distance at site B-1 was approximately 5 km. Data collected during the surveys included distance and direction from observer, and flight characteristics (direction of travel, and height above or below observer), for each bird, or group, observed. In addition, behavior exhibited by birds, which appeared to be using the area for reasons other than migration (i.e., birds foraging, birds moving from perch to perch, birds tending nests or young, etc.) was noted. Passage rates were calculated as the number of birds observed in flight per hour of survey. Detailed methods are described in the Migratory Standwatch Survey report (EDI 2017; Appendix V4-9D).

All birds observed in flight during surveys were classed as being in one of two categories ("yes" or "no") based upon the estimated flight heights (vertically) of the birds relative to proposed wind turbines rotor heights. The classification "at turbine height" is an estimate that assumes that the bird was flying at a height less than the maximum blade height (below 200 m) and above the minimum blade height (50 m). Due to the potential surveyor error in estimating flight heights, rapid height changes by the birds and the difficulty tracking raptors at lower heights, a maximum height of 200 m was conservatively assumed to be within the height of the turbine, whereas the actual maximum height of the blades is approximately 160 m.

To determine the potential for interacting with wind turbines, bird observations that were classified as "at turbine height" were further assessed to determine whether they were within the potential zone of interaction based their movement trajectory in relation to the proposed wind turbine locations. The following conservative approach was used to determine the number of birds observed within the potential zone of interaction with the wind turbine.

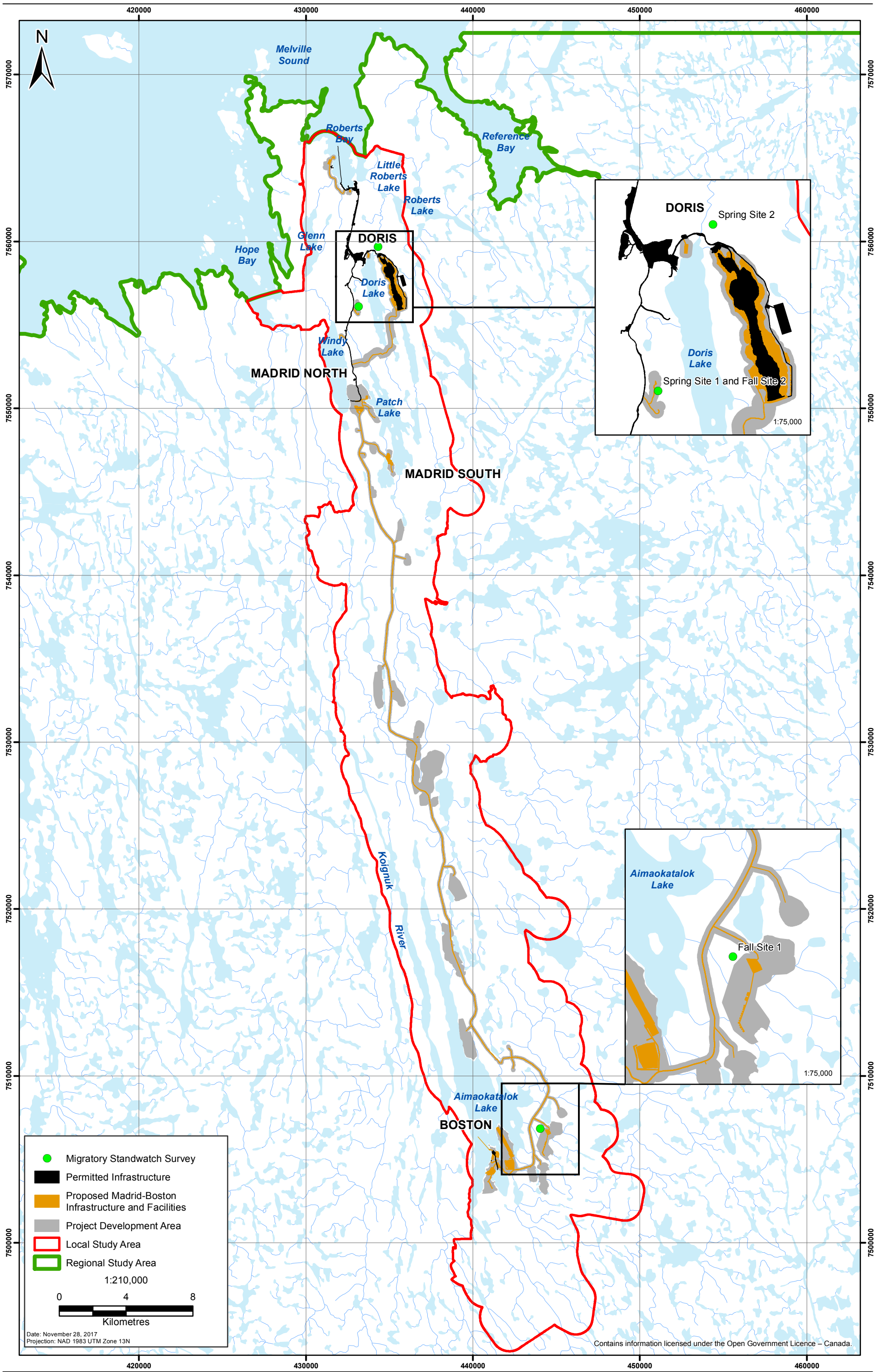
At the Doris site, birds were identified within the potential zone of interaction with wind turbines if the following criteria were met:

- Flying at a height above the observer (vertically) between 50 m and 200 m;
- Flying within 750 m of the observer (horizontally), based on the surveyors proximity to the proposed turbine locations; and
- Flying in a southerly direction in spring, and a northerly direction in fall (based on the position of the survey site relative to the proposed wind turbine location).
- Birds that had the same trajectory as a previous bird noted to be within the potential zone of interaction
- For the Doris site, only birds observed at site D-1 could be identified within the potential zone of interaction with wind turbines because wind turbine locations were refined following the spring standwatch surveys, and a turbine is longer proposed for Site D-2. For this reason, percentage of birds within the potential zone of interaction with wind turbines is based on birds observed at Site D-1 only.

At the Boston site, birds were identified within the potential zone of interaction with wind turbines if the following criteria were met:

- Flying at a height above the observer (vertically) between 50 m and 200 m;
- Flying within 3 to 5 km of the observer (horizontally), based on the surveyors proximity to the proposed turbine locations; and
- Flying in a northerly direction in fall (based on the position of the survey site relative to the proposed wind turbine location).

Figure 9.2-33a
Migratory Standwatch Survey Locations in the Regional Study Area, 2017



Results

During spring standwatch surveys, three species of cliff-nesting raptor species (peregrine falcon, rough-legged hawk and golden eagle), one ground nesting raptor species (short-eared owl), and common raven, were observed during the surveys at Doris D-1 and D-2 (Table 9.2-47). There were a total of 33 raptor observations, including 23 observations at site D-1 and 10 at site D-2. Rough-legged hawk was the most commonly observed species at Site D-1, and short-eared owl was only observed at site D-2. Passage rates were similar between sites D-1 (0.96 obs/hr) and D-2 (0.83 obs/hr; Table 9.2-47). Migration appeared to be broad-front, with birds arriving from all southerly directions and heading north, as is expected.

Table 9.2-47. Raptor Observations during Spring Migratory Standwatch Surveys, 2017

	No. of Raptor Observations									
				Obs. Flying at Turbine Height					Obs. within Potential Zone of Interaction with Wind Turbine	
				Doris D-1		Doris D-2		Total		Doris D-1	
Species	Doris D-1	Doris D-2	Total	No.	%	No.	%	No.	%	No.	%
Peregine Falcon[1]	1	1	2	0	0	0	0	0	0	0	0
Rough-legged Hawk	10	2	12	4	40	2	100	6	50	1	25
Golden Eagle	4	3	7	3	75	3	100	6	86	0	0
Common Raven	8	3	11	0	0	0	0	0	0	0	0
Short-eared Owl[1]	0	1	1	0	-	0	0	0	0	0	0
Total Observations	**23**	**10**	**33**	**7**	**30**	**5**	**50**	**12**	**36**	**1**	**14**
Total Effort (hrs)	**24**	**12**	**36**								
Passage rates (obs/hr)	**0.96**	**0.83**	**0.92**								

[1] *SARA-listed Species of Conservation Concern.*
Notes: Raptors flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height. Number of raptors observed within the potential zone of interaction with wind turbines was determined from the Doris-D1 site only.

Of the total observations of raptors at sites Doris D-1 and D-2 during the spring surveys, 36% (n=12) of raptors were flying at turbine height (heights of between 50 m and 200 m), including six rough-legged hawks (four at D-1 and two at D-2) and six golden eagle (three at D-1 and three at D-2). Only fourteen percent (n=1) of the raptors flying at turbine height were within the potential zone of interaction (Table 9.2-47). The majority of these birds were flying relatively low (i.e., 100 m or less), especially in heavy winds (e.g., 25 km/h). The remainder of the birds observed at site D-1 were outside of the potential zone of interaction with wind turbines.

During fall standwatch surveys, five cliff-nesting raptor species (peregrine falcon, gyrfalcon, rough-legged hawk, golden eagle, and bald eagle) and common raven were recorded across the two survey sites (Doris D-1 and Boston B-1; Table 9.2-48). There were a total of 26 raptor observations; including eight observations at site D-1 and 18 observations at site B-1 (Table 9.2-48). Common raven was observed most frequently, followed by peregrine falcon and rough-legged hawk. Passage rates were slightly higher at site B-1 (1.0 obs/hr) relative to site D-1 (0.48 obs/hr; Table 9.2-48). In general, fall migration appeared to be broad-front, with birds arriving from all northerly directions and heading south.

Table 9.2-48. Raptor Observations during Fall Migratory Standwatch Surveys, 2017

Species	No. of Raptor Observations													
				Obs. Flying at Turbine Height						Obs. within Potential Zone of Interaction with Wind Turbine					
	Boston B-1	Doris D-1	Total	Boston B-1		Doris D-1		Total		Boston B-1		Doris D-1		Total	
				No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Peregine Falcon[1]	1	5	6	0	0	4	80	4	80	0	0	4	100	4	100
Gyrfalcon	1	0	1	0	0	0	-	0	0	0	0	0	-	0	0
Rough-legged Hawk	2	4	6	2	100	2	50	4	67	1	50	0	0	1	25
Golden Eagle	1	1	2	1	100	1	100	2	100	0	0	0	0	0	0
Bald Eagle	1	0	1	1	100	0	-	1	100	0	0	0	-	0	0
Common Raven	2	8	10	2	100	1	13	3	30	0	0	0	0	0	0
Total Observations	**8**	**18**	**26**	**6**	**75**	**8**	**44**	**14**	**54**	**1**	**17**	**4**	**50**	**5**	**36**
Total Effort (hrs)	**16.5**	**18**	**34**												
Passage rates (obs/hr)	**0.48**	**1.00**	**0.75**												

[1] *SARA-listed Species of Conservation Concern.*
Notes: Raptors flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height.

Of the total observations at sites Doris D-1 and B-1 during fall surveys, 54% (n=14) of raptor observations were of birds flying at turbine height (flying at heights of between 50 m and 200 m), including six raptors at site B-1 (two rough-legged hawk, one golden eagle, two common raven, and one bald eagle) and eight at site D-1 (four peregrine falcon, two rough-legged hawk, one golden eagle, and one common raven; Table 9.2-48). Of these, approximately 36% (n=5) of raptors were observed flying within the potential zone of interaction with the wind turbine (Table 9.2-48). The remainder of the birds observed at site D-1 and B-1 were outside of the potential zone of interaction with wind turbines.

Survey results indicate that flights at heights between 50 and 200 m through the proposed wind turbine locations appear to be a small proportion of the total raptors observed in flight (14% of observations during the spring and 36% during the fall). Fall migratory observations were more than spring observations (33 observations in fall vs. 26 in spring). A similar species composition was recorded during both surveys (5 species recorded in spring compared to 6 recorded in fall). Passage rates were slightly higher in spring at 0.92 individuals per hour of effort vs 0.75 individuals per hour of effort in fall; however several factors should be considered when examining these trends in flight activity between the spring and fall, as different airspaces were monitored between the two periods.

On a broad scale, the Project does not appear to be in a major migratory flyway for birds (Figure 9.2-33b; amalgamated from Lincoln 1935; Anderson and P. I. Padding 2015; Ducks Unlimited 2017; Hawkwatch 2017; La Sorte et al. 2017; Pendola 2017) and on the local scale the topography does not appear to concentrate raptors towards the turbines. In both the spring and fall season, migration was a broad front movement over the Project area with no barriers to movement. There is no evidence of topographic features restricting bird movement across the landscape at either the Doris or Boston site. Based on general observations during the fall migratory standwatch surveys, it appeared that birds migrated when the wind was from a northerly direction, taking advantage of a tail wind.

Figure 9.2-33b

Migration Flyway Corridors in Relation to the Regional Study Area



Note: Figure reproduced based on an amalgamation of the following sources: Lincoln 1935; La Sorte et al. 2014; Anderson and Padding 2015; Pendola 2017; Ducks Unlimited 2017; and Washington Valley Hawkswatch 2017.

Ground-based Surveys for Upland Birds and Ground-nesting Raptors

Methods

No established protocol exists for surveys for ground-nesting raptors in Nunavut. Considering that surveys for upland birds, both point count surveys and PRISM surveys (Section 9.2.12.2), cover large areas of habitat including those suitable for supporting ground-nesting raptor species, these surveys are used as a proxy for surveys for ground-nesting raptors. Point count surveys are used to survey for short-eared owl in southern areas of Canada; surveys are carried out within suitable habitats for the species and adapted for times of day when short-eared owl are most active (dawn or dusk; RIC 2001; Schmelzer 2005; Government of Alberta 2013).

Ground-based surveys for upland birds (point count and PRISM) that are used for detection of ground-nesting raptors are described in Section 9.2.12.2. Point count and PRISM surveys were started after official sunrise and were carried out throughout the day, as per standard methodology (Ralph et al. 1993; Environment Canada 2004). It is not known whether short-eared owl and snowy owl, species that are largely crepuscular (active mostly at dawn and dusk), exhibit different daily activity patterns in the Arctic when there is nearly 24 hr daylight (particularly during June). The one other ground-nesting raptor known to occur in the region, northern harrier, is a diurnal species and is active throughout the daylight hours. Considering the high amount of daily sunlight during June when upland bird surveys were completed (Section 9.2.12.2), it is likely that surveys were conducted at times appropriate for detection of all three ground-nesting species anticipated to breed in the region.

Results

Northern harrier and short-eared owl were detected during ground-based surveys carried out for upland birds and ground-nesting raptors. A single northern harrier was recorded once during PRISM surveys in 2012 at a plot located half way between the Doris and Boston deposits (Rescan 2013d). Short-eared owl individuals were recorded on two occasions, once during a point count survey south of the Madrid deposit in 2013 and once during a PRISM survey in the Boston deposit area in 2011(Rescan 2011f; ERM Rescan 2014a). In addition, a short-eared owl nest was recorded incidentally during upland bird surveys conducted in the Boston area in 2010 (Rescan 2011c). The nest, containing 7 eggs, was found in shrubby area typical of the habitat selected by this species for nesting (Wiggins, Holt, and Leasure 2006). In contrast to cliff-nesting species, ground-nesting raptors such as short-eared owl rarely re-nest in the same site, though up to 30% of pairs may be faithful to a general breeding home range (Parmelee 1992; Wiggins, Holt, and Leasure 2006; K. G. Smith et al. 2011). As noted above, short-eared owl is a species of federal conservation concern.

Incidental Observations

Methods

Methods for incidental collection of wildlife are identical to those for caribou and are discussed in Section 9.2.6.2. Incidental observations of raptors were recorded when:

1. observed by Doris Project personnel from 2009 and 2016 and recorded in the Wildlife Sighting Log; and
2. observed by environmental personnel and wildlife biologists when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016, which includes observations collected spatially or temporally outside of targeted VEC studies.

These incidental observations were reviewed to identify species that were not detected on formal raptor surveys to provide a comprehensive view of species diversity in the RSA

Results

Incidental Observations of Raptors by Site Personnel

There were two species recorded in the Doris Wildlife Sightings Log that were not recorded during aerial raptor surveys: bald eagle and short-eared owl. Two bald eagle observations were recorded in one year: 2014. One short-eared owl observation was recorded in 2009; this species had also been detected in the ground-based raptor surveys.

Incidental Observations of Raptors by Field Personnel

Four raptor species were recorded incidentally by field staff from 2006 to 2016 that were not recorded during formal raptor aerial surveys: bald eagle, short-eared owl and snowy owl. Short-eared owl and snowy owl are all considered ground-nesting species, while in the Arctic above the treeline, bald eagle is considered to be a cliff-nesting species (K. G. Poole 2011). All of the species, save for short-eared owl, were recorded in three or less of the last 12 years for which baseline and monitoring studies have been conducted at the Hope Bay Project. Short-eared owl were more frequently recorded, with observation in seven of the last 12 years.

Habitat Suitability Modeling

Methods

Habitat suitability modeling was conducted for cliff-nesting and ground-nesting raptors in the LSA and RSA. Details on habitat suitability modeling methodology is discussed in Section 9.2.6.2 and detailed in Appendix V4-9A.

Cliff-nesting Raptors – Peregrine Falcon

The peregrine falcon was modelled to represent all cliff-nesting raptors for this assessment, as it is a SARA-listed species that breeds in similar habitats to other cliff-nesting raptors. The life requisites rated for peregrine falcon are living and reproducing during spring (nesting) and summer (brood rearing) (Table 9.2-49). This covers the majority of the time that this migratory species is present within the region. Since adults and young do not leave the nest until the young are ready to fly in August (e.g., ERM 2015b), only one model was created that covers both spring and summer habitat. Thus, the spring nesting season and summer brooding season are combined (Rescan 2011h).

Table 9.2-49. Seasonal Life Requisites of Peregrine Falcon

Season	Date	Life Requisite	Habitat Preference
Spring (Nesting) and Summer (Brood Rearing)	May - June	Living and Reproducing	Tall, steep cliffs with flat ledges suitable for nest sites; nearby water for prey selection

The main habitat requirements for this species are a nest site (most commonly scrapes on cliff ledges), a nesting territory (i.e., the defended area within approximately 1 km of the nest site), and a home range (i.e., the non-defended area in which the species hunts for food outside of the defended territory). The area within 400 metres of nesting locations is considered to be the most important hunting area. Significant reductions in the abundance of passerine species (raptor prey) have been documented within 400 metres of peregrine falcons nests (Wightman and Fuller 2005).

Ground Nesting Raptors - Short-eared Owl

To estimate the availability of suitable habitat for ground-nesting species, the short-eared owl was selected as the representative species because it is a species of conservation concern (Rescan 2011h) and is the most consistently observed ground nesting species in the region. Habitat suitability modeling

was conducted for the nesting season. Suitable nesting habitat for ground-nesting raptors was considered to be areas with high cover of low to tall shrubs and close to wetlands and water. All other areas were considered unsuitable nesting habitat for ground-nesting raptors (Rescan 2011h). Suitable brood rearing habitat for ground-nesting raptors was considered to be areas that could support optimal prey hunting opportunities; i.e., areas with an abundance of small mammals and birds. The life requisites assigned to spring were living and reproducing, while the only life requisite assigned to summer habitat was living (Table 9.2-50).

Table 9.2-50. Seasonal Life Requisites of Short-eared Owl

Season	Date	Life Requisite	Habitat Preference
Nesting	May - June	Living and Reproducing	Dense vegetation close to water
Brood-rearing	July - August	Living	Nest sites close to prey (hunting opportunities)

Results

Cliff-nesting Raptors – Peregrine Falcon

Habitat suitability modeling indicated approximately 12% of the LSA was suitable nesting habitat for peregrine falcon (Table 9.2-51). This area equated to the immediate vicinity of known nesting sites and cliffs. The majority of the LSA was not suitable peregrine falcon nesting habitat (88.1%).

Table 9.2-51. Area and Percentage of Nesting Habitat within the Local Study Area and Regional Study Area for Cliff-nesting[1] Raptors

		Local Study Area[2]		Regional Study Area[3]	
Season	Suitability Rating	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Spring/ Summer (Nesting and Brood Rearing)	Suitable	6,755.4	12.0	3,497.3	0.7
	Not Suitable	49,584.6	88.1	483,482.9	98.3

[1] *Based on Peregrine falcon*
[2] *LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the TEM data (see Section 9.2.3.3).*
[3] *RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.3). A total of 4,843.7 ha were categorized as unclassified likely due to coverage of the imagery by cloud cover.*

A small proportion of the RSA is suitable cliff-nesting habitat (0.7%) (Table 9.2-51). The majority of the suitable cliff nesting habitat was found in the southern part of the RSA, east of Boston camp with smaller areas near the coast. However, the full RSA has not been completely surveyed for potential raptor nests, so proportionally far fewer identified nests (the predominant driver of the LSA suitability calculations) are located in the RSA. Further, the WKKS ecosystem classification used for modeling in the RSA is less accurate at identifying suitable cliff-nesting habitat. In particular, the resolution of WKKS is such that it does not account for many areas with cliff habitat habitats because these areas tend to be spatially small and tend to be rolled into the dominant neighbouring classification. Field data collection and modeling using EM for the LSA strongly indicates that smaller areas of cliffs and rocky outcrops are still functionally valuable nesting and brood rearing habitat. Thus, it is likely that there is more cliff-nesting habitat available within the RSA than strictly indicated by modeling (Table 9.2-51).

Ground-nesting Raptors – Short-eared Owl

Habitat suitability modeling in the LSA indicated that the majority of the LSA was suitable for ground nesting (75%) and brood rearing (79%) (Table 9.2-52). Habitat suitability modeling based on the WKSS

ecosystem classification indicated that approximately 39% of the RSA was rated as suitable nesting habitat and 39% as suitable brood-rearing habitat for short-eared owl (Table 9.2-52). Suitable ground-nesting habitat (both for nesting and brood-rearing) was evenly distributed within the RSA, with the exception of small patches on the northwest side of the RSA near the coast, and larger areas found within the LSA (Figures 9.2-34 and 9.2-35).

Table 9.2-52. Area and Proportion of Nesting and Brood Rearing Habitat within the Local Study Area and Regional Study Area for Short-eared Owl

		Local Study Area[1]		Regional Study Area[2]	
Season	Suitability Rating	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Nesting	Suitable	42,404.4	75.3%	193,204.1	39.3%
	Not Suitable	13,872.6	24.7%	293,776.1	59.7%
Brood-rearing	Suitable	44,171.6	78.5%	193,204.1	39.3%
	Not Suitable	12,105.4	21.5%	293,776.1	59.7%

[1] *LSA = 56,277 ha. Habitat Suitability data in the LSA is based on the EM data (see Section 9.2.3.3).*
[2] *RSA = 491,823.9 ha. Habitat Suitability data in the RSA is based on the WKSS ecosystem mapping data (see Section 9.2.3.3). Note: A total of 4,843.7 ha were categorized as unclassified likely due to coverage of the imagery by cloud cover.*

9.2.10.3 The Doris Project

The Doris Project was issued a project certificate in 2006. As part of the WMMP, monitoring of raptors included habitat loss, possible sensory disturbance and avoidance of the Doris Project, attraction to the Doris Project for nesting opportunities and any direct mortality due to collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Surveying and monitoring has occurred during the Pre-Construction, Construction, and Care and Maintenance phases since 2006, as part of the ongoing WMMP. This section summarizes the results of these monitoring activities for raptors.

Habitat Loss

Habitat lost within the Doris footprint has been measured since 2009 when major construction began (Table 9.2-13). The footprint was measured in 2016 as 83.0 ha, or 2.7% of the LSA from the 2006 FEIS for the Doris Project (ERM 2017a). The majority of habitat loss occurred in habitat types rated as moderate for raptors (foraging habitat, as measured by the habitat preferred by the major prey species for raptors; (Miramar 2005): heath tundra (33.6 ha), tussock/hummock (29.5 ha), heath bedrock (4.1 ha; Table 9.2-14). This represents an actual loss of 0.03% of the total suitable habitat identified for raptors in the RSA (Table 9.2-53).

Table 9.2-53. Area of Suitable Habitat Disturbed for Raptors

		Amount of Suitable[1] Habitat in LSA[2]		Actual Disturbed Suitable Habitat	
Species	Season	Total (ha)	% of LSA[2]	Total (ha)	% of LSA[3]
Raptors	Foraging	3,116	100.0	82.3	2.6

[1] *Suitable Habitat does not include Nil-rated habitat in study area.*
[2] *Calculations based on: LSA area of 3,116 ha for all bird species*
[3] *Calculations based on total amount of suitable habitat in LSA*

Sensory Disturbance

The WMMP monitors for potential effects of sensory disturbance, resulting in changes in nesting near the Project site; either fewer nest occupied in the spring, or fewer chicks successfully fledging from those nests. In 2016, a comprehensive analysis of data collected between 2004 and 2015 was conducted to determine if disturbance from the Doris Project altered the territory occupancy (use of territory by a breeding pair in the spring), breeding (proportion of occupied territories where young of any age are recorded during the summer productivity survey) or productivity (proportion of nests with confirmed breeding [young present] where young determined to be at least 80% of fledging age). The RSA has a large number of raptor nesting sites, such that most pairs of raptors have a territory that includes multiple nesting sites, only one of which is used each year.

It was predicted that territory occupancy, breeding, and productivity would be lower during years with more activity within 1.5 km of the footprint, a distance at which raptors may experience threat from disturbances that is severe enough to initiate flight. This distance (1.5 km) mirrors the recommended set back distance for limiting disturbance to raptor nests within the Northern Land Use Guidelines for seismic operations (Aboriginal Affairs and Northern Development Canada (AANDC) 2011) and is consistent with literature (Richardson and Miller 1997; Whittington and Allen 2008; Martínez-Abraín et al. 2010; Aboriginal Affairs and Northern Development Canada (AANDC) 2011; Keeley and Bechard 2011).

Analyses were conducted using generalized linear mixed models (Zuur et al. 2010) to assess whether or not there was a differential change in occupancy between territories within 1.5 km and outside 1.5 km during potential effect and non-effect years. As well, the pattern of occupancy rates across distance from infrastructure, as a continuous measure, was compared in potential effect and non-effect years. There was not sufficient data to assess productivity statistically. However, no significant differences were observed between potential effect and non-effect years in terms of occupancy. There was some evidence of a localized (< 1.5 km) Project-related effect on raptor breeding activity. A power analyses indicated that the power to detect a Project-related effect on raptor breeding within 1.5 km of the Project using monitoring data currently available was sufficient. A secondary power analysis using a theoretical ZOI distance of 5 km indicated no potential Project effect, further supporting a localized effect on breeding activity. For a complete description of the analyses and results, see the 2016 WMMP report (ERM 2017a).

Attraction to the Doris Project

The WMMP evaluates attraction of raptors to the Doris Project as a possible nesting site by monitoring Doris Project infrastructure and quarry pit walls for nesting raptors since 2006. There have been no reported incidents to date involving raptors species being attracted to prey on the Doris Project site or to Doris Project infrastructure such as buildings or quarry walls for nesting (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). Note that there are no open pits as part of the Doris Project, thereby eliminating the major attractant for raptors and the quarries have been shallow and so relatively poor nesting habitat for raptors. These results indicate that there has been no effect of attraction on raptors due to the Doris Project (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Direct Mortality

Any wildlife mortality, including raptors that have been observed by onsite personnel were reported immediately to the ESR Department and in the annual WMMP report. Mortality of VECs or larger fauna, or mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE and KIA, as necessary (ERM 2016c).

Figure 9.2-34
Short-eared Owl Spring Nesting Habitat Suitability Rating

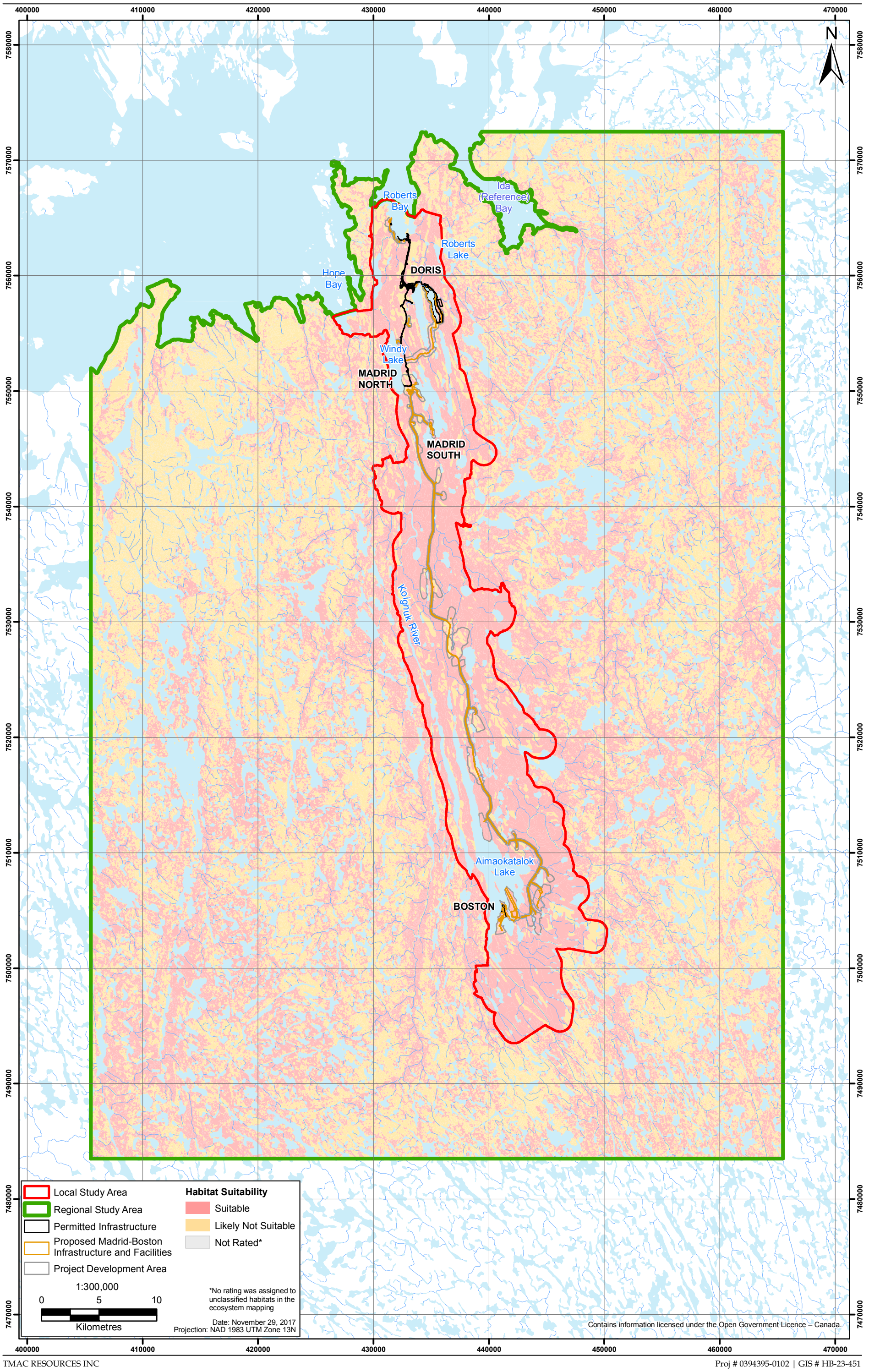
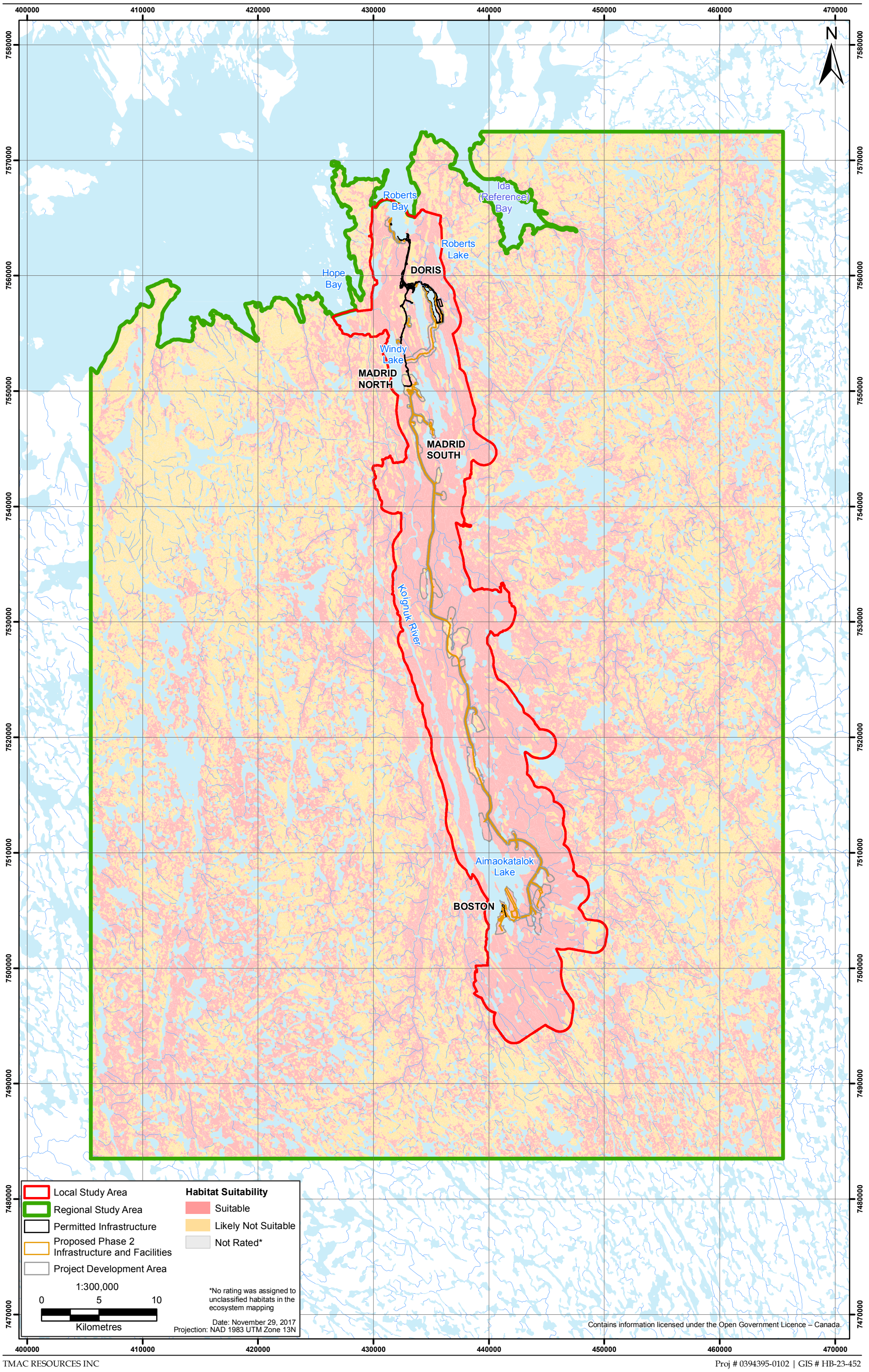


Figure 9.2-35
Short-eared Owl Summer Brood Rearing Habitat Suitability in the Local Study Area and Regional Study Area



In the years that personnel have been at the Doris Project site (2006-2016), there have been no reports of any raptor morality of any sort, including from vehicle and aircraft strikes. Vehicle-raptor collisions are related to locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). Higher vehicle speeds increase the chance of mortality and/or injury to raptors. For example, it has been documented that speeds in excess of 80 km/hour may increase owl-vehicle collisions (Whittington and Allen 2008). The on-site speed limits for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to raptors.

Bird strikes with aircraft must be reported to the Canadian aviation authority due to safety concerns. No bird strikes have been reported at the Doris site due to aircraft. These results indicate that there has been no effect of direct mortality on raptors due to the Doris Project (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on raptors due to Doris Project activities.

9.2.11 Characterization of Baseline Conditions for Waterbirds

9.2.11.1 Introduction

For the purposes of this assessment, waterbirds are defined as birds that primarily forage and/or nest within freshwater waterbodies. Seabirds, birds that predominantly forage and/or nest in/near marine waterbodies, are discussed in Volume 5, Section 11. The Arctic waterbird community is comprised of geese and the tundra swan, several species of dabbling and diving ducks, gulls, Arctic tern, four species of loons, and the sandhill crane. Some species of waterbirds are important food sources to Inuit communities, including eiders, geese, loons, ducks, mergansers, shorebirds, gulls and jaegers (Banci and Spicker 2016). Some waterbird species such as greater scaup also use marine habitats during some portion of the breeding season.

A total of 31 waterbird species have the potential to occur in the RSA (Table 9.2-54). Of these species, 19 waterbird species were identified as species that regularly occur within the RSA during the breeding season or during migration (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a). No waterbirds in the RSA are listed as species of conservation concern under the federal *Species at Risk Act* (SARA; 2002). Several waterbird species in the RSA are designated as Vulnerable in Nunavut by the Canadian Endangered Species Conservation Council (CESCC), including the brant, common eider, and king eider (CESCC 2016). Several others are designated as Apparently Secure, which means that the species at are fairly low risk of extirpation but there are possible cause for some concern due to local recent declines, threats, or other factors; these species include Arctic tern, glaucous gull, herring gull, Thayer's gull, long-tailed duck, red-throated loon, and yellow-billed loon.

Population Trends and Conservation

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994b), which prohibits killing migratory birds and their eggs, taking their nests, and deposition of harmful substances in waters or areas frequented by migratory birds. In addition, migratory birds and ptarmigan in Nunavut are protected under the Nunavut *Wildlife Act* (2003), which prohibits destruction of bird nests when these are being used by birds, and prohibits disturbance to a "substantial number" of birds, such as to flocks of waterbirds during spring and fall staging.

Table 9.2-54. Waterbird Species Potentially Occurring in the Regional Study Area and their Regularity and Timing of Occurrence and Conservation Status

Common Name	Scientific Name	Regularity of Occurrence	Detected during Baseline Studies[1]	Timing of Occurrence	Conservation Status				
					CESCC[2]	COSEWIC[3]	SARA[4]	Global Rank[5]	IUCN Red List[6]
Geese, Swans, and Cranes									
Brant	*Branta bernicla*	Regular	Y	Migrant	Vulnerable	-	-	G5	Least Concern
Canada Goose	*Branta canadensis*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Greater White-fronted Goose	*Anser albifrons*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Ross's Goose	*Chen rossii*	Rare	Y	Breeding	Secure	-	-	G5	Least Concern
Sandhill Crane	*Grus canadensis*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Snow Goose	*Chen caerulescens*	Regular	Y	Migrant	Secure	-	-	G5	Least Concern
Tundra Swan	*Cygnus columbianus*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Dabbling Ducks									
American Green-winged Teal	*Anas crecca*	Regular	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
American Wigeon	*Anser rossii*	Accidental	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
Gadwall	*Anas strepera*	Rare	Y	Breeding	Not Applicable	-	-	G5	Least Concern
Mallard	*Anas platyrhynchos*	Rare	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
Northern Pintail	*Anas acuta*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Northern Shoveler	*Anas clypeata*	Rare	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
Diving Ducks									
Black (American) Scoter	*Melanitta americana*	Rare	N	Migrant	Unrankable/ Undetermined	-	-	G5	Least Concern
Common Eider	*Somateria mollissima*	Regular	Y	Breeding	Vulnerable	-	-	G5	Near Threatened
Common Merganser	*Mergus merganser*	Rare	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern

Common Name	Scientific Name	Regularity of Occurrence	Detected during Baseline Studies[1]	Timing of Occurrence	Conservation Status				
					CESCC[2]	COSEWIC[3]	SARA[4]	Global Rank[5]	IUCN Red List[6]
Greater Scaup	*Aythya marila*	Regular	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
King Eider	*Somateria spectabilis*	Regular	Y	Breeding	Vulnerable	-	-	G5	Least Concern
Lesser Scaup	*Aythya affinis*	Rare	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
Long-tailed Duck	*Clangula hyemalis*	Regular	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Red-breasted Merganser	*Mergus serrator*	Regular	Y	Breeding	Secure	-	-	G5	Least Concern
Ring-necked Duck	*Anthya collaris*	Accidental	Y	Breeding	Not Applicable	-	-	G5	Least concern
Surf Scoter	*Melanitta perspicillata*	Rare	Y	Migrant	Unrankable/ Undetermined	-	-	G5	Least Concern
White-winged Scoter	*Melanitta fusca*	Rare	Y	Migrant	Unrankable/ Undetermined	-	-	G5	Least Concern
Gulls and Terns									
Arctic Tern	*Sterna paradisaea*	Regular	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Glaucous Gull	*Larus hyperboreus*	Regular	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Herring Gull	*Larus argentatus*	Regular	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Thayer's Gull	*Larus thayeri*	Rare	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Loons									
Pacific Loon	*Gavia pacifica*	Regular	Y	Breeding	Unrankable/ Undetermined	-	-	G5	Least Concern
Red-throated Loon	*Gavia stellata*	Regular	Y	Breeding	Apparently Secure	-	-	G5	Least Concern
Yellow-billed Loon	*Gavia adamsii*	Regular	Y	Breeding	Apparently Secure	Not at Risk	-	G4	Least Concern

1: Detected or observed incidentally during baseline studies.
2: CESCC = Canadian Endangered Species Conservation Council.
3: COSEWIC = Committee on the Status of Endangered Wildlife in Canada.
4: SARA = Species At Risk Act (2002).
5: Global Rank = NatureServe Conservation status ranks are based on a one to five scale, ranging from critically imperiled (G1) to demonstrably secure (G5). Status is assessed and documented at three distinct geographic scales-global (G), national (N), and state/province (S).
6: IUCN Red List = The IUCN Red List of Threatened Species.

Arctic populations of geese and the tundra swan have generally remained stable or have increased in abundance (CWS 2011). Five waterbird species that occur in the RSA show declining population trends: lesser scaup, northern pintail, long-tailed duck, red-throated loon, and the Arctic tern (Kushlan et al. 2002; NAWMP 2004; Conant, Roetker, and Groves 2006).

Many breeding areas and adjacent marine areas in Nunavut used by waterbirds during the breeding season or post-breeding for staging and moulting are identified as Key Terrestrial Habitat Sites (KTHSs) and Key Marine Habitat Sites (KMHSs) by the Canadian Wildlife Service (M.L. Mallory and Fontaine 2004; Latour et al. 2008). Other areas are designated as Important Bird Areas (IBAs) by a partnership of conservation organizations including Bird Studies Canada, Nature Canada, and Birdlife International (IBA 2012b). In addition, areas of national importance to migratory birds are designated as Migratory Bird Sanctuaries (MBS) by Environment Canada under the *Migratory Birds Convention Act* (1994b). The selection criteria for MBS and IBAs are similar; as both identify habitats that are important to species of conservation concern, to large congregations of migratory birds, and to species that are limited by range or habitat (IBA 2012b; Environment Canada 2013). However, only MBS are protected under legislation. Key Habitat Sites (Terrestrial and Marine) are areas that support at least 1% of the Canadian population of at least one migratory species (M.L. Mallory and Fontaine 2004; Latour et al. 2008). Key Habitat Sites for Nunavut are included within the 2014 Draft Nunavut Land Use Plan as "Key Migratory Bird Habitat Sites" (NPC 2014).

The Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS) is the closest MBS to the Hope Bay Project, located roughly 50 km to the east of the Hope Bay Project; this area is also recognized as an IBA, and a Key Migratory Bird Habitat Site under the Draft Nunavut Land Use Plan (NPC 2014). In addition, the Bathurst Inlet and Elu Inlet Key Migratory Bird Habitat Site identified within the 2016 Nunavut Land Use Plan encompasses Melville Sound and the northern third of Bathurst Inlet and encompasses the marine wildlife RSA (see Volume 5, Section 11). No other Key Migratory Bird Habitat Sites occur near the Hope Bay Project.

Distribution and Migration Patterns

The majority of bird species that breed in the Arctic migrate long distances between their summer range on the tundra, and their winter ranges at southern latitudes. Migratory waterbirds arrive on the Arctic tundra from early to late May and depart in late August and throughout September. Migration occurs through a series of relatively rapid movements between staging areas, where birds spend days to several weeks foraging prior to moving to the next staging area (M. L. Mallory et al. 2006). Spring arrival at Arctic breeding grounds is earlier (early to mid-May) for the larger-bodied waterbirds, an observation that is consistent with Inuit TK of the Kitikmeot region (Banci and Spicker 2016). The smaller-bodied waterbirds, like loons and ducks arrive in late May to early June.

Breeding for all waterbird species occurs soon after the birds arrive on the tundra and brooding of young occurs from late June to mid-September.

During the breeding season, waterbirds tend to be patchily distributed across the Arctic tundra, concentrating at productive waterbodies and wetlands (Conkin and Alisauskas 2013). Inuit TK reports that Arctic waterbirds nest at higher densities near the Arctic coast (Banci and Spicker 2016). Some waterbird species such as long-tailed ducks, yellow-billed loons, Canada and greater white-fronted geese nest in greater density on inland waterbodies and wetlands across the Arctic tundra, while other species such as the red-throated loon are found at highest densities along coastlines (Derksen, Rothe, and Eldridge 1981; Conkin and Alisauskas 2013).

Waterbirds can spend up to 50% of the year migrating between wintering and breeding areas, and up to 95% of that time staging in areas prior to and following breeding. Waterbirds occur in greater densities within staging areas relative to breeding areas. Birds typically congregate at fall staging sites prior to southward migration, though these are typically smaller congregations than those that occur during spring migration (Dickson and Gilchrist 2002).

Habitat Use

The Arctic provides breeding habitat for one-third of the world's waterbird population, including two-thirds of all geese (Zöckler 1998). Waterbirds typically nest in habitat that provides protection from predators, and thus often nest within approximately 100 m of water, and on small mid-water islands since these offer protection from terrestrial predators (Sovada, Anthony, and Batt 2001). Inuit TK of the Kitikmeot region includes observations of waterbirds nesting on mid-stream islands and on cliffs (Banci and Spicker 2016). Geese nest in flooded wetlands adjacent to large water bodies, which provide escape from terrestrial predators (Bart and Earnst 1991; Stickney et al. 2002). Some waterbird species, especially geese, nest on cliffs near nesting raptors where they receive protection from mutual nest predators (Bety et al. 2001). Loons are unable to walk on land and always nest in emergent vegetation within 1 to 2 m of water. Individuals of many species of waterbirds exhibit year-to-year fidelity to nest sites and territories (Anderson, Rhymer, and Rohwer 1992).

Most waterbird species moult their breeding plumage during or just after breeding in staging areas. The timing of moulting varies across species, gender, and reproductive status. Typically, waterbirds that are not engaged in the care of eggs or young — males of uniparental species, non-breeders, and failed breeders — congregate to moult during the incubation stage and onward (S. R. Johnson and Richardson 1982). Dabbling ducks gather in local wetlands near nesting sites, but geese, swans, seaducks and scaup usually migrate to traditional moulting areas, sometimes up to hundreds of kilometers from breeding sites (Derksen, Rothe, and Eldridge 1981; Reed et al. 2003; Larned, Stehn, and Platte 2012). Greater scaup use shallow, non-turbid, wind and wave sheltered coastal areas with abundant forage, such as lagoons and bays (Dickson and Gilchrist 2002; Fischer and Larned 2004). Species such as the long-tailed duck and red-breasted merganser, all of the loon species, and the glaucous gull stage at coastal sites on the ocean that become ice-free early in the spring (Dickson and Gilchrist 2002).

Birds are flightless for several weeks while moulting but are capable of swimming more than 15 km between coastal moulting sites (Flint et al. 2004). Thus staging areas are considered key habitats necessary to sustain populations (Petrie and Wilcox 2003). These sites were important waterbird hunting areas for Inuit (Banci and Spicker 2016). Both scientific and Inuit TK show that early ice-free areas are important staging areas for waterbirds during the spring. Such areas include coastal areas, shallow and small lakes and ponds, and rivers with fast-flowing water.

9.2.11.2 Baseline Data for Waterbirds

Baseline surveys for waterbirds were conducted in the LSA and RSA to document species presence (especially species of conservation concern), the seasonal abundance and distribution of waterbirds and to identify important waterbird habitats (e.g., breeding sites, migratory staging areas) and include:

1. waterbird aerial surveys by helicopter during breeding periods to document evidence of breeding near and surrounding the LSA; and
2. waterbird aerial surveys by helicopter during spring and fall staging periods (2014) to document important staging areas around the Boston Property.
3. Stand watches to record waterfowl at proposed turbine locations.

In addition, observations of waterbirds were reported incidentally by field staff during other studies conducted in the RSA and by TMAC personnel.

Waterbird Aerial Surveys

Methods

Aerial surveys for waterbirds were conducted annually from 2006 to 2015 in four survey blocks. These survey blocks were designed to both monitor effects of the Doris Project and to collect baseline for the Phase 2 development. Survey blocks were located over Roberts Bay, Doris, Boston and approximately midway between Boston and Doris (Figure 9.2-36). Two surveys were conducted each year at each block; a pair survey during the northern migration/establishment of nesting territories in late June to early July, and a brood survey in late July to early August (Table 9.2-55). These surveys were not conducted in the Boston block after 2011.

Each survey block covered a 15 km x 16 km area and contained six, 16 km long east to west transects spaced 2 km apart. Aerial surveys were flown by helicopter along each transect. Surveyors recorded waterfowl within 400 m on either side of the aircraft (800 m belt transect) during the pair surveys and within 200 m on either side of the aircraft (400 m belt transect) during the brood surveys. Detailed rationale, methodology, data analyses and results for the waterbird baseline surveys is provided in the annual WMMP Reports for the Doris Project (Golder 2007, 2008a; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a).

Separate targeted spring and fall staging surveys were conducted in 2014 at the Boston block as well as along the proposed Phase 2 road alignment between Madrid and Boston Table 9.2-55; Figure 9.2-36). Staging transects followed the methodology of other waterbird aerial surveys except that transect width was 500 m on either side of the aircraft (for 1 km transect width). Groups of waterbirds were mapped to identify potential staging areas. Groups were classified as small (11 to 24 birds), medium (25 to 49), medium-large (50 to 100), and large flocks (>100).

Results

During waterbird aerial surveys, a total of 30 waterbird species were observed during the breeding season within the RSA (Table 9.2-54). Brant goose, Thayer's gull, and surf scoter were the only species not detected during aerial surveys, however these species were detected incidentally in the RSA during other baseline studies.

Across all years of the waterbird aerial surveys, Canada geese were the most commonly detected species, followed by greater white-fronted geese. Tundra swan, long-tailed duck, greater scaup, red-breasted merganser, and northern pintail were also commonly detected in most surveys and years. Of the loon species, Pacific loons were most commonly detected across survey types, areas and years. A number of species were infrequently detected in terrestrial areas during the waterbird aerial surveys, including American wigeon, mallard, white-winged scoter, and Arctic tern.

Three species listed as Vulnerable by CESCC in Nunavut (CESCC 2016) were observed in the RSA during waterbird baseline studies (Table 9.2-54), including the brant, common eider and king eider. Both the common and king eider were only detected in the Doris and Roberts Bay blocks during aerial surveys, likely due to the common and king eider's preference for marine areas. Brant were recorded incidentally in the RSA. Six other species are listed as Apparently Secure, including Arctic tern, glaucous gull, herring gull, long-tailed duck, red-throated loon, and yellow-billed loon. Arctic tern were detected only in the Boston and Mid-belt blocks, while the remaining species were detected in all four survey blocks during waterbird surveys.

Figure 9.2-36
Waterbird Aerial Survey Transects during Pair, Brood, and Staging Surveys, 2006 to 2015

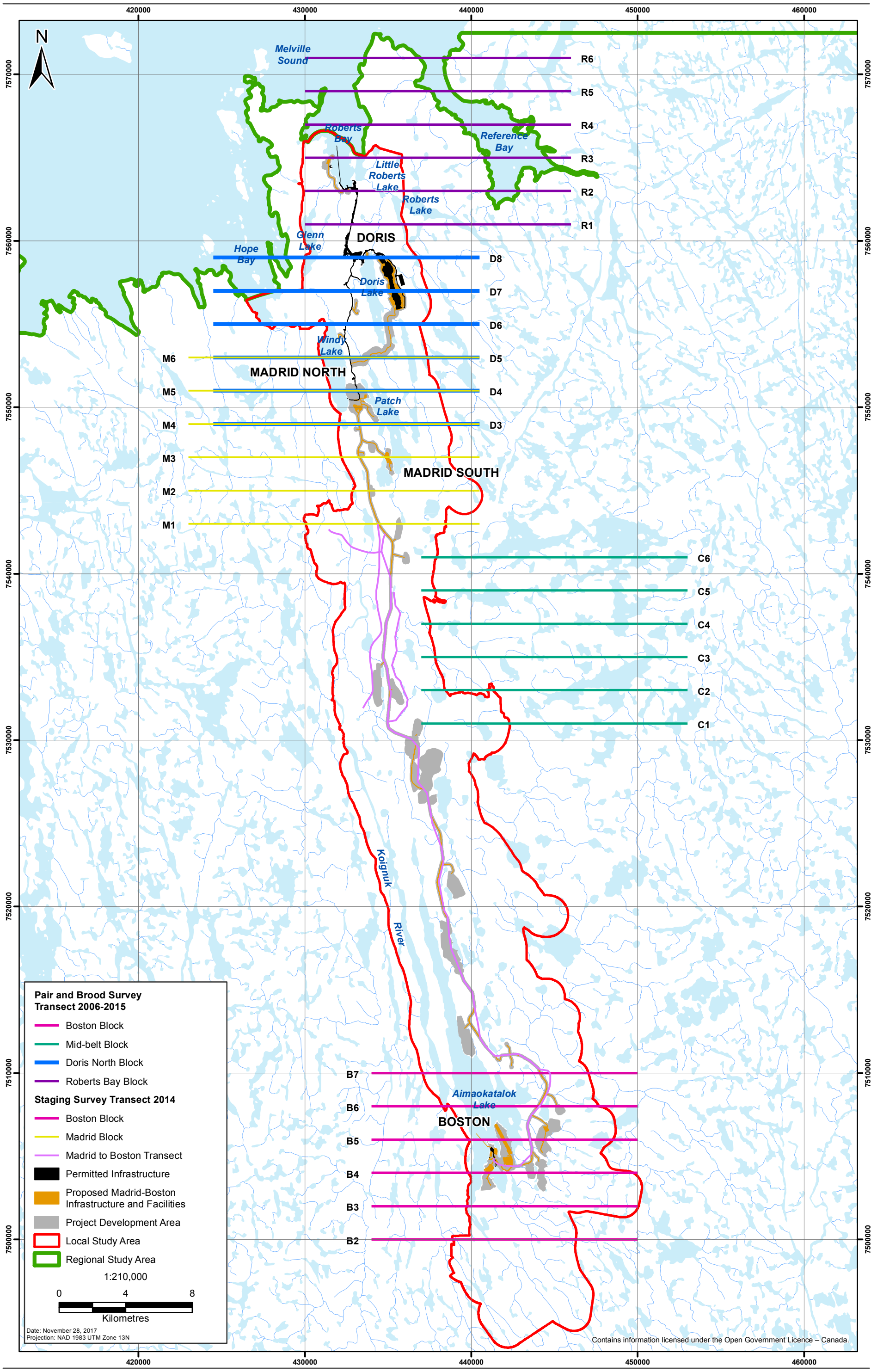


Table 9.2-55. Timing of Waterbird Aerial Surveys, 2006 to 2015

Survey Period	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Pair Survey	June 21-28	June 27	July 5	July 7	June 29 – July 6	June 24 – July 7	June 22	June 12-22	June 21	June 24-25
Brood Survey	August 9	August 6	July 29-30	July 27-28	July 24-28	July 24-27	August 4	August 4-5	July 27-28	August 4-5
Spring Staging Survey									June 5	
Fall Staging Survey									August 23	

Note: No waterbird aerial surveys were conducted in 2016.

Pair Surveys

Waterbird pair surveys were conducted during the early breeding season from 2006 to 2015, with the exception of 2011 to 2015 at the Boston block, in 2011 at the Mid-belt and Doris blocks, and 2009 and 2011 at the Roberts Bay block. Abundance of waterbirds varied by year (Figure 9.2-37) and was greatest in 2010 and lowest in 2007 relative to other years when all four survey blocks were surveyed. In years where all blocks except Boston block were surveyed, waterbird abundance was greatest in 2013 and lowest in 2015.

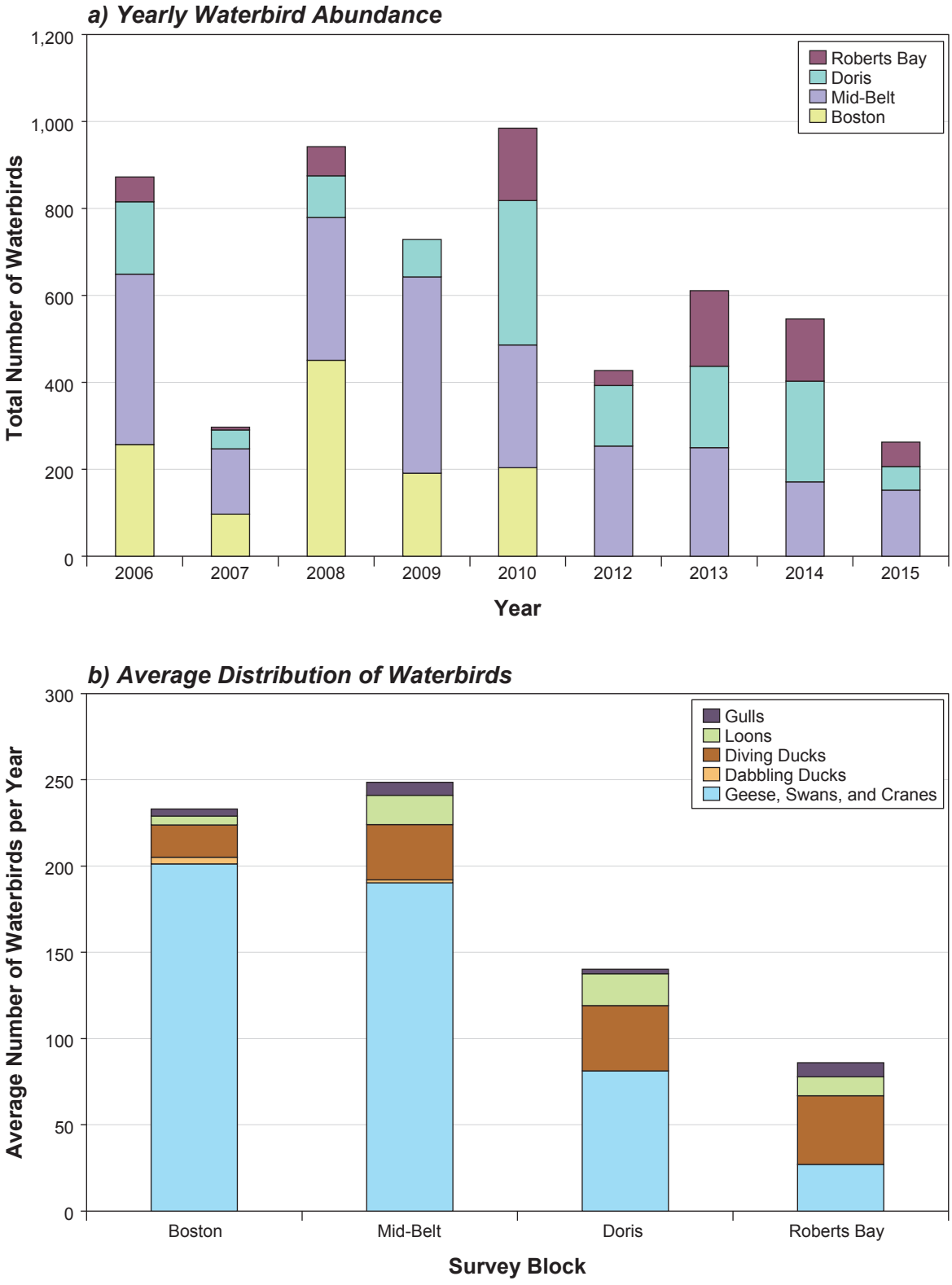
In general, abundance of waterbirds was highest in the Mid-belt block, followed by the Boston block and lowest in the Roberts Bay block (Figure 9.2-37). Geese and swans were the most commonly detected waterbird species group in all blocks (65%, n = 5,669), primarily consisting of Canada geese (51%, n = 5,669); however, these species were more abundant in the Boston and Mid-belt blocks and the southern portion of the Doris block relative to the Roberts Bay block (Figure 9.2-37).

Flocks of waterbirds were consistently observed in the Mid-belt block and in the Boston block in years surveyed, with fewer congregations of waterbirds were observed in the Doris and Roberts Bay blocks (Figure 9.2-38). The majority of flocks consisted of less than 50 birds (Figure 9.2-38). A few medium-large flocks of waterbirds (50 to 100 individuals) were observed in the wetlands and lakes located on the southeast side of the Mid-belt block in 2009, in a river system south of Hope Bay in the Doris block (in 2010 and 2014) and in the wetlands surrounding the Boston exploration camp with a few large flocks (greater than 100 birds) observed south of Boston camp in 2009 (Figure 9.2-38). All flocks greater than 50 individuals consisted of Canadian geese.

Brood Surveys

During waterbird brood surveys in late July or early August from 2006 to 2015 (with the exception of 2012 to 2015 in the Boston block), abundance of waterbirds varied by year (Figure 9.2-39) and was greatest in 2010 and lowest in 2006. In years where all blocks except Boston block were surveyed, waterbird abundance was greatest in 2012 and lowest in 2015. Similar to pair surveys, abundance of waterbirds was highest in the Mid-belt block, followed by the Boston block and lowest in the Roberts Bay block. Geese and swans were the most commonly detected waterbird species group in all survey blocks. Canada geese were the most commonly recorded species (54, n = 9,832%) followed by greater-white fronted geese (8%, n = 9,832). Greater scaup and long-tailed duck were also commonly recorded during the brood surveys in all areas, and northern pintail were commonly seen in the Mid-belt block. Red-breasted mergansers were most abundant in the Roberts Bay and Doris blocks as these blocks are the closest to marine habitat.

Flocks of waterbirds were observed in all survey blocks with the majority of flocks occurring in the Mid-belt block and the Boston block and the fewest flocks observed in the terrestrial areas in the Roberts Bay block (Figure 9.2-39). The majority (95%, n = 334) of flocks consisted of less than 50 individuals (Figure 9.2-39). Medium-large flocks (50 to 100 individuals) were consistently observed in the Mid-belt block in a small wetland area near the center of the block and were observed in 2007, 2009 and 2011 in the Boston block, with one medium-large flock observed in each of the Doris and Roberts Bay blocks. Large flocks of waterbirds (greater than 100 individuals) were only observed in 2011 and were located in a wetland on the west side of the Boston block and in a lake just north of the Boston block. Most medium-large and large flocks consisted of Canada geese, although three medium-large flocks of northern pintail were observed (two in the Mid-belt block in 2010 and 2012 and one in the Boston block in 2011) and one medium-large flock of red-breasted merganser was observed in 2013 on a river system on the southeast side of Reference Bay (in the Roberts Bay block).


a) Yearly Waterbird Abundance
Total Number of Waterbirds
1,200
1,000
800
600
400
200
0
Roberts Bay
Doris
Mid-Belt
Boston
2006
2007
2008
2009
2010
2012
2013
2014
2015
Year
b) Average Distribution of Waterbirds
Average Number of Waterbirds per Year
300
250
200
150
100
50
0
Gulls
Loons
Diving Ducks
Dabbling Ducks
Geese, Swans, and Cranes
Boston
Mid-Belt
Doris
Roberts Bay
Survey Block

Across survey years, a total of 224 broods were detected belonging to 18 waterbird species (Figure 9.2-40). Of the species detected with broods, one is listed as Vulnerable in Nunavut (detections of common/unknown eider, as both eider species are listed as Vulnerable) and five are listed as Apparently Secure, which includes glaucous gull, herring gull, long-tailed duck, red-throated loon, and yellow-billed loon (CESCC 2016). The greatest number of broods observed belonged to greater white-fronted geese, followed by Canada geese (Figure 9.2-40). Other commonly detected species with broods included tundra swan, long-tailed duck and scaup species (most likely belonging to greater scaup). After accounting for survey effort, the highest number of broods was detected in the Mid-belt block followed by the Boston block, then the Doris block and the fewest number of broods was observed in the Roberts Bay block (Figure 9.2-40). The number of broods varied annually, with more broods observed in 2008, and between 2010 and 2013. Seasonal weather may account for some of the differences in brood numbers observed amongst years.

Staging Surveys

During the staging surveys conducted at the Boston block, the Madrid block and along the proposed all weather road in 2014, the density of waterbirds was higher during spring staging than fall staging in all areas surveyed. The most commonly detected species groups were geese and swans, including Canada geese, greater white-fronted geese, snow geese, and tundra swan (Table 9.2-56). Northern pintail and greater scaup were also commonly detected during spring staging surveys.

Canada geese comprised the majority of observations during both staging periods (64.9% during spring and 24.6% during fall; Table 9.2-56). Other species with notable detection during the spring staging period were northern pintail (8.0%), greater white-fronted goose (7.6%), snow goose (5.2%), greater scaup (3.9%), and tundra swan (3.9%) and during the fall staging period were pacific loon (24.6%) and tundra swan (17.8%). Overall, species richness was higher during spring staging (14 species) relative to fall staging (10 species), but within the Madrid block species richness was higher during the fall staging period (9 species) relative to the spring staging period (7 species; Table 9.2-56).

Flocks of staging geese, swans, and ducks were noted in particular locations within the staging survey blocks; along open and flowing streams and rivers, and within shallow, partially open wetlands (Figure 9.2-41). Most flocks were observed during the spring staging surveys with fewer flocks observed in the fall staging surveys. Flocks greater than 50 individuals were only observed during the spring survey.

During the spring staging survey, eight large flocks of over 100 individuals were observed primarily along the proposed all-weather road with two large flocks observed in the Madrid block and one large flock observed in the Boston block (Figure 9.2-41). The largest group of waterbirds observed during the spring staging survey was in the small stream leading into Aimaokatalok Lake located roughly 350 m to the east of Boston camp and airstrip, composed of roughly 900 individuals of seven different species (American green-winged teal, Canada goose, glaucous gull, greater scaup, greater white-fronted goose, northern pintail, and tundra swan; Figure 9.2-41). The main species recorded at this location east of Boston camp and airstrip was Canada goose, with a flock of 600 individuals.

The areas that provide the most important habitat for waterbirds during the spring staging period were well documented during surveys (i.e., streams, rivers, and shallow wetlands). Therefore, it is expected that areas that were not surveyed within the southern portion of the Boston block that contain these types of habitat would also be used by waterbirds during the spring staging period.

Figure 9.2-38
Flocks of Waterbirds Observed in the Regional Study Area during Pair Surveys, 2006 to 2015

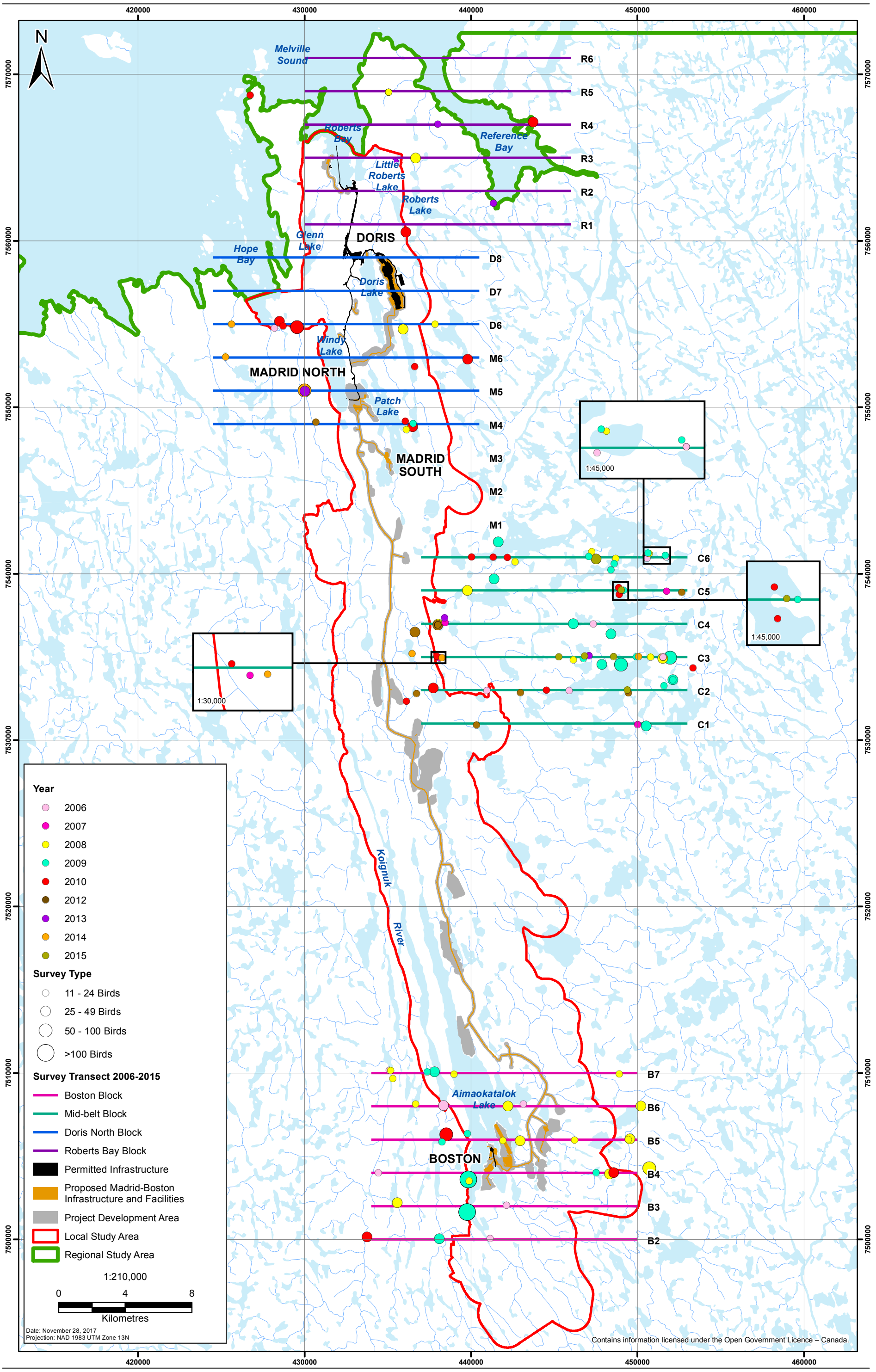


Figure 9.2-39
Flocks of Waterbirds Observed in the Regional Study Area during Brood Surveys, 2006 to 2015

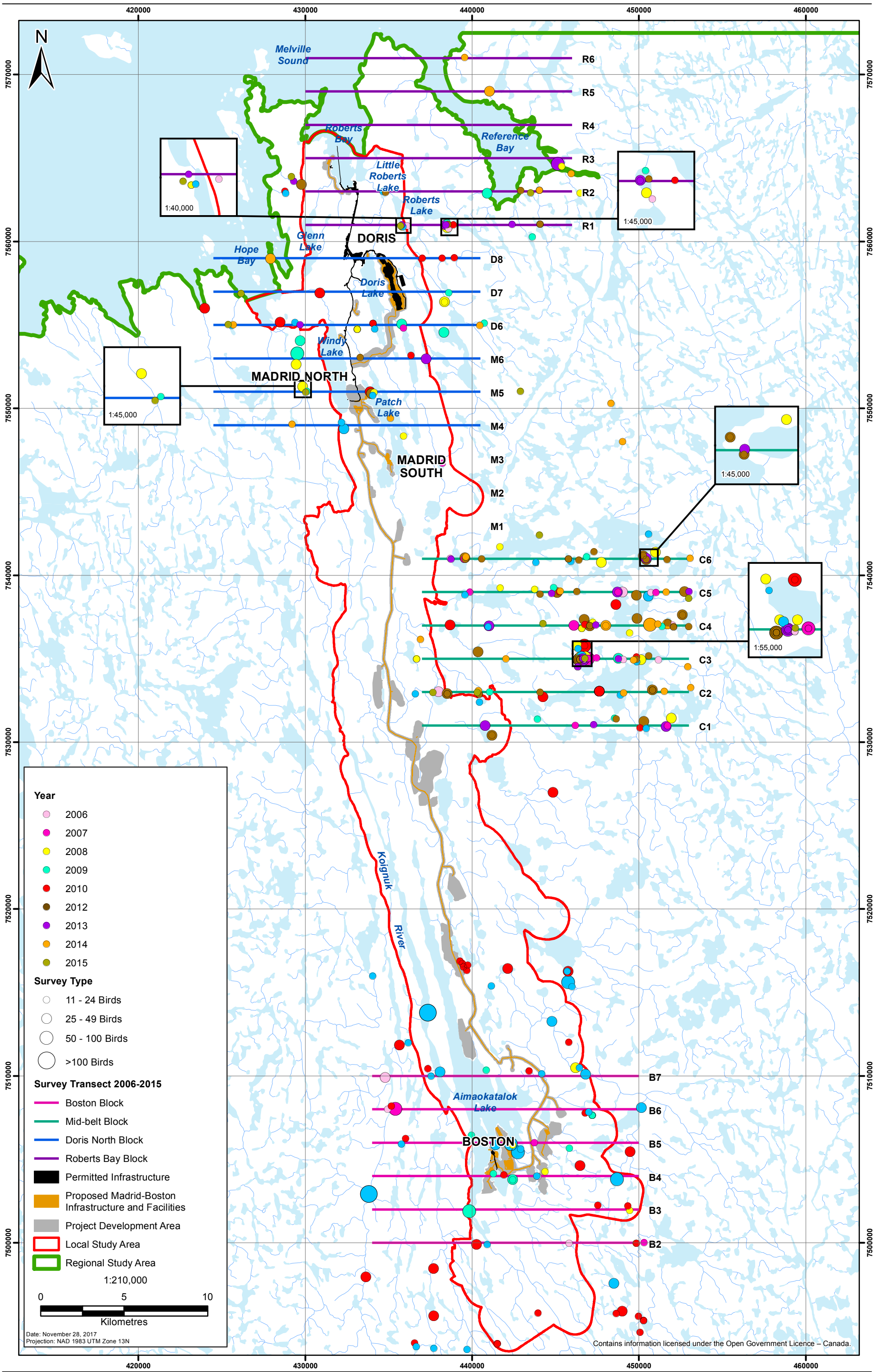
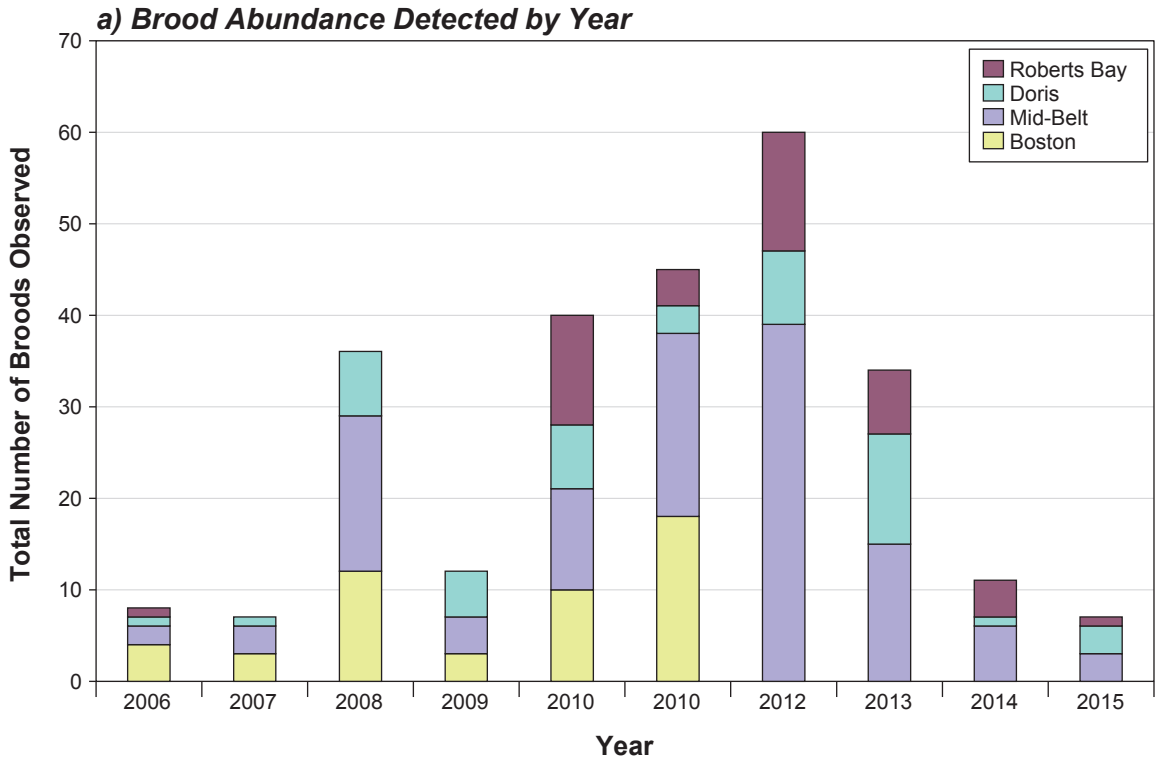


Figure 9.2-40

Abundance and Distribution of Waterbird Broods Observed in the Regional Study Area during Brood Surveys, 2006 to 2015



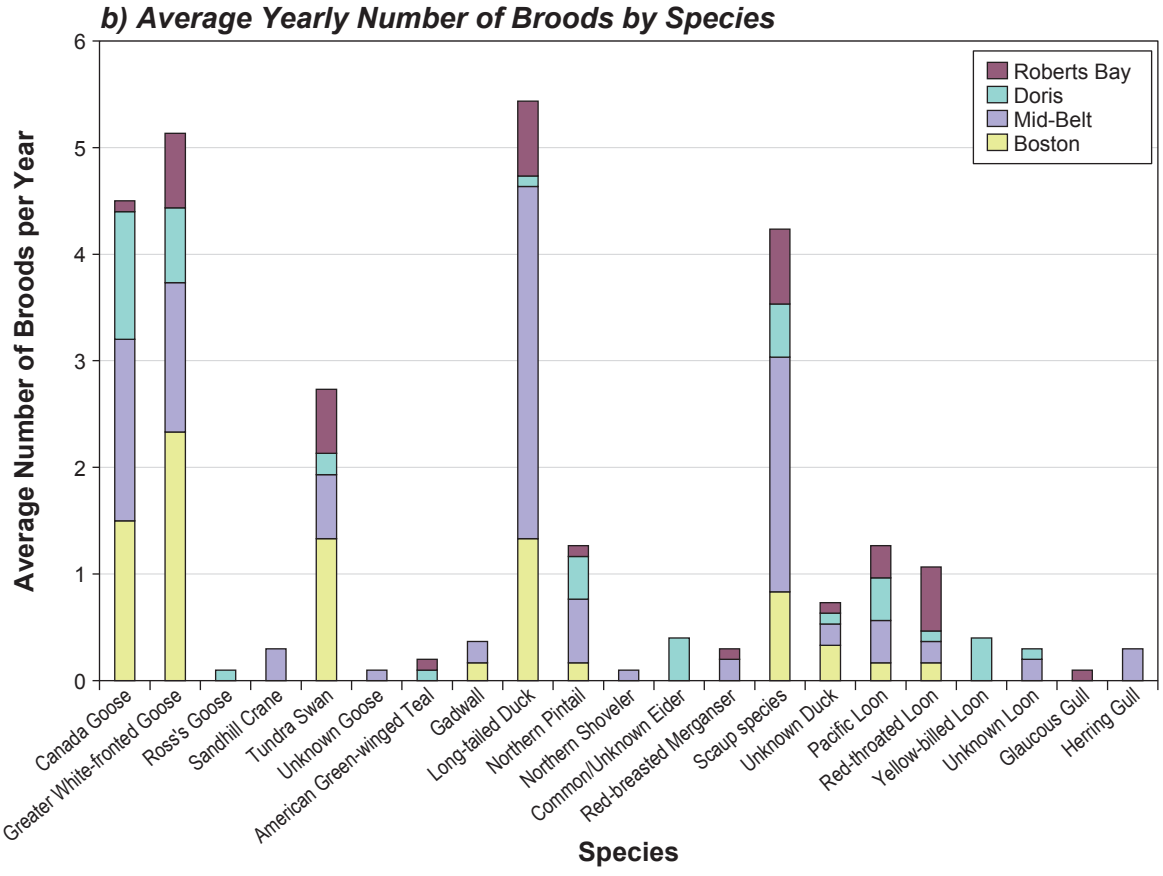


Table 9.2-56. Waterbird Survey Observations, Species Richness and Density during Staging Surveys, 2014

		Boston		Madrid		Proposed All-weather Road		Areas Combined	
Species Group	**Species**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**
Geese, Swans	Canada Goose	521	11	205	5	1307	2	2,033	18
and Cranes	Greater White-fronted Goose	46	-	-	1	192	-	238	1
	Sandhill Crane	2	-	1	1	6	-	9	1
	Snow Goose	87	-	-	-	75	-	162	-
	Tundra Swan	26	3	55	6	41	4	122	13
	Unknown Goose	-	-	150	-	-	-	150	-
Dabbling and Diving Ducks	American Green-winged Teal	1	-	-	-	2	-	3	-
	American Wigeon	-	-	-	-	2	-	2	-
	Greater Scaup	74	-	-	-	49	-	123	-
	Long-tailed Duck[1]	-	1	-	4	2	1	2	6
	Northern Pintail	20	-	50	-	180	-	250	-
	Red-breasted Merganser	-	-	-	2	-	-	-	2
	Unknown Duck	2	2	-	2	-	-	2	4
Loons	Pacific Loon	14	3	6	7	-	8	20	18
	Red-throated Loon[1]	1	-	-	1	-	1	1	2
	Yellow-billed Loon[1]	-	-	-	-	-	1	-	1
	Unknown Loon	-	1	-	-	-	-	-	1
Gulls and Terns	Glaucous Gull[1]	1	-	2	-	4	-	7	-
	Herring Gull[1]	4	4	3	1	3	-	10	5
	Unknown Gull	-	-	-	-	-	1	-	1
Total[2]		**799**	**25**	**472**	**30**	**1,863**	**18**	**3,134**	**73**
Species Richness[3]		**12**	**5**	**7**	**9**	**12**	**7**	**14**	**10**
Density (individuals/km^2)		**31.2**	**0.7**	**12.3**	**0.8**	**97.5**	**0.9**		

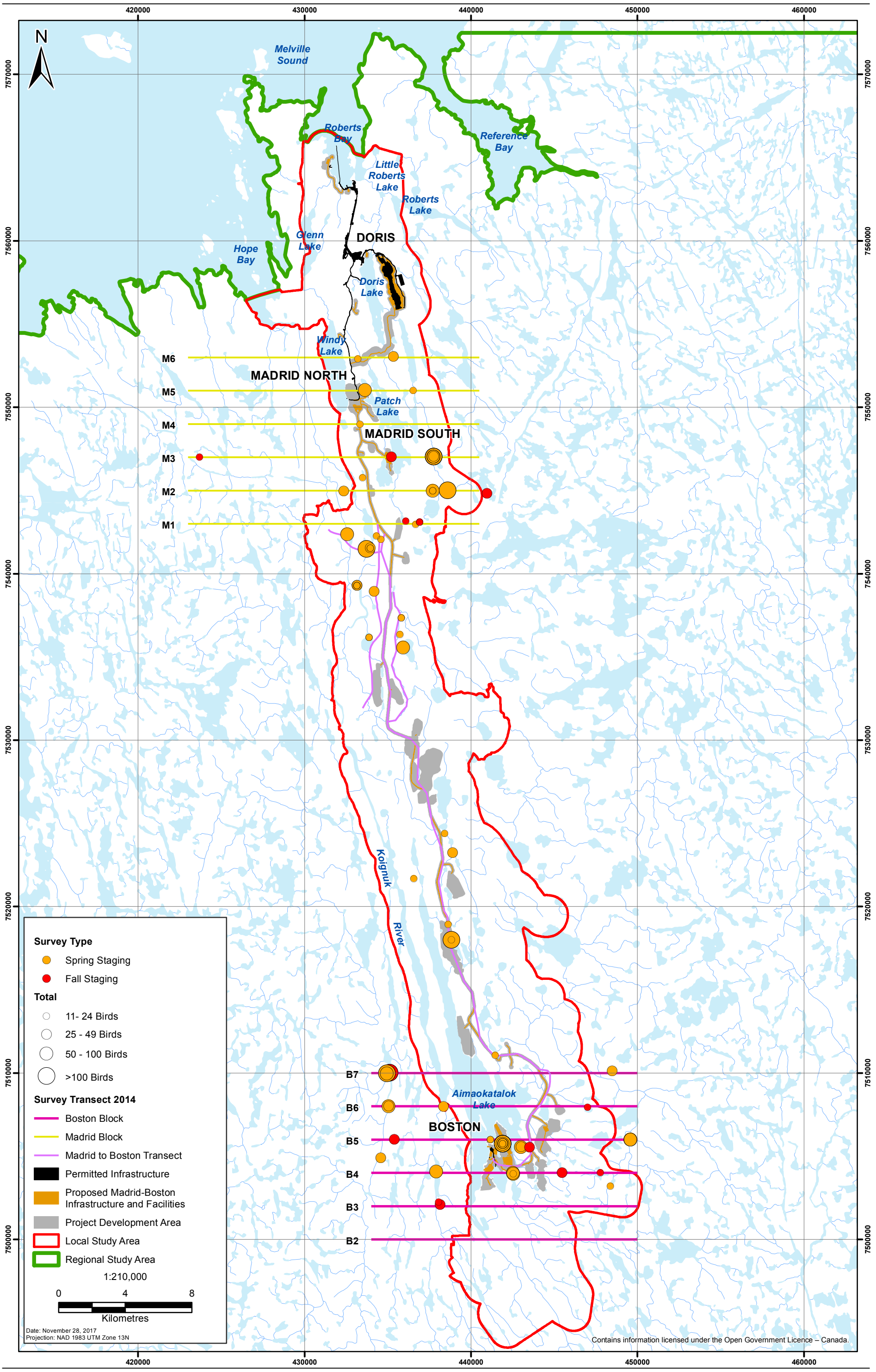
[1] Species listed as Sensitive Apparently Secure in Nunavut (CESCC 2016)
[2] Includes unknown species
[3] Does not include unknown species, unless no counts of the species group were observed during any given survey block

Migratory Standwatch Surveys

Methods

Migratory standwatch surveys were conducted for all bird VECs, including waterbirds during spring and fall migration. Methods followed those outlined in ECCC's Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (Environment Canada 2007a). Figure 9.2-33a shows the locations of the migration survey sites in relation to the Project area. The methods are summarized in Section 9.2.10.2.

Figure 9.2-41
Flocks of Waterbirds Observed in the Regional Study Area during Staging Surveys, 2014



Results

Waterbirds were the most numerous bird VEC recorded during standwatch surveys, comprising 96% of all bird observations during standwatch surveys.

During spring migratory standwatch surveys, eleven species of waterbirds, comprised of 1,699 waterbird individuals were observed; 1,057 observations were at Site D-1 and 642 observations were at Site D-2 (Table 9.2-57). Canada goose was the most commonly observed species (Table 9.2-57). Passage rates were similar between site D-1 (44.0 obs/hr) and site D-2 (53.5 obs/hr; Table 9.2-57). Migration appeared to be broad-front, with birds arriving from all southerly directions and heading north, as is expected.

Of the total observations at sites Doris D-1 and D-2 during the spring surveys, 83% (n=1,403) of waterbirds were flying at turbine height (heights of between 50 m and 200 m), including 973 individuals at D-1 and 430 individuals at D-2. Of the 973 waterbirds observed at Doris D-1, 18% (n=179) of the observations were within the potential zone of interaction with wind turbines (Table 9.2-57). Canada geese were observed in the potential zone of interaction with wind turbines in the highest numbers, comprising 18% of observations (n=171) within the potential zone of interaction.

During fall migratory standwatch surveys, ten species of waterbirds, comprised of 3,611 individuals were recorded across the two survey sites (Doris D-1 and Boston B-1; Table 9.2-58). A total of 3,325 individuals, comprising nine species, were documented at B-1 and seven species consisting of approximately 280 individuals were recorded at D-1 (Table 9.2-58). Canada goose, followed by greater white-fronted goose, snow goose then sandhill crane was the most commonly observed species across both sites. Passage rates were higher at B-1 (201.5 obs/hr) relative to D-1 (18 obs/hr; Table 9.2-58). In general, fall migration appeared to be broad-front, with birds arriving from all northerly directions and heading south.

Of the total observations of waterbirds at sites D-1 and B-1 during fall surveys, 73% (n=2,644) of waterbirds were flying at turbine height (flying at heights of between 50 m and 200 m). A smaller portion of these waterbirds (29%, n=761) were observed flying within the potential zone of interaction with wind turbines (Table 9.2-58). Several groups of unidentified geese flying through the Boston area comprised approximately 50% (n=680) of waterbirds identified in the potential zone of interaction during fall.

The results indicate that flights at heights between 50 and 200 m through the location of the potential wind turbine appear to be a small proportion of the total waterbirds observed in flight (18% of all observations during the spring and 29% during the fall). Fall migratory observations of waterbirds were more than double spring observations (in fall 3,611 vs. 1,699 in spring) and had similar species composition (11 species recorded in spring compared to 10 recorded in fall). Passage rates were higher in fall at 105 individuals per hour of survey effort compared to 47 individuals per hour of effort however several factors should be considered when examining these trends in flight activity between the spring and fall, as different airspaces were monitored between the two periods.

Based on general observations, it appears that in the fall waterbirds migrate when the wind is from a northerly direction, to take advantage of fall conditions, i.e. tail wind. In both seasons, migration occurs as a broad front over the Project area with no barriers to movement. There is no evidence of topographic features restricting bird movement across the landscape at either site.

Table 9.2-57. Waterbird Observations during Spring Migratory Standwatch Surveys, 2017

	No. of Waterbird Observations										
					Obs. Flying at Turbine Height						Obs. within Potential Zone of Interaction with Wind Turbine	
		Doris D-1	Doris D-2	Total	Doris D-1		Doris D-2		Total		Doris-D1	
Species Group	**Species**				**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Geese, Swans and Cranes	Brant[1]	0	3	3	0	-	3	100	3	100	0	0
	Canada Goose	988	588	1,576	944	96	396	67	1,340	85	171	18
	Sandhill Crane	2	14	16	1	13	6	43	7	44	0	0
	Snow Goose	4	0	4	4	100	0	-	4	100	0	0
	Tundra Swan	3	3	6	0	0	0	0	0	0	0	0
	Unknown Goose	0	11	11	0	0	11	100	11	100	0	0
Diving and Dabbling Ducks	Long-tailed Duck[2]	6	12	18	6	100	6	50	12	67	6	100
	Northern Pintail	11	9	20	2	18	2	22	4	20	0	0
Loons	Pacific Loon	3	2	5	3	100	2	100	5	100	0	0
	Red-throated Loon[2]	1	0	1	0	0	0	-	0	0	0	0
Gulls and	Glaucous Gull[2]	6	5	11	1	17	4	80	5	45	0	0
Terns	Herring Gull[2]	33	6	39	12	36	0	0	12	31	0	0
Total No. Obs		**1,057**	**642**	**1,699**	**973**	**92**	**430**	**67**	**1,403**	**31**	**179**	**18**
Total Effort (hrs)		**24**	**12**	**36**								
Passage rates (obs/hr)		**44.0**	**53.5**	**47.2**								

[1] *Species listed as Vulnerable in Nunavut (CESCC 2016)*
[2] *Species listed as Apparently Secure in Nunavut (CESCC 2016)*
Notes: Waterbirds flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height. Number of waterbirds observed within the potential zone of interaction with wind turbines was determined from the Doris D-1 site only.

Table 9.2-58. Waterbird Observations during Fall Migratory Standwatch Surveys, 2017

	No. of Waterbird Observations															
					Obs. Flying at Turbine Height						Obs. within Potential Zone of Interaction with Wind Turbine					
					Boston B-1		Doris D-1		Total		Boston B-1		Doris D-1		Total	
Species Group	**Species**	**Boston B-1**	**Doris D-1**	**Total**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Geese, Swans and Cranes	Canada Goose	640	103	743	486	76	44	43	530	71	27	6	0	0	27	5
	Greater White-fronted Goose	606	58	664	469	77	18	31	487	73	8	0	18	100	18	4
	Sandhill Crane	160	8	168	147	92	7	88	154	92	16	11	0	0	16	10
	Snow Goose	365	37	402	56	15	17	46	73	18	20	36	0	0	20	27
	Tundra Swan	19	4	23	2	11	0	0	2	9	0	0	0	0	0	0
	Unknown Goose	1,508	70	1,578	1,348	89	40	57	1,388	88	680	0	0	0	680	0
Dabbling and Diving Ducks	Long-tailed Duck[1]	10	0	10	0	0	0	-	0	0	0	0	0	-	0	0
Loons	Pacific Loon	14	1	15	7	50	0	0	7	47	0	0	0	0	0	0
	Red-throated Loon[1]	0	3	3	0	-	0	0	0	0	0	-	0	0	0	0
	Yellow-billed Loon[1]	1	0	1	0	0	0	-	0	0	0	0	0	-	0	0
	Unknown Loon	1	1	2	1	100	1	100	2	100	0	0	0	0	0	0
Gulls and Terns	Herring Gull[1]	1	1	2	1	100	0	0	1	50	0	0	0	0	0	0
Total No. Obs		**3,325**	**286**	**3,611**	**2,510**	**75**	**127**	**44**	**2,644**	**73**	**743**	**30**	**18**	**14**	**761**	**29**
Total Effort (hrs)		**16.5**	**18**	**34.5**												
Passage rates (obs/hr)		**201.5**	**15.9**	**104.7**												

[1] *Species listed as Apparently Secure in Nunavut (CESCC 2016)*

Notes: Waterbirds flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height.

Incidental Observations of Waterbirds

Methods

Methods for incidental observations of wildlife are identical to those for caribou and are discussed in Section 9.2.6.2. Incidental observations of waterbirds were recorded when:

1. observed by project personnel near the Doris Project Site from 2009 and 2016 and recorded in the Wildlife Sighting Log; and
2. observed by environmental personnel and wildlife biologists when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016, which includes observations collected spatially or temporally outside of targeted VEC studies.

These incidental observations were reviewed to identify species that were not detected on formal waterbird surveys to provide a comprehensive view of species diversity in the RSA.

Results

Incidental Observations of Waterbirds by Mine Site Personnel

There were no waterbird species recorded in the Doris Wildlife Sightings Log that had not already been documented on aerial waterbird surveys. In general, larger waterbird species, such as geese species, tundra swan, and sandhill crane were the most commonly recorded species in the log, with records in every year from 2009 to 2016.

Incidental Observations of Waterbirds by Field Personnel

Four waterbird species were recorded incidentally that were not recorded during formal waterbird surveys: brant (goose), common goldeneye, Thayer's gull, and white-winged scoter. For the most part, all of these four species were recorded in more recent years. Brant was observed in 2009, Thayer's gull was recorded in 2014, common goldeneye was observed in 2015, and white-winged scoter was observed in 2014 and 2015. Of these four species, two are considered a species of territorial conservation concern in Nunavut: brant is designated as Vulnerable and Thayer's gull is listed as Apparently Secure by the Canadian Endangered Species Conservation Council (CESCC 2016).

The RSA is within the known ranges of brant and Thayer's gull, with the breeding grounds of brant occurring along the coasts of the Arctic mainland (including the RSA) and in coastal areas of the Arctic islands, and Thayer's gull breeding areas on Arctic islands (Snell 2002; Lewis et al. 2013). Thus, both species could pass through the RSA during migration, and brant are a possible breeder in the area. However, numerous surveys have been conducted during the breeding period from 2006-2015 and there has been no documentation of brant despite survey effort across a large amount of suitable breeding habitats for Arctic waterbirds (ERM 2016a). This evidence suggests that brant are not breeding within the RSA and are a seasonal migrant (Table 9.2-54).

The seasonal ranges of common goldeneye and white-winged scoter do not overlap the RSA, with the northern extent of these two species breeding range generally occurring at the treeline (Eadie, Mallory, and Lumsden 1995; P. W. Brown and Fredrickson 1997). Therefore, these species are expected to be rare and uncommon in the RSA (Table 9.2-54).

Habitat Suitability Modelling

Methods

Habitat suitability modeling was conducted in the LSA and RSA for waterbirds. The waterbird model was produced specifically for the EIS and is thus not included within the Hope Bay Project Wildlife Habitat Suitability Study (Appendix V4-9A). The process for identifying suitable habitat followed similar procedures as outlined in detail in Section 9.2.6.2 and used similar datasets for the LSA (EM) and RSA (WKSS ecosystem mapping).

Suitable habitat for waterbird nesting habitat, was considered to be all wetlands, waterbodies, and suitable terrestrial ecosystems within 100 m of waterbodies and wetlands. The use of a 100 m buffer reflects Environment Canada's avoidance guideline recommendation of 50 m for waterfowl nests plus a 50 m buffer to provide a conservative estimate (M.L. Mallory 2016).

Results

A total of 39,476 ha of suitable waterbird habitat was mapped within in the LSA (70.1% of LSA). Within the RSA, a total of 343,935 ha (70.1% of RSA) of suitable habitat was mapped. These results indicate that suitable waterbird that may be used for nesting is widely distributed across the LSA and RSA. More details regarding waterbird habitat and potential effects is presented in Section 9.18.3.1.

9.2.11.3 The Doris Project

The Doris Project was issued a project certificate in 2006. As part of the WMMP monitoring of waterbirds included habitat loss, possible sensory disturbance and avoidance of the Doris Project site, attraction to the Doris Project site, and any direct mortality due to collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Surveying and monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance phases since 2006, as part of the ongoing WMMP. This section summarizes the results of these monitoring activities for muskox.

Habitat Loss

Habitat loss for waterbirds within the Doris footprint has been measured since 2009 when major construction started (Table 9.2-13). The total habitat loss was measured in 2016 as 83.0 ha, or 2.7% of the LSA. The majority of habitat loss occurred in habitat types rated as moderate or low for waterbirds (Miramar 2005): heath tundra (33.6 ha), tussock/hummock (29.5 ha), and heath bedrock (4.1 ha), rather than those classified as high suitability (all terrestrial habitats within 50 m of deep or shallow water) (Miramar 2005) (Table 9.2-13). Of the 83.0 ha of habitat lost, 26.5 ha of habitat lost was classified as suitable waterbird habit. This represents an actual loss of 3.4% of the total suitable habitat identified for waterbirds within the LSA (Table 9.2-59).

Table 9.2-59. Area of Suitable Habitat Disturbed for Waterbirds

		Amount of Suitable[2] Habitat in LSA[3]		Actual Disturbed Suitable Habitat	
Species	Season / Sex	Total (ha)	% of LSA[3]	Total (ha)	% of LSA[4]
Waterbirds[1]	N/A	787	25.3	26.5	3.4

[1] *Waterbirds were referred to as waterfowl in the Doris Project FEIS habitat loss assessment*
[2] *Suitable Habitat does not include Nil-rated habitat in study area.*
[3] *Calculations based on: LSA area of 3,116 ha for all bird species*
[4] *Calculations based on total amount of suitable habitat in LSA*

Sensory Disturbance

The WMMP evaluated the potential for disturbances to cause waterbirds to avoid the Doris Project site, resulting in changes in abundance or species richness or density near the Doris Project compared to a greater distance away.

To assess potential sensory disturbance effects on waterbird species, aerial surveys were conducted during the nesting and brood rearing periods in the Boston block, Mid-belt and Doris blocks, and at the Roberts Bay blocks since 1996; protocols were formalized in 2006 (Miramar 2006). Data analysis compared the density and diversity of waterbirds near the Doris Project site with areas of the same survey grid at a greater distance from the Doris Project to investigate whether a ZOI is detectible surrounding the Doris Project site and/or during project development years. An extensive exploratory analysis conducted to assess trends in waterbird species abundance and richness based on 10 years (2006 to 2015) of data found no significant differences in the proportion of birds near and far from infrastructure areas (within 300 m, 1,000 m, or 1,800 m of infrastructure), or differences in species richness (ERM 2016a). These results indicate that there has been no effect of sensory disturbance on waterbirds due to the Doris Project (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a).

Attraction to the Project

Within the Doris Project area, there have been no reported incidents of waterbird species using Doris Project-related infrastructure as nesting habitat. No permanent waterbodies have been created as a result of Doris Project-related activities, and there have been no incidents of waterbirds being attracted to artificial waterbodies at the Doris Project. Based on a comprehensive statistical analysis of 10 years of aerial survey data (2006 to 2015), there is no evidence to suggest that waterbird abundance or waterbird species richness has significantly increased near infrastructure at the Doris Project during waterbird pair or brood life stages (ERM 2016a).

Direct Mortality

Any wildlife mortality, including waterbirds that have been observed by onsite personnel were reported immediately to the ESR Department and in the annual WMMP report. Mortality of VECs or larger fauna, or mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE, Environment Canada, and KIA, as necessary.

In the years that personnel have been at the Doris Project site (2006-2016), there have been no reports of any waterbird mortality due to vehicle or aircraft strikes (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). Vehicle-waterbird collisions are related to locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). Higher vehicle speeds increase the chance of mortality and/or injury to waterbirds. The on-site speed limits for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to waterbirds. Bird strikes with aircraft must be reported to the Canadian aviation authority due to safety concerns. No bird strikes have been reported at the Doris site due to aircraft.

During the years of waterbird monitoring at Doris Project site, there have been two reports of a non-vehicle/aircraft related mortality. During the Tail Lake fish-out in 2011, four long-tailed ducks and one northern pintail were caught in gill nets and consequently drowned (Rescan 2011f). One loon was caught in a fishing net on Reference Bay but was rescued and set free (Rescan 2011f). Additionally, one gull was discovered dead from unknown causes in November, 2011 (Rescan 2011f). The low frequency of waterbird mortalities at the Doris Project indicates that there has been no effect of direct mortality on waterbirds.

Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on waterbirds due to Doris Project activities.

9.2.12 Characterization of Baseline Conditions for Upland Birds

9.2.12.1 Introduction

For the purposes of this assessment, upland birds are defined as migratory birds that primarily forage and nest in upland areas (i.e., not waterbirds). The Arctic upland bird community is comprised of songbirds, shorebirds, ptarmigan, and jaegers.

A total of 38 upland bird species have the potential to occur in the RSA (Table 9.2-60). Of these species, 28 upland bird species were identified as species that regularly occur within the RSA during migration or the breeding season (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a). Ptarmigan, although not migratory, are included in this assessment because ptarmigan and their eggs are an important food source to Inuit communities (Banci and Spicker 2016).

Population Trends and Conservation

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994b), which prohibits killing migratory birds and their eggs, taking their nests, and deposition of harmful substances in waters or areas frequented by migratory birds. In addition, migratory birds and ptarmigan in Nunavut are protected under the Nunavut *Wildlife Act (2003)*, which prohibits destruction of bird nests when these are being used by birds, and prohibits disturbance to a "substantial number" of birds, such as stating areas used by flocks of shorebirds during migration.

At local scales, populations of upland birds naturally fluctuate due to food availability, weather, and predation rates (C. M. White et al. 2002; Latour, Machtans, and Beyersbergen 2005; Samelius et al. 2007; Barichello and Mossop 2011; Obst 2011; McKinnon et al. 2013). Heavy snow cover late into the season can result in poor breeding (Latour, Machtans, and Beyersbergen 2005). Upland birds and their eggs and young are prey for raptors, especially the gyrfalcon and peregrine falcon, and for mammals, especially red and Arctic foxes (C. M. White et al. 2002; Samelius et al. 2007; Barichello and Mossop 2011). Upland bird's eggs also appear to be an alternative prey for red and Arctic foxes in years when the 3-4 year lemming cycle abundance is low (McKinnon L., Berteaux D., and Bety J. 2014).

Of the 12 shorebird species that regularly occur within the RSA, data suggest a declining global population for all species except the semipalmated plover and stilt sandpiper (Morrison et al. 2006). Of the 13 songbird species that regularly breed in the RSA, data show large scale population decline for two species: Harris's sparrow and horned lark (Berlanga et al. 2010) The breeding range of the Harris's sparrow is small and restricted entirely to Canada.

Only two species potentially in the RSA, the buff-breasted sandpiper and red knot, are listed as a species of conservation concern under the federal *Species at Risk Act* (SARA; 2002). The red knot subspecies *rufa* is listed on Schedule 1 of SARA as Endangered and the buff-breasted sandpiper is Schedule 1 as Special Concern. Neither species has been recorded in the RSA during baseline surveys or incidentally. The red-necked phalarope is not listed under SARA but was assessed by the COSEWIC as a species of Special Concern (Table 9.2-60; COSEWIC 2012b; COSEWIC 2014a). Seven upland bird species that regularly occur in the wildlife RSA are listed as Vulnerable under the CESCC designations for Nunavut and four others are listed as Apparently Secure (Table 9.2-60).

Table 9.2-60. Upland Bird Species Potentially Occurring in the Wildlife RSA and their Regularity and Timing of Occurrence and Conservation Status

Common Name	Scientific Name	Group	Regularity of Occurrence	Detected during Baseline Studies	Timing of Occurrence	Conservation Status				
						CESCC	COSEWIC	SARA	Global Rank	IUCN Red List
American Golden-Plover	*Pluvialis dominica*	Shorebird	Regular	Y	Breeding	Vulnerable			G5	Least Concern
Semipalmated Plover	*Charadrius semipalmatus*	Shorebird	Regular	Y	Breeding	Apparently Secure			G5	Least Concern
Least Sandpiper	*Calidris minutilla*	Shorebird	Regular	Y	Breeding	Vulnerable			G5	Least Concern
Semipalmated Sandpiper	*Calidris pusilla*	Shorebird	Regular	Y	Breeding	Vulnerable			G5	Least Concern
Red-necked Phalarope	*Phalaropus lobatus*	Shorebird	Regular	Y	Breeding	Vulnerable	Special Concern		G4G5	Least Concern
Wilson's Snipe	*Gallinago delicata*	Shorebird	Regular	Y	Breeding	Secure			G5	Least Concern
Pectoral Sandpiper	*Calidris melanotos*	Shorebird	Regular	Y	Breeding	Apparently Secure			G5	Least Concern
Stilt Sandpiper	*Calidris himantopus*	Shorebird	Regular	Y	Breeding	Apparently Secure			G5	Least Concern
Long-tailed Jaeger	*Stercorarius longicaudus*	Jaeger	Regular	Y	Breeding	Secure			G5	Least Concern
Parasitic Jaeger	*Stercorarius parasiticus*	Jaeger	Regular	Y	Breeding	Apparently Secure			G5	Least Concern
White-rumped Sandpiper	*Calidris fuscicollis*	Shorebird	Regular	N	Migrant	Secure			G5	Least Concern
Buff-breasted Sandpiper	*Tryngites subruficollis*	Shorebird	Regular	N	Migrant	Vulnerable	Special Concern	1	G4	Near Threatened
Baird's Sandpiper[1]	*Calidris bairdii*	Shorebird	Regular	Y	Breeding	Secure			G5	Least Concern
Red Phalarope	*Phalaropus fulicaria*	Shorebird	Rare	N	Migrant	Apparently Secure			G5	Least Concern
Lesser Yellowlegs	*Tringa flavipes*	Shorebird	Rare	N	Breeding	Vulnerable			G5	Least Concern
Long-billed Dowitcher	*Limnodromus scolopaceus*	Shorebird	Rare	Y	Breeding	Not Ranked			G5	Least Concern
Ruddy Turnstone	*Arenaria interpres*	Shorebird	Rare	N	Migrant	Vulnerable			G5	Least Concern
Red Knot	*Calidris canutus*	Shorebird	Rare	N	Migrant	Imperiled	EN/SC	1	G4	Least Concern
Sanderling	*Calidris alba*	Shorebird	Rare	N	Migrant	Vulnerable			G5	Least Concern

Common Name	Scientific Name	Group	Regularity of Occurrence	Detected during Baseline Studies	Timing of Occurrence	Conservation Status				
						CESCC	COSEWIC	SARA	Global Rank	IUCN Red List
Pomarine Jaeger	*Stercorarius pomarinus*	Jaeger	Rare	N	Migrant	Secure			G5	Least Concern
Horned Lark	*Eremophila alpestris*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Gray-cheeked Thrush	*Catharus minimus*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
American Pipit	*Anthus rubescens*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
American Tree Sparrow	*Spizella arborea*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Savannah Sparrow	*Passerculus sandwichensis*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
White-crowned Sparrow	*Zonotrichia leucophrys*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Harris's Sparrow[1]	*Zonotrichia querula*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Lapland Longspur	*Calcarius lapponicus*	Songbird	Regular	Y	Breeding	Secure			G5	Least Concern
Lincoln's Sparrow	*Melospiza lincolnii*	Songbird	Regular	Y	Breeding	Not Applicable			G5	Least Concern
Snow Bunting	*Plectrophenax nivalis*	Songbird	Regular	Y	Breeding	Vulnerable			G5	Least Concern
Common Redpoll	*Carduelis flammea*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Hoary Redpoll	*Carduelis hornemanni*	Songbird	Regular	Y	Breeding	Vulnerable			G5	Least Concern
Yellow Warbler	*Setophaga petechia*	Songbird	Regular	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
Willow Ptarmigan	*Lagopus lagopus*	Game Bird	Regular	Y	Resident	Secure			G5	Least Concern
Rock Ptarmigan	*Lagopus muta*	Game Bird	Regular	Y	Resident	Secure			G5	Least Concern
Smith's Longspur	*Calcarius pictus*	Songbird	Rare	Y	Breeding	Unrankable/ Undetermined			G5	Least Concern
American Robin[1]	*Turdus migratorius*	Songbird	Rare	Y	Breeding	Secure			G5	Least Concern
Cliff Swallow	*Petrochelidon phyrrhonota*	Songbird	Rare	N	Breeding	Unrankable/ Undetermined			G5	Least Concern

[1] *Species recorded incidentally during baseline studies and monitoring activities for the Doris Project. 'EN' means Endangered, 'SC' means Special Concern.*

Distribution and Migration Patterns

With the exception of ptarmigan, upland birds breeding in the Kitikmeot region migrate long distances between their summer range on the tundra, and their winter ranges at southern latitudes extending from the treeline to the southern tip of South America. The willow and rock ptarmigans make short local migrations depending on weather conditions, but are otherwise resident species that overwinter on the tundra (Hannon, Eason, and Martin 1998; Montgomerie and Holder 2008; Banci and Spicker 2016).

Upland bird species begin to arrive on the Arctic tundra to breed in late May, coincident with the emergence of insects. The exceptions to this timing include the seed-eating horned lark and hoary redpoll which arrive in early to mid-May. By mid-September most upland birds have migrated south and by October all migratory birds except ptarmigan have left the tundra (Obst 2011). Migration occurs through a series of relatively rapid movements between staging areas, where birds spend days to several weeks foraging prior to moving to the next staging area (M. L. Mallory et al. 2006).

During the breeding season from May to October, the upland bird community is broadly distributed across the Arctic such that almost every hectare of tundra supports at least one individual. The upland bird community in most Arctic regions is dominated by songbirds, which are up to six times more abundant than shorebirds (Andres 2006). Across several studies conducted in the Canadian Arctic that measured upland bird abundance, the Lapland longspur was the most common upland bird, occurring up to three times more abundant than other upland bird species (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and Beyersbergen 2005; Andres 2006; Rescan 2013b).

Habitat Use

Across the Arctic, upland birds are more abundant and diverse in lowlands, which are usually dominated by moist to wet sedge meadows (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and Beyersbergen 2005; Liebezeit, White, and Zack 2011). Most shorebird species prefer to use moist to wet lowland sites for breeding and foraging (S. Brown et al. 2007; Liebezeit, White, and Zack 2011). There are some exceptions, such as the American golden-plover that predominately uses drier upland habitat for nesting (Latour, Machtans, and Beyersbergen 2005; Rescan 2013b). Some species are generally only found within wetland areas, such as red-necked phalarope, but in most cases, upland birds do not confine their use of habitats to only wet or only dry areas (O. W. Johnson and Connors 2010). Though lowlands typically support more species of upland birds, the upland bird community uses a mosaic of habitat types across the full moisture regime from dry to wet.

Species associated with dry upland heath and rocky tundra include: American pipit, Harris's sparrow, horned lark, American golden plover, and rock ptarmigan (Latour, Machtans, and Beyersbergen 2005; S. Brown et al. 2007; Liebezeit, White, and Zack 2011). The Lapland longspur is unique in using both wet and dry habitats. Rock ptarmigan prefer dry heath tundra during breeding, whereas willow ptarmigan tend to select sites in moist areas with dense shrubs (S. Wilson and Martin 2008).

In addition to the moisture regime, the height of tundra vegetation influences habitat selection of upland birds. Tall riparian shrubs are rare on the tundra, but their occurrence provides habitat for a diverse bird community. The LSA contains 1,229 ha (2.2%) of riparian shrubs (i.e., willow and dwarf birch), which are distributed along major rivers (such as along the Koignuk River) and surrounding waterbodies.

9.2.12.2 Baseline Data for Upland Birds

Breeding Bird Surveys

Three types of studies were used to document the diversity and populations of upland birds in the RSA:

1. point count surveys;
2. Program for Regional and International Shorebird Monitoring (PRISM) plot surveys; and
3. Stand watch surveys at proposed turbine locations

In addition, incidental observations of wildlife, including upland birds, were collected during all aspects of baseline data collected for the Hope Bay Project.

Methods

Point Count Surveys

Point count surveys were conducted to document breeding activity and abundance, and to relate species to habitat. Point counts were conducted during the breeding seasons of 2006 -2010 and 2013-2015 at 313 point-count stations (Table 9.2-61; Figures 9.2-42 and 43). Point count surveys were not conducted in 2011 and 2012. Surveys were conducted for 5 minute durations using standard methods consistent with the North American Breeding Bird Survey (BBS; Ralph et al. 1993; Environment Canada 2004). From 2006 to 2010, the radius of point count surveys was 50 m. From 2013 to 2015, the radius of point count surveys was extended to 100 m. Detailed methods are described in the WMMP reports for the Hope Bay Doris (Golder 2007, 2008a; Rescan 2010, 2011c; ERM Rescan 2014a; ERM 2015b, 2016a).

Table 9.2-61. Annual Survey Effort for Point Count and PRISM Plot Surveys of Upland Birds Conducted in the Wildlife Regional Study Area

Year	Point Count			PRISM		
	Number of Stations	Survey Dates	Number of Survey Days	Number of Stations	Survey Dates	Number of Survey Days
2006	261	June 14 – July 2	10	9	June 15 – July 3	5
2007	261	June 20 – June 27	8	9	June 23 – June 27	4
2009	74	June 27 – July 4	6	-	-	-
2010	229	June 19 – July 5	10	9	June 23 – July 7	4
2011	-	-	-	32	June 22 – July 14	18
2012	-	-	-	57	June 21 – July 1	10
2013	133	June 13 – June 27	8	10	June 13 – June 27	4
2014	108	June 15 – June 23	8	17	June 15 – June 23	8
2015	80	June 10 – June 30	8	14	June 10 – June 30	8
Total	**313**		**58**	**50**		**61**

Note: The PRISM plots that were surveyed in 2006 were repeated again in 2010; all other PRISM plots were surveyed in only one year. A new set of PRSIM plots were selected in 2011. No upland bird Pont Count or PRISM plot surveys were conducted in 2016.

PRISM Plots

The Program for Regional and International Shorebird Monitoring (PRISM) is a comprehensive approach to monitor shorebirds in the United States and Canada (Latour, Machtans, and Beyersbergen 2005;

Andres 2006; S. Brown et al. 2007). At the request of the Canadian Wildlife Service (CWS) PRISM plots were established in the RSA as part of an Arctic initiative to monitor shorebird populations.

PRISM plots (300 x 400 m, 12 ha) were surveyed in 2006, 2007, and from 2010 to 2015 (Table 9.2-61; Figure 9.2-44) to estimate species composition and abundance. These plots were chosen using a stratified random sampling approach designed by CWS staff in 2006 and in 2009. Satellite imagery was used by CWS to delineate high, medium, and low-quality habitats for shorebirds, and plots were randomly assigned to each habitat quality stratum within the study area. In consultation with CWS, ten new PRISM plots were added in the RSA in 2013 and an additional seven plots were added in 2014. These plots were positioned close to the Doris infrastructure as part of the effects monitoring program for the Doris Project. The plots were surveyed once per year by systematically walking through the plots along transects (Golder 2007, 2008a; Rescan 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a).

Results

Upland bird species that regularly occur within the RSA were identified from species range maps, and the timing and frequency of detections during baseline surveys. In total, 26 upland bird species were detected during baseline studies, including 25 species that regularly occur in the RSA and one species that rarely occurs: long-billed dowitcher (Tables 9.2-62 and 9.2-63). Three additional species were recorded incidentally (Table 9.2-62); including one which are considered to be rarely occurring (American robin) and two that are expected to be regularly occurring (Baird's sandpiper and Harris's sparrow; ERM 2016a). Two additional species identified as regularly occurring within the RSA; buff-breasted sandpiper and white-rumped sandpiper; were not detected during baseline surveys or incidentally, likely because these are migrants that probably do not breed in the RSA.

Songbirds were the most commonly detected of the upland bird groups, accounting for 97.5% of all detections during point count surveys and 86.4% of all detections during PRISM surveys (Table 9.2-63). The upland bird community in the RSA is dominated by a few songbird species. The savannah sparrow was the most frequently recorded species, with roughly one third (31%) of all detections on point count surveys and one quarter (26.6%) of all detections on PRISM surveys (Table 9.2-64). Lapland longspur was another frequently recorded species, with approximately one-quarter of all detections on point count surveys (25.6%) and PRISM surveys (26.5%) (Table 9.2-64). These observations are consistent with those of other studies in the Arctic (Section 9.2.12.4).

Of the species listed as Vulnerable or Apparently Secure under the CESCC designations for Nunavut that potentially occur within the RSA, ten species were detected during upland bird surveys (Table 9.2-62). All of these species were observed within the RSA, and survey data suggests that all but parasitic jaeger, stilt sandpiper, and snow bunting occur regularly in the area during the breeding season (i.e., recorded in the majority of survey years during point count and PRISM surveys).

Across years, a total of 13 songbird species were identified during baseline surveys in the RSA, with similar species composition amongst both point count and PRISM surveys (Tables 9.2-62, 9.2-64, and 9.2-65). Eight of the 13 songbird species were recorded consistently across years (detected in 5 or more sampling years; Tables 9.2-64 and 9.2-65). The remaining five species were all rarely recorded (grey-cheeked thrush, Lincoln's sparrow, Smith's longspur, snow bunting, and yellow warbler); each of these five species was only recorded in one or two years from 2006 to 2015 of surveys (Tables 9.2-64 and 9.2-65).

Figure 9.2-42
Upland Breeding Bird Point Count Survey Locations in the Northern Portion of the Regional Study Area, 2006 to 2015

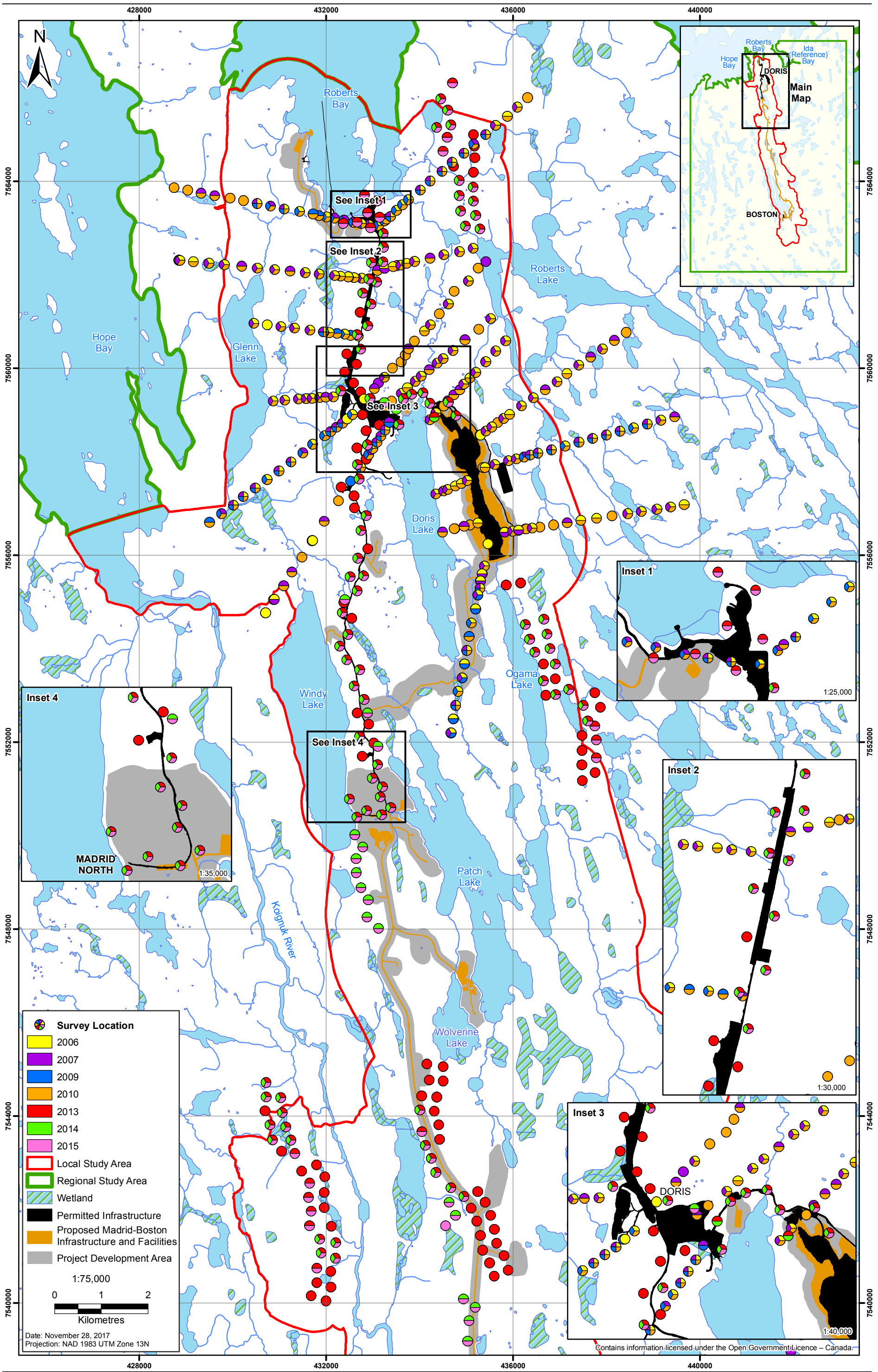


Figure 9.2-43
Upland Breeding Bird Point Count Survey Locations in the Southern Portion of the Regional Study Area, 2006 to 2015

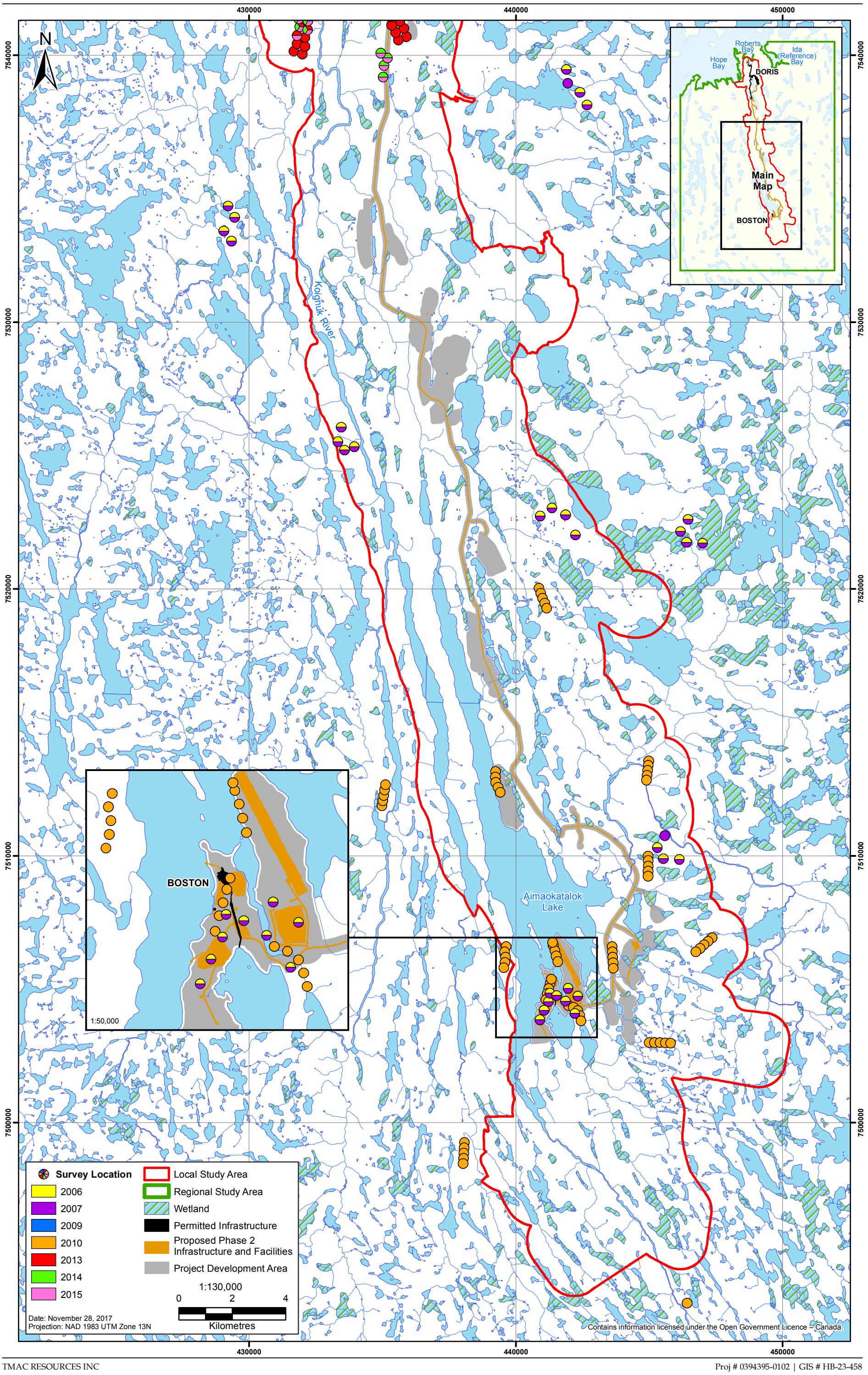


Figure 9.2-44
Upland Breeding Bird PRISM Plot Survey Locations in the Regional Study Area, 2006 to 2015

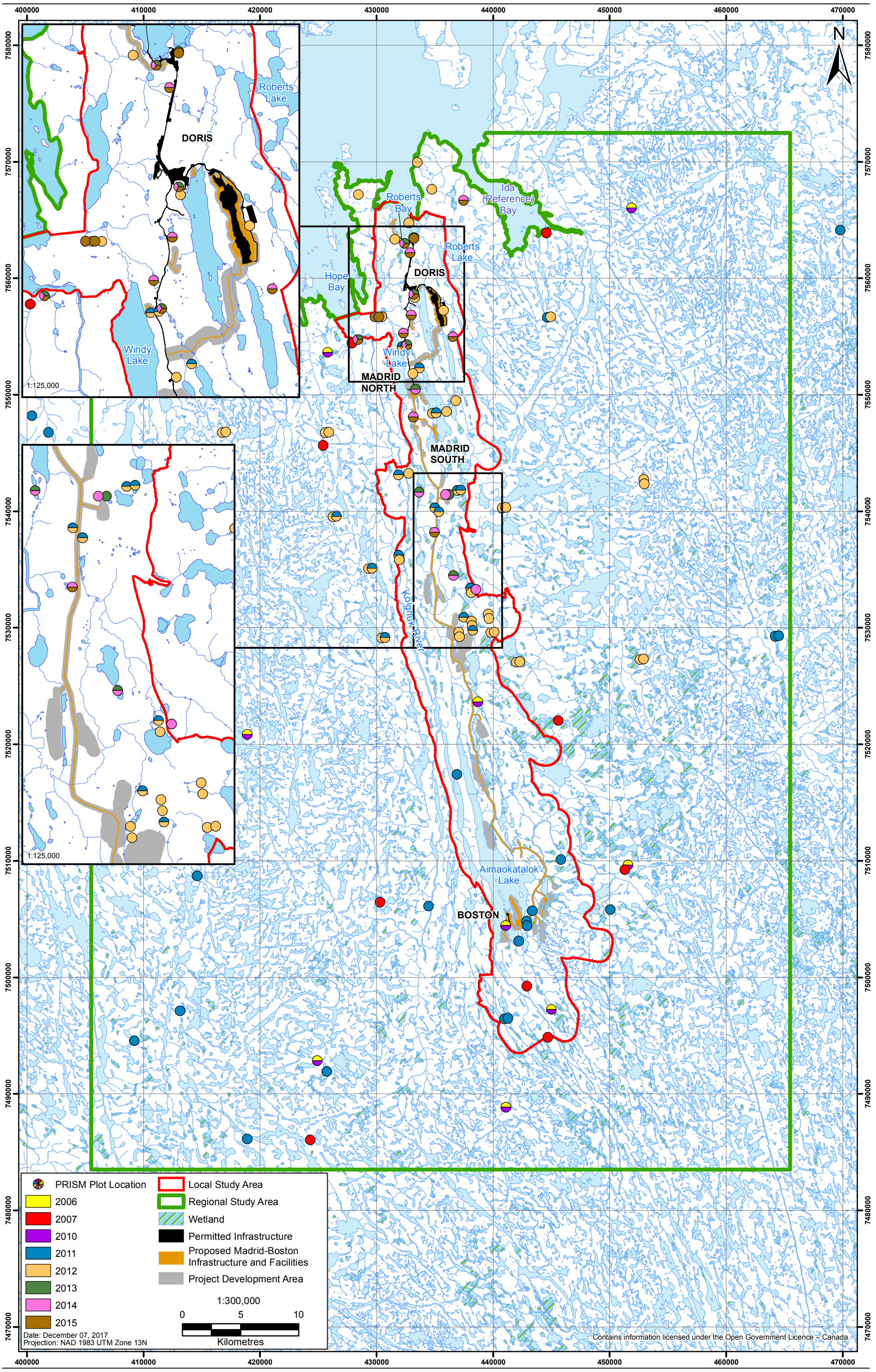


Table 9.2-62. Summary of Upland Breeding Bird Abundance Recorded by Species during Point Count and PRISM Surveys

		Abundance Recorded during Surveys[1]			
		Point Count		PRISM	
Group	Species	No. of Individuals	% of Total	No. of Individuals	% of Total
Shorebird	American Golden-plover	4	0.1	14	0.6
	Least Sandpiper	29	1.0	73	3.3
	Long-billed Dowitcher	0	0	1	0.04
	Pectoral Sandpiper	3	0.1	41	1.8
	Red-necked Phalarope	1	0.0	84	3.8
	Semipalmated Plover	4	0.1	21	0.9
	Semipalmated Sandpiper	1	0.04	7	0.3
	Stilt Sandpiper	0	0	6	0.3
	Wilson's Snipe	1	0.04	19	0.9
	Unknown Shorebird	2	0.1	12	0.5
Ptarmigan	Rock Ptarmigan	14	0.5	7	0.3
	Willow Ptarmigan	11	0.4	15	0.7
	Unknown Ptarmigan	1	0.04	1	0.04
Songbird	American Pipit	79	2.8	26	1.2
	American Tree Sparrow	249	8.7	126	5.6
	Common Redpoll	100	3.5	116	5.2
	Gray-cheeked Thrush	0	0	1	0.04
	Hoary Redpoll	155	5.4	109	4.9
	Horned Lark	251	8.8	130	5.8
	Lapland Longspur	731	25.6	592	26.5
	Lincoln's Sparrow	1	0.04	1	0.04
	Redpoll sp.	148	5.2	190	8.5
	Savannah Sparrow	885	31.0	594	26.6
	Smith's Longspur	2	0.1	1	0.04
	Snow Bunting	0	0	2	0.1
	White-crowned Sparrow	175	6.1	36	1.6
	Yellow Warbler	5	0.2	0	0
	Unknown Songbird	5	0.2	3	0.1
Jaeger	Long-tailed Jaeger	0	0	2	0.1
	Parasitic Jaeger	0	0	1	0.04
Total		**2,857**		**2,231**	

[1] *Counts do not include incidental observations (i.e., birds recorded outside of the point count survey area (50 m radius for 2006, 2007, 2009, and 2010, and 100 m radius in 2013 - 2015) or PRISM survey area (12 ha plot)), before or after surveys, and flying over survey areas.*

Table 9.2-63. Summary of Upland Breeding Bird Abundance Recorded by Species Group during Point Count and PRISM Surveys

Group	Abundance Recorded during Surveys[1]			
	Point Count		PRISM	
	No. of Individuals	% of Total	No. of Individuals	% of Total
Shorebird	45	1.6	278	12.5
Ptarmigan	26	0.9	23	1.0
Songbird	2,786	97.5	1,927	86.4
Jaeger	0	0.0	3	0.1
Total	**2,857**		**2,231**	

[1] Counts do not include incidental observations (i.e., birds recorded outside of the point count survey area (50 m radius for 2006, 2007, 2009, and 2010, and 100 m radius in 2013 - 2015) or PRISM survey area (12 ha plot)), before or after surveys, and flying over survey areas.

Table 9.2-64. Upland Breeding Birds Species Recorded During Point Count Surveys by Year, 2006 to 2015

Group	Species	No. of Individuals Recorded in Survey Year[1]							No. Years Recorded[2]
		2006	2007	2009	2010	2013	2014	2015	
Shorebird	American Golden-plover	1	1		2				3
	Least Sandpiper		6	2	3	18			4
	Pectoral Sandpiper	1		1	1				3
	Red-necked Phalarope					1			1
	Semipalmated Plover				1	3			2
	Semipalmated Sandpiper				1				1
	Wilson's Snipe					1			1
	Unknown Shorebird				2				1
	Shorebird Abundance	**2**	**7**	**3**	**10**	**23**	**0**	**0**	
	Shorebird Species Richness	**2**	**2**	**2**	**5**	**4**	**0**	**0**	
Ptarmigan	Rock Ptarmigan		5		5	1	3		4
	Willow Ptarmigan	3	1		5	2			4
	Unknown Ptarmigan		1						1
	Ptarmigan Abundance	**3**	**7**	**0**	**10**	**3**	**3**	**0**	
	Ptarmigan Species Richness	**1**	**2**	**0**	**2**	**2**	**1**	**0**	
Songbird	American Pipit	12	23	2	14	25	3		6
	American Tree Sparrow	34	28	14	47	73	46	7	7
	Common Redpoll	2	35	9	32	15	2	5	7
	Hoary Redpoll		34	26	34	51	2	8	6
	Horned Lark	49	43	20	75	27	20	17	7
	Lapland Longspur	154	118	24	133	172	96	34	7
	Lincoln's Sparrow				1				1
	Savannah Sparrow	133	108	50	174	240	138	42	7
	Smith's Longspur	1	1						2
	White-crowned Sparrow	14	18	4	37	50	37	15	7

Group	Species	No. of Individuals Recorded in Survey Year[1]							No. Years Recorded[2]
		2006	2007	2009	2010	2013	2014	2015	
	Yellow Warbler				3			2	2
	Redpoll spp.	57	11	8		44	16	12	6
	Unknown Songbird	5							1
	Songbird Abundance	**461**	**419**	**157**	**550**	**697**	**360**	**142**	
	Songbird Species Richness	**8**	**9**	**8**	**10**	**8**	**8**	**8**	
Overall Abundance		**466**	**433**	**160**	**570**	**723**	**363**	**142**	
Overall Species Richness		**12**	**14**	**10**	**17**	**14**	**9**	**8**	

[1] Counts do not include incidental observations (i.e., birds recorded outside of the point count survey area (50 m radius for 2006, 2007, 2009, and 2010, and 100 m radius in 2013 - 2015), before or after surveys, and flying over survey areas
[2] Total Number of Survey Years = 7

Table 9.2-65. Upland Breeding Birds Species Recorded During PRISM Surveys by Year, 2006 to 2015

Group	Species	No. of Individuals Recorded in Survey Year[1]								No. Years Recorded[2]
		2006	2007	2010	2011	2012	2013	2014	2015	
Shorebird	American Golden-plover		6	1	6	1				4
	Least Sandpiper	3		9	2	13	14	20	12	7
	Long-billed Dowitcher					1				1
	Pectoral Sandpiper	6	2	2	9	12	3	3	4	8
	Red-necked Phalarope	1	4	8	18	20	8	22	3	8
	Semipalmated Plover			1		3	6	9	2	5
	Semipalmated Sandpiper			2	1			4		3
	Stilt Sandpiper			1	1	4				3
	Wilson's Snipe	1		2		2	3	7	4	6
	Unknown Shorebird		1	1		6		3	1	5
	Shorebird Abundance	**11**	**13**	**27**	**37**	**62**	**34**	**68**	**26**	
	Shorebird Species Richness	**4**	**3**	**8**	**6**	**8**	**5**	**6**	**5**	
Ptarmigan	Rock Ptarmigan		2	2		3				3
	Willow Ptarmigan	2	1	1	6	5				5
	Unknown Ptarmigan								1	1
	Ptarmigan Abundance	**2**	**3**	**3**	**6**	**8**	**0**	**0**	**1**	
	Ptarmigan Species Richness	**1**	**2**	**2**	**1**	**2**	**0**	**0**	**1**	
Songbird	American Pipit		3	3	1	18	1			5
	American Tree Sparrow	7	2	9	23	53	13	15	4	8
	Common Redpoll	5	8	11	10	62	1	3	16	8
	Gray-cheeked Thrush					1				1
	Hoary Redpoll		4	14	46	33	5	3	4	7
	Horned Lark	12	11	16	23	49	1	7	11	8
	Lapland Longspur	56	53	61	75	191	38	64	54	8
	Lincoln's Sparrow				1					1
	Savannah Sparrow	26	23	51	60	185	63	102	84	8

Group	Species	No. of Individuals Recorded in Survey Year[1]								No. Years Recorded[2]
		2006	2007	2010	2011	2012	2013	2014	2015	
	Smith's Longspur		1							1
	Snow Bunting					2				1
	White-crowned Sparrow			1	5	17	4	5	4	6
	Redpoll spp.	8	11		8	135	9	2	17	7
	Unknown Songbird					3				1
	Songbird Abundance	**114**	**116**	**166**	**252**	**749**	**135**	**201**	**194**	
	Songbird Species Richness	**5**	**8**	**8**	**9**	**10**	**8**	**7**	**7**	
Jaegar	Long-tailed Jaeger			2						1
	Parasitic Jaeger			1						1
	Jaeger Abundance	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	
	Jaeger Species Richness	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	
Overall Abundance		**127**	**132**	**199**	**295**	**819**	**169**	**269**	**221**	
Overall Species Richness		**11**	**14**	**20**	**17**	**21**	**14**	**14**	**13**	

[1] Counts do not include incidental observations (i.e., birds recorded outside of the PRISM Plot boundaries), before or after surveys, and flying over plots
[2] Total Number of Survey Years = 8

A total of nine shorebird species were identified during baseline surveys in the RSA from 2006 to 2015 (Tables 9.2-62, 9.2-64, and 9.2-65). Seven of these species were recorded on point count surveys, and all nine were recorded during PRISM surveys (Tables 9.2-64, and 9.2-65). Lower numbers of shorebird individuals were recorded during point count surveys relative to PRISM surveys (Tables 9.2-64, and 9.2-65), a result that is expected as the PRISM survey methodology specifically targets recording secretive shorebirds and survey locations are for the most part representative of good shorebird breeding habitat (e.g., wet lowland areas). Of the nine species recorded on PRISM surveys, long-billed dowitcher, semipalmated sandpiper, and stilt sandpiper, were species with relatively few detections; these three species were recorded in three or less of the eight years when PRISM surveys were conducted between 2006 to 2015 (Table 9.2-65).

Two ptarmigan and two jaeger species were identified during baseline surveys in the RSA (Tables 9.2-62, 9.2-64, and 9.2-64). Rock and willow ptarmigan were recorded in about half of the years. Long-tailed and parasitic jaegers were only recorded in 2010 during PRISM surveys.

Density estimates (birds/km^2) were generated from PRISM survey data because all species groups were generally better represented in this survey type relative to point count surveys. In most years, songbird density was around 100 birds/km^2, except in 2010 when the density was 153.7 birds/km^2 and in 2011 when the density was 56.8 birds/km^2 (Table 9.2-66). By comparison, shorebirds occurred at much lower densities, ranging from 8.3 ± 6.4 birds/km^2 (± standard error) in 2011 to 42.1 ± 10.2 birds/km^2 in 2014. Ptarmigan generally occurred at 1 to 2 birds/km^2 in the years they were recorded, and in the single year that a jaeger species was recorded, the density was calculated as 2.7 birds/km^2 (Table 9.2-66).

The baseline densities recorded for upland birds are comparable to those recorded in other studies in the Canadian Arctic, including those conducted at treeline near the Ekati Diamond Mine (A. C. Smith et al. 2005), within the western Kitikmeot Region near the Back River Project (Sabina 2015b), on northern Baffin Island near the Mary River Project (EDI 2014), and across several studies in the Canadian Arctic (compiled by Bart and Smith 2012). Each of these studies report songbirds as having the highest density, followed by shorebirds, and ptarmigan (A. C. Smith et al. 2005; Bart and Smith 2012; EDI 2014; Sabina 2015b).

Table 9.2-66. Density Estimates for Upland Breeding Birds by Group and Year, 2006 to 2015

Year	No. of Plots Sampled	Density Estimates (Birds/km^2 ± Standard Error)			
		Songbird	Shorebird	Ptarmigan	Jaeger
2006	9	105.6 ± 23.4	10.2 ± 3.6	1.9 ± 1.9	0
2007	9	107.4 ± 20.1	12 ± 6.5	2.7 ± 1.4	0
2010	9	153.7 ± 18.1	25 ± 8.4	2.7 ± 1.4	2.7[1]
2011	37	56.8 ± 11.4	8.3 ± 6.4	1.4 ± 0.7	0
2012	56	111.5 ± 9.2	9.2 ± 2.5	1.2 ± 0.4	0
2013	10	112.5 ± 13.7	28.3 ± 8.4	0	0
2014	17	98.5 ± 11.1	42.1 ± 10.2	0	0
2015	14	115.5 ± 17.6	15.5 ± 6.9	0.6 ± 0.6	0

[1] *Standard error was not calculated for jaeger because there were only two plots in which individuals were recorded in 2010 and thus there were insufficient sample size with which to calculate variance around the mean.*

Wetter habitats contained approximately 30% more birds than dry upland areas. Baseline studies conducted to the southwest of the Hope Bay Project recorded a higher density of upland birds in wet, lowland habitats (133 ± 9.8 pairs/km^2) than in dry upland habitats (94 ± 6.8 pairs/km^2), which was consistent across songbirds (98 ± 7.6 vs. 74 ± 5.7), shorebirds (13 ± 1.5 vs. 5 ± 1.2) and ptarmigan (1 ± 2.1 vs. 1 ± 0.6; Sabina 2015b). Densities of upland birds were similar at the Hope Bay Project site.

Migratory Standwatch Surveys

Methods

Migratory standwatch surveys were conducted for all bird VECs, including upland birds, during spring and fall migration. Figure 9.2-33a shows the locations of the migration survey sites in relation to the Project area. The methods are summarized in Section 9.2.10.2.

Results

During spring migratory standwatch surveys, six species of upland birds, comprised of 29 individuals, were observed (Table 9.2-67). There were 16 observations of upland birds at Doris D-1 and 13 observations at Doris D-2. Passage rates were similar between site D-1 (0.67 obs/hr) and site D-2 (1.08 obs/hr; Table 9.2-67). Rock ptarmigan was the most commonly observed species. Most of the rock ptarmigans observed were perched either on the rock bluff or on the ground in the river valley. The single American pipit was observed preforming its breeding display. In general, migration appeared to be broad-front, with birds arriving from all southerly directions and heading north.

Of the total observations at sites Doris D-1 and D-2 during the spring surveys, two upland bird individuals were flying at turbine height (heights of between 50 m and 200 m; Table 9.2-67). Both individuals were Baird's sandpipers. No upland birds were observed flying within the potential zone of interaction with wind turbines. All birds observed in flight were flying relatively low (i.e., 20 m or less).

During fall migratory standwatch surveys, two species of upland birds, comprised of 19 individuals, were observed (Table 9.2-68). All individuals were observed at D-1 during a single standwatch survey on September 6. No upland birds were observed during fall migration at B-1. No upland birds were observed flying at turbine height or within the potential zone of interaction with wind turbines (Table 9.2-68). Similar to spring surveys, all birds observed in flight were flying relatively low (i.e., 20 m or less).

Table 9.2-67. Upland Breeding Bird Observations during Spring Migratory Standwatch Surveys, 2017

Species Group	Species	No. of Upland Bird Observations									
					Obs. Flying at Turbine Height						Obs. within Potential Zone of Interaction with Wind Turbine	
					Doris D-1		Doris D-2		Total		Doris D-1	
		Doris D-1	Doris D-2	Total	No.	%	No.	%	No.	%	No.	%
Shorebird	Baird's Sandpiper	1	2	3	0	0	2	67	2	67	0	0
	Unknown shorebird	2	0	2	0	0	0	0	0	0	0	0
Ptarmigan	Rock Ptarmigan	12	4	16	0	0	0	0	0	0	0	0
Songbird	Horned Lark	0	1	1	0	0	0	0	0	0	0	0
	American Pipit	3	0	3	0	0	0	0	0	0	0	0
	Hoary Redpoll[1]	0	2	2	0	0	0	0	0	0	0	0
Jaeger	Pomarine Jaeger	0	4	4	0	0	0	0	0	0	0	0
Total No. Obs		**16**	**13**	**31**	**0**	**0**	**2**	**67**	**2**	**6**	0	0
Total Effort (hrs)		**24**	**12**	**36**								
Passage rates (obs/hr)		**0.67**	**1.08**	**0.81**								

[1] *Species listed as Vulnerable in Nunavut (CESCC 2016).*
Note: Upland birds flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height. Number of upland birds observed within the potential zone of interaction with wind turbines was determined from the Doris-D1 site only.

Table 9.2-68. Upland Breeding Bird Observations during Fall Migratory Standwatch Surveys, 2017

Species Group	Species	No. of Upland Bird Observations													
					Obs. Flying at Turbine Height						Obs. within Potential Zone of Interaction with Wind Turbine					
					Boston B-1		Doris D-1		Total		Boston B-1		Doris D-1		Total	
		Boston B-1	Doris D-1	Total	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Ptarmigan	Rock Ptarmigan	0	7	743	0	-	0	0	0	0	0	0	0	0	0	0
Songbird	Hoary Redpoll[1]	0	12	10	0	-	0	0	0	0	0	0	0	0	0	0
Total No. Obs		**0**	**19**	**3,611**	**0**	**-**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Effort (hrs)		**16.5**	**18**	**34.5**												
Passage rates (obs/hr)		**0**	**10.6**	**0.55**												

[1] *Species listed as Vulnerable in Nunavut (CESCC 2016).*
Note: Upland birds flying at an estimated height of between 50 to 200 m were assumed to be flying at turbine height.

Spring migratory observations of upland birds were higher than fall observations (in fall 31 vs. 19 in spring). Species composition was also higher during spring surveys (6 species recorded in spring compared to 2 recorded in fall). Passage rates were higher in spring at 0.8 individuals per hour of effort vs 0.5 individuals per hour of effort in fall, however no birds were observed flying within the potential zone of interaction in spring or fall at either survey site.

Based on general observations, it appears that in the fall birds will migrate when the wind is from a generally northerly direction to take advantage of a tail wind. In both seasons, migration occurs as a broad front over the Project area with no barriers to movement. There is no evidence of topographic features restricting bird movement across the landscape at either site.

Incidental Observation of Upland Birds

Methods

Methods for incidental wildlife data collection are identical to those for caribou and are discussed in Section 9.2.6.2. Incidental observations of upland birds were recorded when:

1. observed by project personnel near the Doris Project site from 2009 and 2016 and recorded in the Wildlife Sighting Log; and
2. Observed by environmental personnel and wildlife biologists when conducting baseline and monitoring program surveys in the RSA between 2006 and 2016, which includes observations collected spatially or temporally outside of targeted VEC studies.

These incidental observations were reviewed to identify species that were not detected on formal upland bird surveys to provide a comprehensive view of species diversity in the RSA.

Results

Incidental Observations of Upland Birds by Mine Site Personnel

American robin was the only upland bird species recorded in the Wildlife Sightings Log that was not detected on upland bird surveys: American robin was recorded in 2014. The current breeding range of American robin is located to the southwest of the RSA. Considering that American robin was relatively recently observed in the RSA and the adjacency of this species breeding range to the RSA, it is possible that this species could breed in the RSA. In northern portions of their range, American robins nest in tall shrubs and even along cliffs, habitats that are available within the RSA (Vanderhoff, Sallabanks, and James 2014).

Incidental Observations of Upland Birds by Field Personnel

There were three species recorded by field personnel not recorded during formal upland bird surveys: American robin, Baird's sandpiper, and Harris's sparrow. American robin was observed by field biologists in 2014, the same year it was also separately recorded in the Wildlife Sightings Log. Baird's sandpiper was recorded in 2009 and Harris's sparrow in 2011.

The breeding range of Baird's sandpiper overlaps the RSA, as well as the main migration route for species breeding in the Arctic (Moskoff and Montgomerie 2002). As such, Baird's sandpiper is expected to be a regularly occurring within the area. The breeding habitats of Harris's sparrow and distribution of its breeding range is poorly understood (Norment and Shackleton 2008).

The known breeding range of Harris's sparrow is located to the south and west of the RSA, encompassing much of the arctic mainland from the Yukon to the west side of Bathurst Inlet, from

which the range extends southeast towards the Thelon Game Sanctuary (Norment and Shackleton 2008)). There have been documented observations of Harris's sparrow during the breeding season outside of this known breeding range, such as on Banks Island and Jenny Lind Island. While no breeding has been confirmed for these extralimital occurrences, these observations indicate that the species regularly wanders during the summer (Norment and Shackleton 2008). As such, Harris's sparrow are considered to be a regularly occurring species during the breeding season, though it is possible that the species may not be breeding within the RSA (Table 9.2-60).

Habitat Suitability Modelling

Methods

Habitat suitability modeling was conducted in the LSA and RSA for upland birds. The upland bird model was produced specifically for the EIS and is thus not included in the Hope Bay Project Wildlife Habitat Suitability Study (Appendix V4-9A). The process for identification of suitable habitat followed similar procedures as outlined in detail in Section 9.2.6.2 and used similar datasets for the LSA (EM) and RSA (WKSS ecosystem mapping).

The upland bird species community is known to vary across moisture gradients (Section 9.2.12.2). Hence, suitable upland bird habitat was identified as dry upland habitat and wet to moist lowland habitats. The dry and moist to wet vegetation communities from the EM within the LSA were:

- Dry Upland: Betula-Ledum-Lichen (BL), Dry Carex-Lichen (CL), Dryas Herb Mat (DH), Dry Willow (DW), Dwarf Shrub-Head (SH), Blockfied (BI), Rock Outcrop (RO), and Betula-Moss (BM) (Volume 4, Section 8)
- Wet to Wet Lowland: Emergent Marsh (EM), Low Bench Floodplain (FP), Polygonal Ground (PG), Riparian Willow (RW), Eriophorum Tussock Meadow (TM), Wet Meadow (WM), and Shallow Open Water (OW) (Volume 4, Section 8)

The dry and moist to wet vegetation communities from the WKSS ecosystem mapping in the RSA were:

- Dry Upland: Bedrock Association, Boulder Association, Bare Ground, Gravel Deposit, Lichen Veneer, Esker Complex, Heath Tundra, Heath/Boulder, Heath/Bedrock, and Low Shrub associations (Volume 4, Section 8)
- Wet to Wet Lowland: Shallow Water, Wetland (Sedge Meadow), Tussock/Hummock, and Riparian Tall Shrub (Volume 4, Section 8).

Results

A total of 19,901 ha and 280,133 ha of suitable dry upland habitat for upland birds was mapped within the LSA and RSA, respectively. Suitable moist to wet lowland habitats was mapped across 26,524 ha 183,326 ha of the LSA and RSA, respectively. More details regarding upland bird habitat and potential effects is presented in Section 9.20.3.1.

9.2.12.3 The Doris Project

The Doris Project was issued a project certificate in 2006. As part of the WMMP, monitoring of upland birds included habitat loss, possible sensory disturbance and avoidance of the Doris Project, attraction to the Doris Project, and any direct mortality due to collisions with vehicles or aircraft. Changes to environmental media quality due to the Doris Project were also modeled as part of the EIS. Surveying and monitoring has occurred during the Pre-construction, Construction, and Care and Maintenance

phases since 2006, as part of the ongoing WMMP. This section summarizes the results of these monitoring activities for upland birds.

Habitat Loss

Habitat loss due to the Doris Project was measured in 2016 as 83.0 ha, or 2.7% of the LSA. The majority of habitat loss occurred in habitat types rated as moderate for upland birds (defined as all terrestrial habitats not dominated by rock): heath tundra (33.6 ha), tussock/hummock (29.5 ha), and heath bedrock (4.1 ha) (Table 9.2-13). Of the 83.0 ha of habitat lost, 82.3 ha of habitat lost was classified as suitable upland bird habit. This represents an actual loss of 3.0% of the total suitable habitat identified for upland birds within the LSA (Table 9.2-69). These percentages are considered minimal for upland birds, and below critical threshold levels reported in the literature for mammal and birds (40% to 90% loss of suitable habitat; Andren 1994; Fahrig 1997).

Table 9.2-69. Area of Suitable Habitat Disturbed for Upland Breeding Bird

		Amount of Suitable[1] Habitat in LSA[2]		Actual Disturbed Suitable Habitat	
Species	Season / Sex	Total (ha)	% of LSA[2]	Total (ha)	% of LSA[3]
Upland Birds	N/A	2,727	82.5	82.3	3.0

[1] *Suitable Habitat does not include Nil-rated habitat in study area.*
[2] *Calculations based on: LSA area of 3,116 ha for all bird species*
[3] *Calculations based on total amount of suitable habitat in RSA/LSA*

Sensory Disturbance

The WMMP includes monitoring for potential sensory disturbance and resulting avoidance of the Project site by upland birds when choosing nest sites. Upland birds within the Doris Project study area have been monitored annually since 2006 to evaluate if there is a zone of influence (ZOI) of lower density and species richness near the Project footprint.

A comprehensive analysis of both PRISM and VRPC data was conducted to determine if the relative abundance of upland birds changed with increasing distance from the Doris footprint, and between years when there was more activity (construction during 2007 through 2012 and 2015) and less or no activity (2006 and care and maintenance 2013 to 2014). A generalized additive mixed regression model (Zuur et al. 2010; Zuur 2013) was used to determine if fewer birds were observed near the footprint during years with more activity compared to distal areas and years with less activity (ERM 2016c).

Overall, the relative abundance data was highly variable in space and time. The results of the regression analyses indicated there was no differential effect of distance to infrastructure on upland breeding bird relative abundance between potential effect years and non-effect years using point count data collected on surveys within 7 km of the Project and north of northing 7550000 (roughly the terminus of the Doris-Windy AWR) and PRISM data collected on surveys within 60 km of the Project. Upland breeding bird relative abundance appeared to be lower in potential effect years as compared to non-effect years, but confidence intervals around predictions overlapped in all cases, which indicated that relative abundance in potential effect years was not significantly lower than that recorded in non-effect years.

A regression analysis of species diversity using all PRISM data collected on surveys located within 60 km of the Project indicated that there was a significant increase in species diversity with increasing distance to infrastructure in potential effect years and not in non-effect years. However, confidence intervals around regression splines for potential effect years and non-effect years overlapped, which indicates that the predicted species diversity in potential effect years and non-effect years at varying distances from infrastructure were not significantly different from one another. A similar result was

obtained in the sensitivity analysis of the subset of PRISM data collected on surveys located within 20 km of the Project. However, in the 20 km sensitivity analysis, the effect of habitat covariate upland habitat was found to be significant, with the predicted species diversity declining as the proportion of upland habitat within PRISM plot boundaries increased in all years. Due to the overlapping confidence intervals, it was concluded that out to 20 km and 60 km, there is no evidence of upland breeding bird diversity declining as a function of distance to infrastructure in either potential effect years or non-effect years. There were no strong indications of a potential ZOI for species diversity using either data within 20 or 60 km of the Project. For a complete description of the analyses and results, see the 2016 WMMP report (ERM 2017a). .

Attraction to the Doris Project

Attraction to the Doris Project has been monitored on an annual basis and reported in the annual WMMP report. Wildlife attractants refer to Doris Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. This may include artificial structures which provide habitat for nesting upland birds.

In the 11 years that personnel have been at the Doris Project site (2006-2016), there have been seven incidents of upland birds being attracted to infrastructure at the Doris Project for nesting purposes; all nests were monitored to completion by ESR, and the majority fledged successfully (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). In 2010, a common redpoll was observed nesting within 150 metres of a scheduled blast area. In accordance with the mitigation measures, ECCC was contacted and the nest was flagged as a “no go” zone to minimize disturbance, and was monitored by the ESR Environmental Coordinator until it failed due to predation. In 2011, two redpolls pairs were observed nesting on Doris Project infrastructure: one on a set of cables near the construction of the North Dam and the other at the 5 ML tank farm on top of a metal housing. Both nests had eggs, and were monitored until the young had fledged successfully. In 2012, three redpolls were observed nesting on Doris Project infrastructure: one on an inactive drill, one on fish fence equipment, and one on a core box at Windy camp. The drill nest was successful in fledging two young and the nest on the fish fence fledged its clutch of five, whereas the third nest failed due to predation the day after it was discovered. In 2014, a common redpoll built a nest on one of the wildlife camera stands and laid five eggs. A poster was made by TMAC ESR to alert personnel to the presence of this nest, its location, and recommendations to limit disturbance of the nesting bird. Similarly, in 2015, a songbird nest with young was located on the post for one of the wildlife cameras; signage was erected to alert personnel. The wildlife camera contained images of ravens approaching and possibly predating the nest in July of 2015.

While there have been reported incidents of upland birds being attracted to the Doris Project infrastructure, mainly for nesting purposes, the majority of incidents were monitored by TMAC personnel according to ECCC recommendations, and mortality or injury rarely occurred. These results indicate that the effect of attraction on upland birds has been minimal due to the Doris Project (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a).

Direct Mortality

Any wildlife mortality, including upland birds that have been observed by onsite personnel were reported immediately to the ESR Department and reported in the annual WMMP report. Mortality resulting from potential interaction with Doris Project activity is reported directly to GN DOE, ECCC, and KIA, as necessary.

In the 11 years that personnel have been at the Doris Project site (2006-2016), there have been three reported incidents of mortality for upland birds that became trapped in infrastructure (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a, 2017a). In 2011,

two unidentified songbirds were caught in a megabag of cuttings, one redpoll was rescued from a piece of machinery but later died, and one redpoll died in a fuel pail at Roberts Bay (Rescan 2011f). To prevent further incidents, wire mesh is now used to cover the fuel pails and the use of megabags for cuttings is being phased out and replaced with open metal bins which will prevent entrapment of birds inside the bags. In 2011, there was an additional record of a songbird in a cuttings bag, but it was rescued and flew away (Rescan 2011f).

Since monitoring began in 2006, there have been three reported incidents of vehicle-related mortality for upland birds. In 2011, one unidentified sparrow was struck by a vehicle on the Tail Lake road, and one ptarmigan in August (Rescan 2011d). In 2012, one road-killed ptarmigan was observed and reported on July 1, 2012 (Rescan 2013d). The on-site speed limit for vehicles is a maximum of 50 km/h, thereby limiting the chance for direct mortality to upland birds. Bird strikes with aircraft must be reported to the Canadian aviation authority due to safety concerns. No bird strikes have been reported at the Doris site due to aircraft (Golder 2007, 2008a; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016b, 2017a). The low number of upland bird mortalities and injuries indicate that there has been no significant effect of direct mortality on upland birds due to the Doris Project.

Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Doris Project. This assessment determined that effects of the Doris Project on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects on upland birds due to Doris Project activities.

9.2.13 Data Limitations

The data collected to date are sufficient in spatial and temporal scales to describe existing wildlife conditions. However, all data has spatial, temporal or methodological limitations. This section describes the limitations of the scientific data collected for the Phase 2 baseline and Doris Project ongoing monitoring.

Satellite collar data was used to determine the seasonal and annual herd ranges of the Dolphin and Union and Beverly/Ahiak caribou. These data were used to define which seasons/life stages of the year caribou may interact with the Hope Bay Project (i.e., spring migration, summer, etc.). The primary limitation with this type of data is the sample size of collars. The GNWT estimates that at approximately 65 collars are required on a herd to accurately estimate its movements. Neither the Dolphin and Union or the Beverly/Ahiak caribou have this many collars installed in any one year. However, this limitation is offset by using multiple years of data. As long as caribou herds move in similar ways from year to year, multiple years of data can be used to better estimate seasonal herd ranges, as was done in this assessment.

From a practical perspective, the number of collars on caribou is sufficiently low that the presence of collars during seasons such as summer, fall and winter, when caribou are typically spread out into small groups moving independently on the tundra - should not be relied upon to determine if groups of caribou are near a project site for management purposes.

Aerial surveys for caribou were conducted from 1996 to 2010 at the Hope Bay Project site. This program was proposed as the primary monitoring program for caribou as part of the 2006 WMMP for the Doris Project. Aerial surveys can provide good data for estimating a zone of influence surrounding a project, as long as there is a sufficient sample size of caribou observed to conduct appropriate statistical analyses. Sufficient caribou were observed during aerial surveys to conduct a zone of

influence analysis during the period between 1996 and 2005, and that analysis is reported in Section 9.2.6. After 2006, too few caribou were observed during aerial surveys to have sufficient power to conduct statistical tests. Consequently, after discussions with the GN DOE, this form of monitoring was discontinued after 2010.

Wildlife camera data has been used to examine for a zone of influence between 2014 and 2015 for caribou, grizzly bear, muskox and wolverine. The two principal limitations with wildlife camera data are sample size and habitat-based differences in capture rate. The sample size was sufficient to conduct a zone of influence analysis for caribou and grizzly bear, but insufficient to conduct this analysis for the less common muskox and wolverine. The cameras provide a large amount of data throughout the year for the specific locations where they are placed, but the area which each camera monitors is relatively small (30-100 m). In this way, camera studies have the opposite data limitations that aerial surveys, which provide data over a large area but do not capture temporal variability.

The second challenge with working with wildlife cameras is that the capture rate of wildlife (number of photos per camera day) is influenced by the habitat in which the camera is placed. Cameras on eskers or other movement corridors identified by TK record more wildlife than cameras on heath tundra. Cameras must be segregated by habitat type before analysis, as has been done in this assessment. To maximize statistical power, cameras should be placed in similar habitat types. To address existing limitations in the camera monitoring program, in February 2016, TMAC met with the KIA and GN DOE and re-designed the camera monitoring program and the camera locations were changed accordingly during summer 2016.

Capture-recapture DNA methods were used to estimate the baseline population of grizzly bear and wolverine in the RSA, as required as part of the Doris Project Certificate. The primary limitation with this type of study is that it can be used to determine population size (as is reported in this assessment), but it has poor resolution to determine differences in density within the study area. Hence, this method cannot be used to estimate a zone of influence surrounding a project site. It is for this reason that monitoring of grizzly bear and wolverine for a potential zone of influence surrounding the Doris Project was conducted using wildlife cameras and not DNA studies. In addition, the ability to estimate a super-population in capture-recapture studies can be limited by the recapture rate of individuals. A sufficient number of individuals must be recaptured in the study to make the estimation of the super-population possible. In the baseline studies conducted for the Doris Project, there were sufficient recaptures to calculate a super-population for grizzly bears, but not for wolverine. The low number of recaptures for wolverine limit this method's ability to track changes in population through time, should this study be repeated in the future.

Carnivore (wolf, fox and wolverine) dens were identified using aerial surveys over several years – both dedicated surveys and recorded as incidentals during caribou or other aerial surveys. Dens of these species are often located in characteristic habitat locations (eskers, etc.), making them relatively straight forward to find. The fact that dens are often repeatedly used through time means that incidental observations can be used to build up a database of den locations. The long-term monitoring program as part of the Doris Project records incidental observations of this type, making for a robust assessment of den locations in the RSA.

Baseline studies and ongoing monitoring of cliff-nesting raptors for the Doris Project was conducted using aerial surveys by helicopter during the spring (occupancy survey) and summer (productivity survey), as proposed in the 2006 WMMP Plan. Cliff nesting sites are abundant in the RSA due to the geology of the area that produces many cliff habitats. Repeated surveys by avian specialists during the period of 2006 to 2016 have repeatedly identified nests from a common pool of possible nesting sites. This indicates that the survey for raptors has been thorough. A comprehensive analysis conducted in

2016 indicated that there were no significant differences in occupancy of territories between impact and non-impact years, and there were two few data to statistically assess productivity. Identification of ground-nesting raptor nests is more difficult. Short-eared owl nests were identified through PRISM plot surveys, but short-eared owls will establish new nests each season. Hence, the future locations of these nests can be predicted to appropriate habitat types, but it is not possible to predict the exact location of these nests in future years. As a consequence, mitigation includes construction in these habitats outside of the raptor breeding season and pre-construction surveys if construction must occur during the summer months.

Baseline studies and ongoing monitoring of waterbirds for the Doris Project was conducted using a grid of aerial surveys over the Doris Project site and a mid-belt block. This survey design was proposed as part of the 2006 WMMP Plan for the Doris Project. A comprehensive statistical analysis conducted in 2016 of these data indicated that there are several limitations to these data. First, the treatment and control (mid-belt) blocks have different densities of lakes, so comparisons were made within the treatment block using distance from infrastructure as a variable. Despite this limitation, this monitoring program had sufficient power to detect a potential zone of influence surrounding the Doris Project site.

Baseline studies and ongoing monitoring of upland birds for the Doris Project were proposed in the 2006 WMMP Plan using variable radius point counts (VRPC) in transects perpendicular to the generally north-south axis of the Doris Project site. After several years of surveys, it was determined that this experimental design did not account for differences in habitat along the transects, which was also influencing upland bird abundance and diversity. Following this, the monitoring program was re-designed to take habitat into account. A comprehensive analysis conducted in 2016 indicated that disturbance from the Doris Project does not have a measurable effect on relative abundance of upland bird populations. Ongoing monitoring of upland birds has also been conducted using the Program for Regional and International Shorebird Monitoring (PRISM) plots at the request of CWS. This survey program includes walking transects within a large, repeatedly measured, plot. Advantages of this design is that each plot has higher numbers of recorded birds because searchers flush the birds as they conduct their transects. Disadvantages of this design are that the long period required to survey each plot means that fewer plots can be conducted than more traditional VRPC methods.

9.3 VALUED COMPONENTS

9.3.1 Potential Valued Components and Scoping

Potential terrestrial wildlife Valued Ecosystem Components (VECs) were identified through a scoping process to identify those with potential interactions with the Phase 2 Project. The candidate wildlife VECs were identified based on:

- Inuit TK;
- the potential interactions with Phase 2 and issues or concerns raised during the EIS pre-application phase and through consultation activities and the input of regulators, Aboriginal and other stakeholder groups, scientific knowledge, past experience on other northern projects (particularly in Nunavut) and professional judgment;
- legislative or regulatory requirement or government management priority;
- the availability of data and analytical tools to measure effects on wildlife VECs; and
- the practicality of measuring and monitoring.

9.3.1.1 The Scoping Process and Identification of Wildlife VECs

The scoping of terrestrial wildlife VECs followed the process outlined in the Assessment Methodology (Volume 2, Section 4). The NIRB's EIS guidelines propose a number of terrestrial wildlife VECs to be considered for inclusion in the terrestrial wildlife effects assessment (Section 8.1.11, Wildlife and Wildlife Habitat):

- caribou (including habitat, migration, and behaviour),
- muskox,
- wolverine,
- polar bears,
- brown bears (including brown and grizzly bears),
- wolves,
- less conspicuous species that may be maximally exposed to contaminants, and
- wildlife migration routes and crossings.

The EIS guidelines (Section 8.1.12, Birds and Bird Habitat) identify the following avian wildlife VECs:

- raptors,
- migratory birds,
- marine birds, and
- the associated habitat of each.

For the purposes of this assessment, migratory birds are split into two groups, waterbirds (ducks, swans and geese) and upland birds (songbirds) because these two groups use different habitats and can be differently affected by the development of mining projects. Wildlife migration routes and crossings are addressed for each wildlife species, as appropriate, instead of as an independent wildlife VEC.

The identified wildlife VECs represent an appropriate starting point to guide the identification and scoping of VECs (NIRB 2012a). The selection of wildlife VECs began with those proposed in the EIS guidelines and was further informed through consultation with communities, regulatory agencies, available TK, professional expertise, and the NIRB's final scoping report (Appendix B of the EIS Guidelines). For an interaction to occur there must be spatial and temporal overlap between a wildlife VEC and Project component and/or activities. The determination of VECs and potential effects for inclusion in this effects assessment considered and was informed by:

- the KIA TK Report (Banci and Spicker 2012; Banci and Spicker 2016);
- wildlife baseline studies conducted for the Phase 2 Project;
- ongoing wildlife effects monitoring of the Doris Project;
- consultation and engagement with local and regional Inuit groups (for example, the KIA);
- the Environmental Impact Statement (EIS) guidelines and appendices (NIRB 2012a);
- the public, during public consultation and open house meetings held in the Kitikmeot communities in May, 2016 (see Volume 2, Section 3, Public Consultation and Engagement);
- wildlife review of recently completed Nunavut EAs (e.g., Back River, Meliadine);

- the Draft Nunavut Land Use Plan (NPC 2014);
- A caribou-focused risk management workshop (ERM 2016d); and
- the NIRB reference and guidance documents (NIRB 2013a, 2013b, 2013c).

Topics discussed during community meetings, focus groups, interviews, and other meetings with the KIA and relevant government bodies were integrated within specific VSECs for further examination in the assessment process.

The content and results of other EIS sections were reviewed to inform the selection of wildlife VECs and effects including Public Consultation (Volume 2, Section 2), Public Consultation and Engagement (Volume 2, Section 3), and Human Health Risk Assessment (Volume 6, Section 5). Specific sections of these volumes are referenced, where appropriate.

9.3.1.2 NIRB Scoping Sessions

Scoping sessions hosted by NIRB (NIRB 2012b) with key stakeholders and local community members (i.e., the public) focused on identifying the wildlife species and habitats that are important to local residents, as related to the Project. Comments made during these sessions were compiled and analysed as part of VEC scoping.

9.3.1.3 TMAC Consultation and Engagement Informing VEC Selection

Community meetings for the Phase 2 Project were conducted in each of the five Kitikmeot communities as described in Section 3 of Volume 2. The meetings are a central component of engagement with the public and an opportunity to share information and seek public feedback. Overall, the community meetings were well attended. Public feedback (questions, comments, and concerns) about the proposed Project was obtained through open dialogue during Project presentations, through discussions that arose during the presentation of Project materials and comments provided in feedback forms. Questions, comments, and concerns related to:

- effects due to wildlife interactions with tailings;
- noise from helicopters and equipment;
- impact of road from Madrid to Boston on caribou;
- management of bears;
- wildlife, including wolves, in the vicinity of the Project;
- differences in wildlife numbers relative to distance from the Project;
- effects to the Bathurst caribou herd's calving grounds;
- effects to migratory animals like caribou and muskox;
- impacts to wildlife (general); and
- impacts of shipping on marine wildlife.

These issues are addressed in assessments for caribou (Section 9.8), grizzly bears (Section 9.10), muskox (Section 9.12), furbearers (Section 9.14), raptors (Section 9.16), waterbirds (Section 9.18), upland birds (Section 9.20) and in the assessment of Project effects on marine wildlife (Volume 5, Section 11).

9.3.1.4 TMAC Consultation and Engagement with Elders and Harvesters about Caribou

Caribou workshops were held with Elders and harvesters in Cambridge Bay in September 2016, and April and August 2017 to refine the assessment of potential effects. The overall objective of the workshop was to inform the environmental assessment, gain local knowledge about the Phase 2 Project's potential risks to caribou, and inform the design of measures to protect caribou.

The workshop discussed the potential effects of the Phase 2 Project on wildlife, with a focus on caribou and related land use activities. TMAC shared information on Phase 2 and the environmental assessment that is being undertaken, as well as experience to date on interactions with caribou and proposed ways to mitigate impacts. The workshop heard from Elders and harvesters regarding their knowledge of caribou, experience of managing risks on the land, and a discussion about potential risks of Phase 2 to caribou, and ways in which to manage (i.e., mitigate) those risks.

The Elders and harvesters identified caribou herds which may interact with the Project and potential effects to those herds. More information on the caribou workshops is available in Section 9.8.

9.3.2 Valued Components Included in the Assessment

The wildlife VECs included in the wildlife and wildlife habitat assessment are summarized in Table 9.3-1. Table 9.3-2 describes wildlife species or groups which were proposed during scoping sessions or as part of the NIRB guidelines and are assessed elsewhere in the EIS.

Table 9.3-1. Wildlife Valued Ecosystem Components Included in the Terrestrial Wildlife Assessment

Species or Group	Identified by			Rationale for Inclusion
	TK	NIRB Guidelines	Regulations and Regulators	
Caribou – Dolphin and Union (island caribou)	X	X	X	TK and land users identified caribou as a key component of the environment for Inuit historically, currently and for the future (Banci and Spicker 2016). The Dolphin and Union herd is COSEWIC designation as Special Concern, and are on Schedule 1 of SARA. Caribou were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB 2012a). Information from TK, land users, collars and ongoing monitoring for the Doris Project WMMP indicate that the distribution of this herd overlaps the Project site during the winter.
Caribou – Beverly/Ahiak (mainland caribou)	X	X	X	TK and land users identified caribou as a key component of the environment for Inuit historically, currently and for the future (Banci and Spicker 2016). The Beverly/Ahiak caribou are not listed by COSEWIC or SARA at the time of publication. Caribou were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB 2012a). Information from TK, land users, collars and ongoing monitoring for the Doris Project WMMP indicate that the distribution of this herd overlaps the Project site during the summer, and to a lesser degree during fall and winter.

Species or Group	Identified by			Rationale for Inclusion
	TK	NIRB Guidelines	Regulations and Regulators	
Muskox	X	X	X	Muskox were identified as an important food source by Inuit, and are currently harvested by land users. Muskox were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development. Information from TK, land users and ongoing monitoring for the Doris Project WMMP indicate that muskox occur in the Project area.
Grizzly Bear	X	X	X	Grizzly bear were identified as a spiritually and culturally important species and as food source in Inuit TK (Banci and Spicker 2016). Grizzly bear were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB 2012a). Information from TK, land users and ongoing monitoring for the Doris Project WMMP indicate that grizzly bear occur in the Project area.
Furbearers – Wolverine	X	X		Wolverine and wolves are identified as candidate VECs in the NIRB guidelines for the Phase 2 development. Furbearers, including wolverine were identified in Inuit TK as an important species for their fur (Banci and Spicker 2016). Prior to the fur trade, wolverine were regarded as pests by Inuit, but since the fur trade began in Nunavut, wolverine became an important economic species for their fur (Banci and Spicker 2016). Information from TK, land users, and ongoing monitoring for the Doris Project WMMP indicate that wolverine are present in the Project area. For the assessment, the VEC “furbearers” is evaluated, with one indicator species – wolverine.
Raptors		X	X	Inuit TK indicates that Inuit typically did not actively hunt raptors, but would use the feathers, meat and eggs if available (Banci and Spicker 2016). Raptors are identified as a candidate VEC in the NIRB guidelines for the Phase 2 development. Baseline studies and ongoing monitoring for the Doris Project WMMP indicate that there are several raptor species in the Project area, including the peregrine falcon and short-eared owl, both of which are listed as Special Concern on SARA Schedule 1.
Waterbirds		X	X	Waterbirds are identified by Inuit TK as an important food source, particularly where colonies are located on cliffs (Banci and Spicker 2016). Migratory birds are identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB 2012a). Information from TK and ongoing monitoring for the Doris Project WMMP indicate that waterbirds are located in the Project area. For this assessment, the group “migratory birds” is split into two groups, waterbirds and upland birds because the habitats and ecology of these groups is different.

Species or Group	Identified by			Rationale for Inclusion
	TK	NIRB Guidelines	Regulations and Regulators	
Upland Breeding Birds		X	X	Upland birds, specifically ptarmigan, are identified as an important food item (Banci and Spicker 2016). Migratory birds are identified as a candidate VEC in the NIRB guidelines for the Phase 2 development. Information from ongoing monitoring for the Doris Project WMMP indicate that upland birds are located in the Project area. For this assessment, the group "migratory birds" is split into two groups, waterbirds and upland birds because the habitats and ecology of these groups is different.

Table 9.3-2. Wildlife Valued Ecosystem Components Evaluated Elsewhere in the EIS

Species or Group	Identified by			Rationale for Exclusion
	TK	NIRB Guidelines	Regulators	
Marine Birds	X	X	X	Marine birds are evaluated as a VEC in the marine section (Volume 5, Section 11).
Marine Mammals	X	X	X	Marine mammals are evaluated as a VEC in the marine section (Volume 5, Section 11).
Small, resident mammals that may be affected by environmental contaminants		X		Potential effects on a variety of wildlife species, including small, resident mammals is evaluated in Volume 6, Section 5; Human Health and Environmental Risk Assessment.

9.3.3 Valued Components Excluded from the Assessment

This section lists the candidate wildlife VECs that have been excluded from the assessment. Wildlife VECs were excluded because their range does not overlap with the Project RSA or site (e.g., Bathurst caribou herd and polar bears) or they are addressed elsewhere as a wildlife VEC (Arctic and red fox, and brown bears) (Table 9.3-3).

Table 9.3-3. Wildlife Valued Ecosystem Components Excluded from the Terrestrial Wildlife Assessment

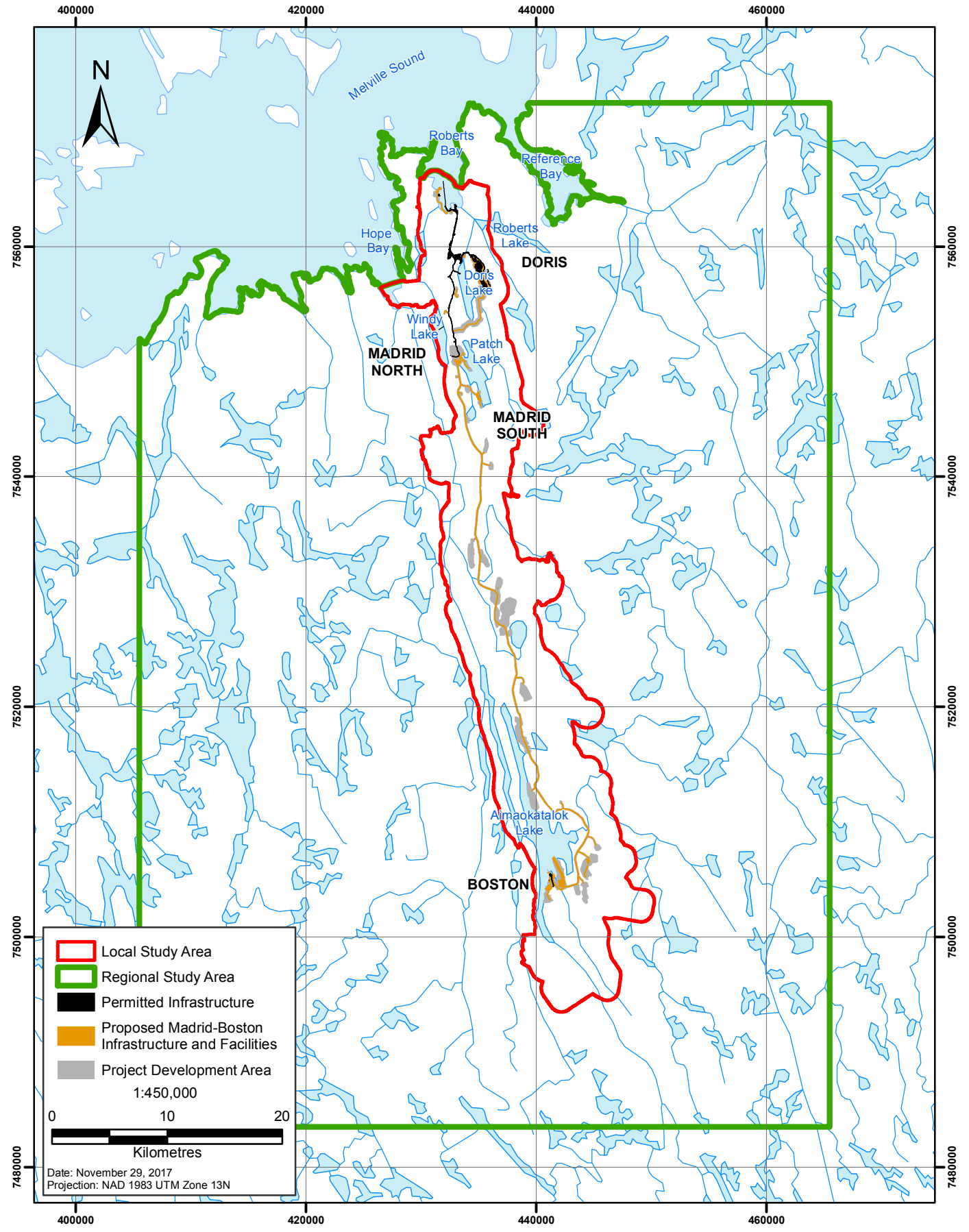
Species or Group	Identified by			Rationale for Exclusion
	TK	NIRB Guidelines	Regulators	
Caribou – Bathurst				TK and land users identified caribou as a key component of the environment for Inuit historically, currently and for the future (Banci and Spicker 2016). Caribou were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB 2012a). Information from collars and ongoing monitoring for the Doris Project WMMP indicate that the distribution of this herd does NOT overlap the Project site at any time of year.

Species or Group	Identified by			Rationale for Exclusion
	TK	NIRB Guidelines	Regulators	
Wildlife migration routes and crossings.		X		Wildlife migration routes and crossings were identified as a candidate VEC in the NIRB guidelines. Potential Project effects on migration of wildlife VECs is addressed in the assessment for each VEC, rather than as a stand-alone VEC.
Polar Bear	X	X	X	Polar bear were identified as a candidate VEC in the NIRB guidelines for the Phase 2 development (NIRB). TK information indicates that polar bear have occurred in the past rarely in the northern islands of Bathurst Inlet during winter. However, the current range of polar bear does not overlap the Project marine regional study area (MRSA). No polar bears have been observed in the MRSA during the 10 years of construction and care and maintenance of the Doris Project. Both Inuit TK and baseline studies indicate that polar bear are not present on the southern shore of Melville Sound. Project shipping will be occurring in the open water season, when TK and baseline studies indicate that they are not present in the MRSA. As a consequence, is was determined that there is no potential overlap between the landward components of the Project or with the marine components of the Project (shipping) and polar bears were excluded from the assessment.
Furbearers – Wolf	X	X		Wolverine and wolves are identified as candidate VECs in the NIRB guidelines for the Phase 2 development. Furbearers, including wolf were identified in Inuit TK as an important species for their fur (Banci and Spicker 2016). Information from TK, land users, and ongoing monitoring for the Doris WMMP indicate that wolf are present in the Project area. The wolf populations in Nunavut are primarily dependent on caribou. Therefore, the assessment for wolves is dependent on the assessment for caribou and not considered further.
Furbearers - Arctic and Red Fox	X	X		Arctic and red foxes generally have similar ecology as wolverine; they are resident on the tundra year round, do not hibernate and are dependent on small mammals, medium-sized prey animals and scavenging. Therefore the wolverine are used as a proxy for both Arctic and red foxes in this assessment.
Brown Bear		X	X	Brown bears are identified as a candidate VEC in the Final EIS guidelines. The term “brown bear” is a common name for grizzly bear, which is already a wildlife VEC.

9.4 SPATIAL AND TEMPORAL BOUNDARIES

The spatial and temporal boundaries for the Project are common to all wildlife VECs, with a Project Development Area (PDA), Local Study Area (LSA), and Regional Study Area (Figure 9.4-1). Effects are considered for the life of the Project, and where relevant, are identified by Project phase. The spatial boundaries selected to shape this assessment are determined by the Project’s potential impacts on the terrestrial wildlife.

Figure 9.4-1
Local Study Area and Regional Study Area for Terrestrial Wildlife



Temporal boundaries are selected that consider the different phases of the Project and their durations. The Project's temporal boundaries reflect those periods during which planned activities will occur and have potential to affect a wildlife VEC.

The determination of spatial and temporal boundaries also takes into account the development of the entire Hope Bay Greenstone Belt. The assessment considers both the incremental potential effects of the Project as well as the total potential effects of the additional Project activities in combination with the existing and approved Projects including the Doris Project and advanced exploration activities at Madrid and Boston.

9.4.1 Project Overview

The Madrid-Boston Project consists of proposed mine operations at the Madrid North, Madrid South and Boston deposits. The Madrid-Boston Project is part of a staged approach to continuous development of the Hope Bay Greenstone Belt, comprised of existing operations at Doris, a bulk sample followed by commercial mining at Madrid North and Madrid South, and commercial mining of the Boston deposit. The Madrid-Boston Project would utilize and expand upon the existing Doris Project infrastructure.

The Madrid-Boston Project is the focus of this application. Because the infrastructure of existing and approved projects will be utilized by the Madrid-Boston Project, and because the existing and approved projects have the potential to interact cumulatively with the Madrid-Boston Project, existing and approved project are described below.

9.4.1.1 Existing and Approved Projects

Existing and approved projects include:

- the Doris Project (NIRB Project Certificate 003, NWB Type A Water Licence 2AM-DOH1323);
- the Hope Bay Regional Exploration Project (NWB Type B Water Licence 2BE-HOP1222);
- the Madrid Advanced Exploration Program (NWB Type B Water Licence 2BB-MAE1727); and
- the Boston Advanced Exploration Project (NWB Type B Water Licence 2BB-BOS1727).

<u>The Doris Project</u>

The Doris Project was approved by NIRB in 2006 (NIRB Project Certificate 003) and licenced by NWB in 2007 (Type A Water Licence 2AM-DOH0713). The Type A Water Licence was amended in 2010, 2011 and 2012 and received modifications in 2009, 2010, and 2011.

Construction of the Doris Project began in early 2010. In early 2012, the Doris Project was placed into care and maintenance, suspending further Project-related construction as well as exploration activity along the Hope Bay Greenstone Belt. Following TMAC's acquisition of the Hope Bay Project in March of 2013, NWB renewed the Doris Project Type A Water Licence (Type A Water Licence 2AM-DOH1323), and TMAC advanced planning, permitting, exploration and construction activities. In 2016, NIRB approved an amendment to Project Certificate 003 and NWB granted Amendment No. 1 to Type A Water Licence 2AM-DOH1323, extending operations from two to six years through mining two additional mineralized zones (Doris Connector and Doris Central zones) to be accessed via the existing Doris North portal. Amendment No. 1 to Type A Water Licence 2AM-DOH1323 authorizes a mining rate of up approximately 2,000 tonnes per day of ore and a milling throughput of approximately 2,000 tonnes per day of ore. The Doris Project began production early in 2017.

The Doris Project includes the following components and facilities:

- The Roberts Bay offloading facility: marine jetty, barge landing area, beach laydown area, access roads, weather havens, fuel tank farm/transfer station, waste storage facilities and incinerator, and quarry;
- The Doris site: 280-person camp, laydown areas, service complex (e.g., workshop, wash bay, administration buildings, mine dry), two quarries (mill site platform and solid waste landfill), core storage areas, batch plant, brine mixing facilities, vent raise (3), air heating units, reagent storage, fuel tank farm/transfer station, potable water treatment, waste water treatment, incinerator, landfarm and handling/temporary hazardous waste storage, explosives magazine, and diesel power plant;
- Doris Mine works and processing: underground portal, overburden stockpile, temporary waste rock pile, ore stockpile, and processing mill;
- Tailings Impoundment Area (TIA): Schedule 2 designation for Tail Lake with two dams (North and South dams), sub-aerial deposition of flotation tailings, emergency tailings dump catch basins, pump house, and quarry;
- All-season main road with transport trucks: Roberts Bay to Doris site (4.8 km, 150 to 200 tractor and 300 fuel tanker trucks/year);
- Access roads from Doris site used predominantly by light-duty trucks to: Tail Lake (5.9 km), the explosives magazine (0.5 km), Doris Lake float plane dock (0.5 km), solid waste disposal site (0.2 km), and to the tailings decant pipe (0.4 km),from the Roberts Bay offloading facility to the location where the discharge pipe enters the ocean (0.6 km); and
- All-weather airstrip (914 m), winter airstrip (1,524 m), helicopter landing site and building, and Doris Lake float plane and boat dock.

Water is managed at the Doris Project through:

- freshwater input from Doris Lake for mining, milling and associated activities and domestic purposes ;
- freshwater input from Windy Lake for domestic purposes;
- process water input primarily from Tail Lake;
- saline water from mining, porewater from waste rock and ore discharged to Tail Lake;
- sewage and greywater treated in a waste water treatment plant and discharged to Tail Lake; and
- water from Tail Lake treated and discharged to Roberts Bay via a discharge pipeline, with use of a marine outfall mixing box (MOMB).

Hope Bay Regional Exploration Project

The Hope Bay Regional Exploration Project has been renewed several times since 1995. The current extension expires in June 2022. Much of the previous work for the program was based out of Windy Lake and Boston camps. These camps were closed in October 2008 with infrastructure either decommissioned or moved to the Doris site. All exploration activities are now based from the Doris site and in the future from the Boston site. Components and activities for the Hope Bay Regional Exploration Project include:

- operation of helicopters from Doris (4 hours per day in the summer months); and
- the use of exploration drills, which are periodically moved by helicopter.

Madrid Advanced Exploration

In 2017, the NWB approved a Type B Water Licence (2BB-MAE1727) for the Madrid Advanced Exploration Program to support continued exploration and a bulk sample program at the Madrid North and Madrid South sites, located approximately 4 km south of the Doris site. The program includes extraction of a bulk sample totaling 50 to 60 tonnes, which will be trucked to the mill at the Doris site for processing and placement of tailings in the tailings impoundment area (TIA). All personnel will be housed in the Doris camp.

The Madrid Advanced Exploration Program includes the following components and activities.

- Utilization of existing infrastructure associated with the Doris Project:
  - camp facilities to support up to 70 personnel as required to undertake the advanced exploration activities;
  - mill to process ore;
  - TIA;
  - landfill and hazardous waste areas, particularly if closure and remediation becomes required for the Madrid Advanced Exploration Program infrastructure;
  - fuel tank farms; and
  - Doris airstrip and Roberts Bay facility for transport of personnel and supplies.
- Utilization of existing infrastructure at the Madrid and Boston areas:
  - borrow and rock quarry facilities: existing Quarries A, B, and D along the Doris-Windy AWR;
  - AWR between Doris and Windy Lake for transportation of personnel, ore, waste, fuel, and supplies; and
  - future mobilization of existing exploration site infrastructure, should it become necessary.
- Construction of additional facilities at Madrid North and South:
  - access portals and ramps for underground operations at Madrid North and at Madrid South;
  - 4.7 km extension of the existing AWR originating from the Doris to the Windy exploration area (Madrid North) to the Madrid South deposit, with branches to Madrid North, Madrid North vent raise, and the Madrid South portal;
  - development of a WRR from Madrid North to access Madrid South until AWR has been constructed;
  - all weather access road and tailings line from Madrid North to the south end of the TIA;
  - borrow and rock quarry facilities; two quarries referenced as Quarries G and H;
  - waste rock and ore stockpiles;
  - water and waste management structures; and
  - additional site infrastructure, including compressor building, brine mixing facility, saline storage tank, air heating facility, four vent raises, workshop and office, laydown area, diesel generator, emergency shelter, fuel storage facility/transfer station.

- Undertaking of advanced exploration access to aforementioned deposits through:
  - continue field mapping and sampling, as well as airborne/ground/downhole geophysics;
  - diamond drilling from the surface and underground; and
  - bulk sampling through underground mining methods and mine development.

Boston Advanced Exploration

The Boston Advanced Exploration Project Type B Water Licence No. 2BB-BOS1217 was renewed as Water Licence No. 2BB-BOS1727 in July 2017 and includes:

- the Boston camp (120 person), maintenance shops, workshops, laydown areas, water pumphouse, vent raise, warehouse, site service roads, sewage and greywater treatment plant, fuel storage and transfer station, landfarm, solid waste landfill and a heli-pad;
- mine works, consisting of underground development for exploration drilling and bulk sampling, temporary waste rock pile, and ore stockpile;
- potable water and industrial water from Aimaokatalok Lake; and
- treated sewage and greywater discharged to the tundra.

9.4.1.2 The Madrid-Boston Project

The Madrid-Boston Project includes: the Construction and Operation of commercial mining at the Madrid North, Madrid South and Boston sites; the continued operation of Roberts Bay and the Doris site to support mining at Madrid and Boston; and the Reclamation and Closure and Post-Closure phases of all sites. Excluded from the Madrid-Boston Project for the purposes of the assessment are the Reclamation and Closure and Post-closure components of the Doris Project as currently permitted and approved.

Construction

Madrid-Boston construction will utilize the infrastructure associated with Existing and Approved Projects. This may include:

- an all-weather airstrip at the Boston exploration area and helicopter pad;
- seasonal construction and/or operation of a winter ice strip on Aimaokatalok Lake;
- Boston camp with expected capacity for up to 65 people during construction
- Quarry D Camp with capacity for approximately 180 people;
- seasonal construction/operation of Doris to Boston winter road route (WRR);
- three existing quarry sites along the Doris to Windy all-weather road (AWR);
- Doris camp with capacity for up to 280 people;
- Doris airstrip, winter ice strip, and helicopter pad;
- Roberts Bay offloading facility and road to Doris; and
- Madrid North and Madrid South sites and access roads.

Additional infrastructure to be constructed for the proposed Madrid-Boston Project includes:

- expansion of the Doris TIA (raising of the South Dam, construction of West Dam, development of a west road to facilitate access, and quarrying, crushing, and screening of aggregate for the construction);
- construction of an off-loading cargo dock at Roberts Bay (including a fuel pipeline, upland mooring points, beach landing and gravel pad, shore manifold);
- construction of an additional tank farm at Robert's Bay (consisting of two 5 ML tanks);
- expansion of accommodation facility (from 280 to 400 person), mine dry and administrative building, water treatment at Doris site;
- complete development of the Madrid North and Madrid South underground workings;
- incremental expansion of infrastructure at Madrid North and Madrid South to accommodate production mining, including vent raise, access road, process plant buildings.;
- construction of a 1,200 tpd concentrator, fuel storage, power plant, mill maintenance shop, warehouse/reagent storage at Madrid North;
- all weather access road and tailings line from Madrid North to the south end of the TIA;
- AWR linking Madrid to Boston (approximately 53 km in length, nine quarries for permitting purposes, four of which will likely be used);
- all-weather airstrip, airstrip building, helipad and heliport building at Boston;
- construction of a 2400 tpd process plant at Boston;
- all infrastructure necessary to support mining and processing activities at Boston including construction of a new 300-person accommodation facility, mine office and dry and administration building s, additional fuel storage, laydown area, ore pad, waste rock pad, diesel power plant and dry-stack tailings management area (TMA);
- infrastructure necessary to support ongoing exploration activities at both Madrid and Boston; and
- wind turbines near the Doris site (2), Madrid (2) and Boston (2).

Operation

Madrid-Boston Project is intended to cover the proposed incremental development of the Hope Bay Greenstone Belt. The operation phase includes:

- mining of the Madrid North, Madrid South, and Boston deposits;
- operation of a concentrator at Madrid North;
- transportation of ore from Madrid North, Madrid South and Boston to the Doris process plant, and transportation of concentrate from the Madrid North concentrator to the Doris process plant;
- extending the operation at Roberts Bay and Doris;
- processing the ore and/or concentrate from Madrid North, Madrid South and Boston at the Doris process plant with disposal of the detoxified tailings underground at Madrid North, flotation tailings from the Doris process plant pumped to the expanded Doris TIA, and discharge of the TIA effluent to the marine environment;

- operation of a concentrator at Madrid North and disposal of tailings at the Doris TIA;
- operation of a process plant and wastewater treatment plant at Boston with disposal of flotation tailings to the Boston TMA and the detoxified leached tailings in the underground mine at Boston;
- operation of two wind turbines for power generation; and
- ongoing maintenance of transportation infrastructure at all sites (cargo dock, jetty, roads, and quarries).

Reclamation and Closure

Areas which are no longer needed to carry out Madrid-Boston Project activities will be progressively reclaimed during Construction and Operation. Where practicable, progressive rehabilitation will be implemented to achieve the site abandonment goal and closure principles (see Volume 3, Chapter 5).

At Reclamation and Closure, all sites will be deactivated and reclaimed in the following manner (see Volume 3, Chapter 5):

- Camps and associated infrastructure will be demolished and/or disposed of in approved non-hazardous site landfills.
- Non-hazardous landfills will be progressively covered with quarry rock, as cells are completed. At final closure, the facility will receive a final quarry rock cover which will ensure physical and geotechnical stability.
- Rockfill pads occupied by construction camps and associated infrastructure and laydown areas, will be re-graded to ensure physical and geotechnical stability and promote free-drainage, and any obstructed drainage patterns will be re-established.
- Quarries no longer required will be made physical and geotechnically stable by scaling high walls and constructing barrier berms upstream of the high walls.
- Landfarms will be closed by removing and disposing of the liner, and re-grading the berms to ensure the area is physically and geotechnically stable.
- Mine waste rock will be used as structural mine backfill.
- The Doris TIA surface will be covered waste rock. Once the water quality in the reclaim pond has reached the required discharge criteria, the North Dam will be breached and the flow returned to Doris Creek.
- The Madrid to Boston All-Weather Road and Boston Airstrip will remain in place after Reclamation and Closure. Peripheral equipment will be removed. Where rock drains, culverts, or bridges have been installed, the roadway or airstrip will be breached and the element removed. The breached opening will be sloped and armoured with rock to ensure that natural drainage can pass without the need for long-term maintenance.
- A low permeability cover, including a geomembrane, will be placed over the Boston TMA. The contact water containment berms will be breached and the liner will be cut to prevent collecting any water. The balance of the berms will be left in place to prevent localised permafrost degradation.

9.4.2 Project Development Area

The Project Development Area (PDA) is shown in Figure 9.4-1 and is defined as the area which has the potential for infrastructure to be developed as part of the Madrid-Boston Project. The PDA includes engineering buffers around the footprints of structures. These buffers allow for latitude in the final placement of a structure through later design and construction phases, reflecting the certainty of design and construction. Compounds with buildings and other infrastructure in close proximity are defined as pads with buffers whereas roads are defined as linear corridors with buffers. The buffers for pads varied depending on the local physiography and other buffered features such as sensitive environments or riparian areas. The average engineering buffer for roads is 100 m either side.

Since the infrastructure for the Doris Project is in place, the PDA exactly follows the footprints of these features. In all cases, the PDA does not include the Madrid –Boston Project design buffers applied to potentially environmentally sensitive features. These are detailed in Volume 3, Chapter 2 (Project Description).

9.4.3 Local Study Area

The boundaries of the LSA for terrestrial wildlife VECs were set to encompass the Project Development Area, which contains all proposed Project infrastructure as well as a 1 km buffer (Figure 9.4-1). The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components including infrastructure and connecting roads. The LSA boundary was selected based on empirical data and expert opinion regarding the scale at which there is a reasonable potential for immediate and local effects on wildlife species under operating conditions.

9.4.4 Regional Study Area

The Regional Study Area (RSA) for terrestrial wildlife encompasses the wildlife LSA, and an approximate 30 km buffer surrounding all proposed Project infrastructure and road corridors (Figure 9.4-1). The size of the wildlife RSA was designed to include wildlife with larger home ranges that could potentially come into contact with, or may be affected by the workings at, the Project.

The size of the RSA was chosen to be at least twice as large as the zone of influence (ZOI) reported for a mine in the Canadian Arctic for caribou, so that it would encompass an area where wildlife may be affected and a control area of at least equal size outside of that area. The RSA was not made larger to prevent potential effects of the Project from being diluted in a larger area.

The RSA is also used as the cumulative effects boundary for most wildlife VECs, including raptors, waterbirds, upland birds because it encompasses an area larger than their summer home range sizes. For VECs with larger home ranges, such as caribou, muskox, grizzly bear and furbearers (wolverine and wolves), a species specific cumulative effects study area was created based on the published home range sizes, and is discussed in the cumulative effects section for each VEC.

9.4.5 Temporal Boundaries

The Project represents a significant development in the mining of the Hope Bay Greenstone Belt. Even though this Project spans the conventional Construction, Operation, Reclamation and Closure, and post-Closure Phases of a mine project, Phase 2 is a continuation of development currently underway. Phase 2 has four sites: Roberts Bay, Doris, Madrid (North and South), and Boston and three mine sites: Madrid North, Madrid South and Boston. Development, Operation and Closure of the Phase 2 Project will overlap mining and post-mining activities at the existing Doris mine. As such, the temporal

boundaries of this Project overlap with a number of Existing and Approved Authorizations (EAAs) for the Hope Bay Project and the extension of activities during Phase 2.

For the purposes of the EIS, distinct Phases of the Project are defined (Table 9.4-1). Construction, Operation and Closure activities will overlap among sites; this is outlined in Table 9.4-1 and described in the Project Description and Alternatives (Volume 3, Sections 3 to 5).

Table 9.4-1. Temporal Boundaries for the Effects Assessment for Wildlife

Phase	Project Year	Calendar Year	Length of Phase (Years)	Description of Activities
Construction	1 - 4	2019 - 2022	4	• **Roberts Bay:** construction of access road (Year 1), marine dock and additional fuel facilities (Year 2 – Year 3); • **Doris**: expansion of the Doris TIA and accommodation facility (Year 1); • **Madrid North:** construction of concentrator and road to Doris TIA (Year 1 – Year 2); • **All-weather Road**: construction (Year 1 – Year 3); • **Boston**: site preparation and installation of all infrastructures including process plant (Year 2 – Year 5).
Operation	5 - 14	2023 - 2032	10	• **Roberts Bay**: shipping operations (Year 1 – Year 14) • **Doris**: processing and infrastructure use (Year 1 – Year 14); • **Madrid North:** mining (Year 1 – 13); ore transport to Doris process plant (Year 1 -13); ore processing and concentrate transport to Doris process plant (Year 2 – Year 13); • **Madrid South:** mining (Year 11 – Year 14); ore transport to Doris process plant (Year 11 – Year 14); • **All-weather Road**: operational (Year 4 – Year 14); • **Boston**: winter access road operating (Year 1 – Year 3); mining (Year 4 – Year 11); ore transport to Doris process plant (Year 4 – Year 6); and processing ore (Year 5 – Year 11).
Reclamation and Closure	15 - 17	2033 - 2035	3	• **Roberts Bay**: facilities will be operational during closure (Year 15 – Year 17); • **Doris**: camp and facilities will be operational during closure (Year 15 – Year 17); mine, process plant, and TIA decommissioning (Year 15 – Year 17); • **Madrid North:** all components decommissioned (Year 15 – Year 17); • **Madrid South:** all components decommissioned (Year 15 – Year 17); • **All-weather Road**: road will be operational (Year 15 – Year 16); decommissioning (Year 17); • **Boston**: all components decommissioned (Year 15 – Year 17).
Post-Closure	18 - 22	2036 - 2040	5	• **All Sites:** Post-closure monitoring.
Temporary Closure	NA	NA	NA	• **All Sites:** Care and maintenance activities, generally consisting of closing down operations, securing infrastructure, removing surplus equipment and supplies, and implementing on-going monitoring and site maintenance activities.

9.5 ASSESSMENT METHODOLOGY

9.5.1 Methodology Overview

To provide a comprehensive understanding of the potential effects for the Project, the Phase 2 components and activities are assessed on their own as well as in the context the Approved Projects (Doris and exploration) within the Hope Bay Greenstone Belt. The effects assessment process is summarized as follows:

1. Identify potential interactions between the Phase 2 Project and the VECs or VSECs;
2. Identify the resulting potential effects of those interactions;
3. Identify mitigation or management measures to eliminate or reduce the potential effects;
4. Identify residual effects (potential effects that would remain after mitigation and management measures have been applied) for Phase 2 in isolation;
5. Identify residual effects of Phase 2 in combination with the residual effects of Approved Projects; and
6. Determine the significance of combined residual effects.

9.5.2 Methods for Identification of Potential Effects

Potential effects were identified through scoping meetings conducted by TMAC and the NIRB with community members, identified by Inuit TK, scientific research, review of similar mining projects in Nunavut, the Northwest Territories and the Arctic. These potential effects are described in Section 9.6. Potential effects of each Project component on each VEC are discussed in the Introduction section for each wildlife VEC.

A caribou workshop was held with Elders and harvesters in Cambridge Bay in September 2016, to refine the assessment of potential effects. The overall objective of the workshop was to inform the environmental assessment, gain local knowledge about the Phase 2 Project's potential risks to caribou, and inform the design of measures to protect caribou.

The workshop discussed the potential effects of the Phase 2 Project on wildlife, with a focus on caribou and related traditional land use activities. The workshop heard from Elders and harvesters regarding their knowledge of caribou, experience of managing risks on the land, and a discussion about potential risks of Phase 2 to caribou, and ways in which to manage (i.e., mitigate) those risks.

The Elders and harvesters identified 18 potential effects, which were rated by the workshop attendees in terms of the level of the potential effect (i.e., often described as depending on the number of caribou that could be affected) and the likelihood that the potential effect would occur. These potential effects are discussed in the caribou assessment (Section 9.8).

9.5.3 Methods for Identification of Mitigation and Management Measures and Monitoring Programs

Mitigation and management measures were identified through a review of best management practices at similar mining projects in the Arctic, comments from community members during scoping meetings, formal review by the KIA and GN DOE of the existing Doris Project WMMP, the scientific literature and professional experience.

Mitigation and monitoring methods common to all wildlife VECs are discussed in Section 9.7, and mitigation and monitoring specific to each wildlife VEC are discussed in Section 9.X.2 of each VEC assessment section.

9.5.4 Methods for Characterization of Potential Effects

Project residual effects are the effects that are remaining after mitigation and management measures are taken into consideration. If the implementation of mitigation measures eliminates a potential effect and no residual effect is identified on that VEC, the effect is eliminated from further analyses. If the proposed implementation controls and mitigation measures are not sufficient to eliminate an effect, a residual effect is identified and carried forward for additional characterization and a significance determination. Residual effects of the Project can occur directly or indirectly. Direct effects result from specific Project/environment interactions between Project activities and components, and VECs. Indirect effects are the result of direct effects on the environment that lead to secondary or collateral effects on VECs.

9.5.5 Definitions for Characterization of Residual Effects

To determine the significance of a Project residual effect, each potential negative residual effect is characterized by a number of attributes consistent with those defined in Section 7.14 of the NIRB's EIS guidelines. A definition for each attribute and the contribution that it has on significance determination is provided in Table 9.5-1.

Table 9.5-1. Attributes to Evaluate Significance of Potential Residual Effects

Attribute	Definition and Rationale	Impact on Significance Determination
Direction	The ultimate long-term trend of a potential residual effect - positive, neutral, or negative.	Positive, neutral, and negative potential effects on VECs are assessed, but only negative residual effects are characterized and assessed for significance.
Magnitude	The degree of change in a measurable parameter or variable relative to existing conditions. This attribute may also consider complexity - the number of interactions (Project Phases and activities) contributing to a specific effect.	The higher the magnitude, the higher the potential significance.
Duration	The length of time over which the residual effect occurs.	The longer the length of time of an interaction, the higher the potential significance.
Frequency	The number of times during the Project or a Project Phase that an interaction or environmental/ socio-economic effect can be expected to occur.	Greater the number times of occurrence (higher the frequency), the higher the potential significance.
Geographic Extent	The geographic area over which the interaction will occur.	The larger the geographical area, the higher the potential significance.
Reversibility	The likelihood an effect will be reversed once the Project activity or component is ceased or has been removed. This includes active management for recovery or restoration.	The lower the likelihood a residual effect will be reversed, the higher the potential significance.

For the determination of significance, each attribute is characterized. The characterizations and criteria for the characterizations are provided in Table 9.5-2. Each of the criteria contributes to the determination of significance.

Table 9.5-2. Criteria for Residual Effects for Environmental Attributes

Attribute	Characterization	Criteria[1]
Direction	Positive	Beneficial
	Variable	Both beneficial and undesirable
	Negative	Undesirable
Magnitude	Negligible	No change on the exposed indicator/VEC
	Low	Differing from the average value for the existing environment to a small degree, but within the range of natural variation and well below a guideline or threshold value
	Moderate	Differing from the average value for the existing environment and approaching the limits of natural variation, but below or equal to a guideline or threshold value
	High	Differing from the existing environment and exceeding guideline or threshold values so that there will be a detectable change beyond the range of natural variation (i.e., change of state from the existing conditions)
Duration	Short	Up to 4 years (Construction Phase)
	Medium	Greater than 4 years and up to 17 years (4 years Construction Phase, 10 years Operation Phase, 3 years Reclamation and Closure Phase)
	Long	Beyond the life of the Project
Frequency	Infrequent	Occurring only occasionally
	Intermittent	Occurring during specific points or under specific conditions during the Project
	Continuous	Continuously occurring throughout the Project life
Geographic Extent	Project Development Area (PDA)	Confined to the PDA
	Local Study Area (LSA)	Beyond the PDA and within the LSA
	Regional Study Area (RSA)	Beyond the LSA and within the RSA
	Beyond Regional	Beyond the RSA
Reversibility	Reversible	Effect reverses within an acceptable time frame with no intervention
	Reversible with effort	Active intervention (effort) is required to bring the effect to an acceptable level
	Irreversible	Effect will not be reversed

9.5.6 Methods for Determining the Significance of Residual Effects

Section 7.14 of the NIRB's EIS guidelines provided guidance, attributes, and criteria for the determination of significance for residual effects. Also, the Canadian Environmental Assessment Agency's *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects (CEA Agency 1992)* also guided the evaluation of significance for identified residual effects. The significance of residual effects is based on comparing the predicted state of the environment with and without the Project, including a judgment as to the importance of the changes identified.

9.5.6.1 Probability of Occurrence or Certainty

Prior to the determination of the significance for negative residual effects, the probability of the occurrence or certainty of the effect is evaluated. For each negative residual effect, the probability of occurrence is categorized as unlikely, moderate or likely. Table 9.5-3 presents the definitions applied to these categories.

Table 9.5-3. Definition of Probability of Occurrence and Confidence for Assessment of Residual Effects

Attribute	Characterization	Criteria
Probability of occurrence or certainty	Unlikely	Some potential exists for the effect to occur; however, current conditions and knowledge of environmental trends indicate the effect is unlikely to occur.
	Moderate	Current conditions and environmental trends indicate there is a moderate probability for the effect to occur.
	Likely	Current conditions and environmental trends indicate the effect is likely to occur.
Confidence	High	Baseline data are comprehensive; predictions are based on quantitative predictive model; effect relationship is well understood.
	Medium	Baseline data are comprehensive; predictions are based on qualitative logic models; effect relationship is generally understood, however, there are assumptions based on other similar systems to fill knowledge gaps.
	Low	Baseline data are limited; predictions are based on qualitative data; effect relationship is poorly understood.

9.5.6.2 Determination of Significance

The evaluation of significance was determined based on the residual effects characterization. The criteria used in assessing significance for Terrestrial Wildlife include:

Not significant: The direction of effects can be positive to negative. The magnitude of effects can be negligible to moderate, and the duration of effects can be short to long. Frequency of effects can be infrequent to continuous, and the geographic extent must be limited to the LSA. Potential effects can be reversible within 25 years to irreversible (greater than 100 years required).

Significant: The direction of effects is negative. The magnitude of effects is high and the duration is long. Frequency of effects can be infrequent to continuous. Geographic extent must extend beyond the LSA and may be within the RSA or beyond the RSA and has regional geographic extent, and effects can be reversible with effort (25 to 100 years) or irreversible (greater than 100 years required).

9.5.6.3 Confidence

The knowledge or analysis that supports the prediction of a potential residual effect—in particular with respect to limitations in overall understanding of the environment and/or the ability to foresee future events or conditions—determines the confidence in the determination of significance. In general, the lower the confidence, the more conservative the approach to prediction of significance must be. The level of confidence in the prediction of a significant or non-significant potential residual effect qualifies the determination, based on the quality of the data and analysis and their extrapolation to the predicted residual effects. “Low” is assigned where there is a low degree of confidence in the inputs, “medium” when there is moderate confidence and “high” when there is a high degree of confidence in the inputs. Where rigorous baseline data were collected and scientific analysis performed, the degree of confidence will generally be high. Table 9.5-3 provides descriptions of the confidence criteria.

Residual effects identified in the Project-related effects assessment are carried forward to assess the potential for cumulative interactions with the residual effects of other projects or human activities and to assess the potential for transboundary impacts should the effects linked directly to the activities of

the Project inside the Nunavut Settlement Area (NSA), which occurs across provincial, territorial, international boundaries or may occur outside of the NSA.

9.5.7 Methods for the Cumulative Effects Assessment

The general methodology for cumulative effects assessment (CEA) is described in Volume 2, Section 4, and focuses on the following activities:

1. Identify the potential for Project-related (Phase 2 and the Hope Bay Project) residual effects to interact with residual effects from other human activities and projects within specified assessment boundaries. Key potential residual effects associated with past, existing, and reasonably foreseeable future projects were identified using publicly available information or, where data was unavailable, professional judgment was used (based on previous experience in similar geographical locations) to approximate expected environmental conditions.
2. Identify and predict potential cumulative effects that may occur and implement additional mitigation measures to minimize the potential for cumulative effects.
3. Identify cumulative residual effects after the implementation of mitigation measures.
4. Determine the significance of any cumulative residual effects.

9.6 IDENTIFICATION OF POTENTIAL EFFECTS

Potential effects were identified by Inuit TK, through scoping meetings conducted by TMAC with community members, scoping meetings conducted by the NIRB and the subsequent NIRB guidelines (NIRB 2012), a review of scientific literature of the effects of developments on wildlife, review of similar mining projects in Nunavut, the Northwest Territories and the Arctic, professional judgement, and harvester experience.

Specific to caribou, TMAC hosted a workshop with Elders and harvesters in September, 2016, in Cambridge Bay, focused potential interactions and risk to caribou (ERM 2016d). Potential interactions of each Project component on each VEC are discussed in the Introduction section for each wildlife VEC.

Potential effects at the Project site have been monitored at the existing Doris Project (Golder Associates 2005; Rescan 2011b, 2013c; ERM 2016c). The effects of mining developments in the Arctic have also been documented through monitoring programs at the Lupin Gold Mine (Hohnstein 1996), the Ekati Diamond Mine (BHP Billiton 2000, 2003, 2006, 2009; DDEC 2016), and the Diavik Diamond Mine Inc. (DDMI 2002; Golder and Associates 2015).

These scoping processes identified seven potential effects for terrestrial wildlife:

1. habitat loss;
2. disturbance;
3. disruption of movement;
4. attraction to the Project;
5. direct mortality;
6. increased access and harvest; and
7. changes in environmental media quality.

Some areas of wildlife habitat may be lost to the Project footprint. Adjacent areas of the tundra may be altered by the physical process of construction, dust, altered surface hydrology, etc. Elders and harvesters who participated in the caribou workshop identified habitat loss as a concern should the Phase 2 grow too large and advised that the footprint of the Project be managed to minimize it. In some cases, particular habitats may be of higher quality than the surrounding tundra, including areas used as residences (dens and nests), for foraging (e.g., wetlands in summer), escape from insects (e.g., hilltops). The potential loss or alteration of these special habitat features is discussed for each wildlife VEC. The potential effect of **habitat loss** was included and evaluated in this assessment.

Disturbances, including visual and auditory stimuli, can cause wildlife to alter their regular behaviour patterns, avoiding the disturbance and resulting in indirect habitat loss. Elders and harvesters who participated in the caribou workshop identified disturbance from helicopters, fixed wing aircraft, the mine site, vehicles as well as dust as their primary concern for caribou. Therefore, the potential effects of **disturbance** is included in this assessment.

Many Arctic wildlife species occupy large home ranges and make long migrations between seasonal habitats, often along travel corridors (e.g., eskers and freshwater crossings). Research indicates that in some cases, disturbance from vehicles on roads can also alter wildlife movements (Dyer et al. 2002b). The effect of disruption of movement was also identified as a concern during the caribou workshop, primarily due to vehicles. The potential effect of **disruption of movement** is therefore included and considers the loss of migratory corridors and potential effects of the Boston road.

Some wildlife species, particularly grizzly bears and wolverine, are known to be attracted to mining exploration camps and operating projects. Also, during the Doris Project water licence hearings, reviewers requested particular mitigation for the potential for caribou to be attracted to the TIA as a source of salt. Workshop participants also commented that the Project should have good management for grizzly bears should they approach the site. Thus, the effect of **attraction to the Project** is included as a potential effect in the assessment for select wildlife VECs.

Some wildlife may interact with the Project and suffer mortality or injury from vehicle strikes, entanglement, or other factors. Workshop participants identified vehicle strikes as a potential issue, but that it would be a low level effect on caribou. While the rate of wildlife mortality at many projects is very low, the potential effect of **direct mortality** was evaluated for the Project.

The potential for the Construction and Operation of the Project to increase access to habitats and therefore the rate of harvest in formerly inaccessible or less accessible areas is a feature in projects in southern Canada. Caribou workshop participants were also concerned about workers at site to communicate the location of caribou to harvesters in Cambridge Bay. For this reason, **increased access and harvest** is included as a potential effect in the assessment.

The Project will produce some dust and will discharge water to the environment and will use a variety of hazardous substances such as fuel, oil, etc. Caribou workshop participants were concerned about maintaining a clean environment, and were concerned that there may be changes to water quality or additional dust deposited on vegetation. Workshop participants also identified a concern that caribou may drink from the TIA. The potential for substances to be deposited in the environment and alter the quality of environmental media (water, soil and vegetation) and subsequently lead to wildlife exposure through the food chain is also assessed through a formal risk assessment conducted as part of the Human Health and Environmental Risk Assessment (Volume 6, Section 5). Results of this analysis for each wildlife VEC are evaluated in this section as the potential effect of **changes in environmental media quality**.

The NIRB guidelines for the Phase 2 Project identified a variety of potential effects to be evaluated. These guidelines and the corresponding potential effect evaluated in this assessment are listed in Tables 9.6-1 and 9.6-2.

Table 9.6-1. NIRB Guidelines for the Terrestrial Wildlife and Potential Effects for the Assessment

NIRB Guidelines	Potential Effect
Potential general impacts on terrestrial wildlife in the LSA, including: interference with migratory routes;	Disruption of movement
alienation from important habitat (e.g., denning sites, calving and post- calving areas); habitat fragmentation and general disturbance or disruption caused by Project activities;	Disturbance
Potential impacts on population size, abundance, distribution and behaviour of wildlife VECs from: • Direct and indirect loss of habitat from the presence of and use of infrastructure, the conduct of project activities and associated sensory disturbances;	Habitat loss
• Direct and indirect impacts from potential degraded water quality and ground contamination, as well as airborne contaminants resulting from project facilities and associated activities;	Changes in environmental media quality
• Direct and indirect impacts from potential ice-breaking (prior to spring break-up or following fall freeze-up) associated with shipping activities, and ice management at the dock facility;	Disruption of movement
• Direct and indirect impacts from climate change; and	Habitat loss (Cumulative Effects section), Addressed in Climate Change (Volume 4 Section 1)
• Where relevant, the Proponent shall take into account the alteration of normal behaviour or patterns and provide any associated outcomes for overall energy balance for the relevant VEC;	Disturbance
Potential impacts on wildlife from ground traffic and air traffic disturbance, particularly low level flights (i.e., lower than 610 metres) during critical periods (caribou calving and post-calving). For this impact assessment, a delineated flight impact zone could be useful in determining the potential impact of flights on wildlife, with a particular focus on critical life cycle periods and planned air traffic volume and routes;	Disturbance
Potential impacts on wildlife from injury or mortality caused by Project activities, particularly the use of the all-weather road, mine hauling roads and other access roads, as well as intentional killing of wildlife to defend human life or property by mine personnel;	Direct mortality
Potential impacts on wildlife from increased hunting pressure resulting from improved access due to Project infrastructure;	Increased access and harvest
Potential impacts of noise and vibration on wildlife from drilling, blasting and other activities as results of Project Construction and Operation;	Disturbance
Assessment of the potential for Project activities to act as an attractant to wildlife species, and associated effect/changes to behaviour and condition;	Attraction to the Project
Evaluation of the potential for contaminants to be released into the environment as a result of the Project and to be taken up by VEC species;	Changes in environmental media quality
Potential impacts of contamination to sources of traditional food (including those trapped, fished, hunted, harvested or grown for subsistence or medicinal purposes) as a result of bioaccumulation, i.e. food chain uptake through air, water and soil as well as any proposed monitoring methods to track these potential impacts;	Changes in environmental media quality
List of all potential contaminants and a determination of whether possible uptake of these contaminants into country foods will result from project activities.	Changes in environmental media quality
Potential impacts from the loss or alteration of habitat (i.e. vegetation) due to pollutants and noise and any ancillary effects; and	Disturbance, Changes in environmental media quality

NIRB Guidelines	Potential Effect
Evaluation of the relative health and potential for chemical toxicity for inherently sensitive wildlife species based on an analysis of exposure pathways and demographic parameters.	Changes in environmental media quality

Table 9.6-2. NIRB Guidelines for Birds and Bird Habitat and Identified Potential Effects for the Assessment

NIRB Guidelines	Potential Effects
Description of the potential loss, alteration or isolation of habitat (e.g., staging and nesting habitats) as a result of the Project development. Special consideration should be given to Species at Risk listed on Schedule 1 of the federal SARA, species with designations by the COSEWIC, species having significant ecological functions or importance for Inuit life and culture;	Habitat loss, Disturbance
Potential disruption or alteration of migration routes due to all Project Phases and activities;	Disruption of movement
Where relevant, the Proponent shall account for alteration of normal behaviour or patterns and provide any associated outcomes for overall energy balance for the relevant VEC;	Disturbance
Potential impacts on birds and bird habitat use from air contamination, vegetation contamination, ground contaminants or degraded water quality;	Changes in environmental media quality
Potential disturbances to birds from noise and vibrations as a result of blasting, and land and marine transportation;	Disturbance
Potential impact from pre-determined Flight Impact Zones, and potential for collision with aircraft;	Direct mortality
Potential for Project facilities to attract wildlife such as polar bear, brown and grizzly bear, wolverine, foxes, ravens and gulls that may prey upon migratory birds and resulting impacts on the migratory bird populations;	Attraction to the Project, Increased access and harvest
Potential attraction of birds and other scavengers/predators by domestic waste at camp sites;	Attraction to the Project
Potential attraction of birds to Project facilities and infrastructure for roosting and nesting sites;	Attraction to the Project
Potential for bird mortality due to collisions with tall structures, overhead wires or guy wires;	Direct mortality
Potential effects of shipping on coastal and marine birds and habitat, as well as potential disturbance on key migratory bird habitat areas and sanctuaries in proximity to shipping routes in the NSA;	Disturbance, Addressed in marine wildlife (Volume 5, Section 11)
Incidental spills, malfunctions and other accidents associated with shipping Operations and potential impacts to marine birds;	Changes in environmental media quality, Addressed in marine wildlife (Volume 5, Section 11)
Potential interactions, accidental injuries and mortality of marine birds directly or indirectly from proposed shipping (open water and potential ice breaking during break-up in the spring and freeze-up in the fall) activities, in particular those marine birds which congregate in areas where the shipping routes would pass through;	Direct mortality, Addressed in marine wildlife (Volume 5, Section 11)
Potential direct and indirect effects on marine bird behaviour, distribution, abundance, migration patterns, species health and reproduction from marine shipping;	Disturbance, Addressed in marine wildlife (Volume 5, Section 11)
Evaluation of the potential for contaminants to be released to the environment from marine shipping and taken up by marine bird VECs as a result of the Project;	Changes in environmental media quality, Addressed in marine wildlife (Volume 5, Section 11)

NIRB Guidelines	Potential Effects
Assessment of potential cumulative effects on marine bird VECs resulting from escalated marine traffic in the RSA over the mining lifecycle (and including the potentially extended minimum Operation period). Consideration should be given to the possible significant increase of marine vessel traffic along shipping routes;	Disturbance, Addressed in marine wildlife (Volume 5, Section 11)
Potential impacts of contaminant bioaccumulation via food chain uptake through air, water and soil, including specific impacts to traditional food sources including potential monitoring methods to track the progress of this potential impact; and	Changes in environmental media quality
Potential impacts from the loss or alteration of habitat (i.e. vegetation) due to pollutants and noise and its effects on bird and bird habitat.	Habitat Loss, Disturbance

Potential Project-related effects on wildlife VECs are identified in Tables 9.6-3 and 9.6-4 and are discussed in the introduction for each assessment section.

Table 9.6-3. Potential Interactions between Project Components and Potential Effects on Terrestrial Mammals; Caribou, Grizzly Bear, Muskox, and Wolverine

Project Component/ Activity	Habitat loss and Alteration	Disturbance	Disruption of Movement	Attraction to the Project site	Direct Mortality	Increased Access and harvest	Altered Media Quality
Construction							
Expansion of Roberts Bay facility	X	X					X
Expansion of the Doris Site	X	X	X				X
Expansion of the TIA	X	X		X			X
Construction of the Boston Road	X	X	X			X	
Construction of the Boston Site	X	X	X		X	X	X
Operations and Closure							
Operation of the Roberts Bay facility		X				X	
Operation of Doris site		X			X	X	
Operation of the expanded TIA							X
Continued Operation of Madrid site		X					
Operation of the Boston Road			X		X	X	
Operation of the Boston Site		X	X		X	X	X

Table 9.6-4. Potential Interactions between Project Components and Potential Effects on Birds; Raptors, Waterbirds and Upland Birds

Project Component/ Activity	Habitat loss and Alteration	Disturbance	Disruption of Movement	Attraction to the Project site	Direct Mortality	Increased Access and harvest	Altered Media Quality
Construction							
Expansion of Roberts Bay facility	X	X					X

Project Component/ Activity	Habitat loss and Alteration	Disturbance	Disruption of Movement	Attraction to the Project site	Direct Mortality	Increased Access and harvest	Altered Media Quality
Expansion of the Doris Site	X	X	X				X
Expansion of the TIA	X	X		X			X
Construction of the Boston Road	X	X		X			
Construction of the Boston Site	X	X	X		X		X
Operations and Closure							
Operation of the Roberts Bay facility		X					
Operation of Doris site		X			X		
Operation of the expanded TIA							X
Continued Operation of Madrid site		X					
Operation of the Boston Road					X		
Operation of the Boston Site		X			X		X

9.7 MITIGATION COMMON TO ALL WILDLIFE VECS

The Wildlife Mitigation and Monitoring Plan (WMMP) (Volume 8, Annex V8-3) contains the mitigation, monitoring and management actions intended to reduce or eliminate potential effects to terrestrial wildlife. Mitigation and management measures are also in place to minimize potential effects to air quality, the noise environment, and marine water/sediment quality and described in the following plans:

- Annex V8-2 - Air Quality Management Plan;
- Annex V8-8 - Hope Bay Project Noise Abatement Plan; and
- Annex V1-7 - Hope Bay Project Aquatic Effects Monitoring Plan.

Management plans to control non-hazardous, hazardous and food wastes in Volume 1, Annex V1-7 of the EIS:

- P4-13 - Hope Bay Project Non-hazardous Waste Management Plan;
- P4-15 - Hope Bay Project Hazardous Waste Management Plan; and
- P4-16 - Hope Bay Project Incinerator Management Plan.

Management plans to manage water quality at each site and ensure that water quality objectives are met in Volume 1, Annex V1-7 of the EIS:

- P4-4 - Doris Project Domestic Wastewater Treatment Management Plan;
- P4-5 - Hope Bay Project: Boston Sewage Treatment Operations and Maintenance Management Plan;
- P4-6 - Hope Bay Project Groundwater Management Plan.

The Closure and Reclamation plan to minimize long-term effects on wildlife habitat is located in Volume 1, Annex V1-7 of the EIS:

- P4-19 - Hope Bay Project Boston Conceptual Closure and Reclamation Plan, November 2017.

9.7.1.1 Mitigation by Project Design

The Project design includes mitigation for potential effects of the Project on terrestrial wildlife. Design mitigation to reduce the effects of the Project footprint include:

- Infrastructure designed to minimize the Project footprint to reduce habitat loss.
- Infrastructure located close to deposits to keep activities confined to specific areas, in order to confine noise-generating activities.
- Underground mining, which removes the open pits used in most mines and produces only a fraction of the waste rock of a typical open pit mine.
- Project infrastructure, including the Boston road, designed to avoid, where possible, identified wildlife sensitive areas such as caribou calving grounds, carnivore dens and raptor nests. Environmental sensitivities (dens, raptor nests, high value habitats, and wetlands) were mapped and infrastructure sighting was conducted to avoid the sensitive areas.
- Marine infrastructure will be minimized.

The following Project infrastructure components will be designed to reduce potential effects on wildlife:

- Waste management facilities will be wildlife-proof.
- Buildings designed and maintained to exclude wildlife including skirting, screens over vents and other protective measures, as needed.
- Roads will be constructed with caribou crossing structures where roads cross identified movement corridors for caribou.
- Design of transmission line to reduce mortality risk associated with potential collisions with the transmission line for birds, including consulting guidance provided in the Avian Power Line Interaction Committee (2012).

9.7.1.2 Best Management Practices

The WMMP (Volume 8, Annex V8-3) includes best management practices intended to address specific potential effects on wildlife, including habitat alteration and mortality or disturbance in the terrestrial environment. These management actions include the following policies applicable to all employees:

- training for all personnel in their responsibilities to protect wildlife and their habitat;
- a no feeding of wildlife policy;
- a no littering policy;
- a no hunting policy for all Project staff and contractors while on site;
- all Project roads will be closed to the public; and
- an anonymous reporting procedure to allow personnel to report any lapses in environmental protection.

The following best management practices will be carried out to minimize potential effects on terrestrial wildlife through management of:

Shipping:

- Open-water shipping will conform to all applicable laws and regulations.

Aircraft:

- Helicopters and fixed-wing aircraft will avoid disturbing wildlife and sensitive wildlife habitats such as bird colonies through minimum elevation or horizontal offsets.
- Airstrips monitored prior to take-off and landings to ensure marine birds are not present on the landing strip.

Vehicles and heavy mobile equipment:

- A speed limit will be set on all Project roads to reduce the potential for wildlife-vehicle collisions.
- Wildlife given the right-of-way on all roads at all times.
- All equipment maintained to reduce noise.
- Vehicles restricted to site roads and quarry footprints and ice roads.
- Dust control will be carried out, as needed, on all-season roads.

Camps, quarries and the Process Plant:

- Berms or other markers built at high walls of quarries.
- Waste will be managed to reduce the potential for attracting wildlife.
- Protocols for human-wildlife interactions will be developed to protect both Project personnel and marine wildlife in cases where wildlife may come in contact with Personnel.
- Cyanide destruction inside the mill.

Best management practices will also be used to manage fuels, hazardous materials to prevent spills and to contain and clean up any spills that may occur, including:

- Volume 8, Annex V8-1 - Oil Pollution Prevention Plan (OPPP)/Oil Pollution Emergency Plan (OPEP); and
- Volume 1, P4-3 - Hope Bay Project Spill Contingency Plan.

9.7.1.3 Proposed Monitoring Plans and Adaptive Management

The Project will conduct wildlife monitoring to evaluate the effectiveness of mitigation and test the predictions of the EIS. Potential effects on terrestrial wildlife will be adaptively managed, and plans will be reviewed periodically meet current standards, in response to unexpected monitoring results, in response to scientific findings, or due to a significant change in Project activities.

Monitoring will be conducted at Project facilities to evaluate management actions:

- footprint monitoring to monitor habitat loss;
- noise monitoring;
- dust monitoring;
- recording any hunters using the Project site;
- waste management monitoring;
- recording any collisions between vehicles and wildlife;
- water quality monitoring in the TIA; and
- recording incidental wildlife observations to help identify unexpected interactions with marine wildlife.

Monitoring will also be conducted for terrestrial wildlife VECs to evaluate the predictions of the EIS. These monitoring programs are specific to each wildlife VEC and are discussed in the section for each VEC.

9.8 CARIBOU – EFFECTS ASSESSMENT

9.8.1 Introduction

TMAC has evaluated the potential effects of the Madrid-Boston (Phase 2) Project and Hope Bay Project on both Island (Dolphin and Union herd) and Mainland (Beverly and Ahiak sub-populations) caribou. TMAC identified issues and concerns about caribou and identified options for management and consequences to caribou in a variety of ways, including:

- Traditional Knowledge – TMAC commissioned a Traditional Knowledge report from the KIA through the *Naonaiyaotit Traditional Knowledge Project (NTKP)* report (Banci and Spicker 2016).
- Community Meetings - TMAC conducted community meetings during 2016 and 2017 in Cambridge Bay, Kugluktuk, and Gjoa Haven to meet community members and hear their concerns about caribou.
- Environmental Advisory Committee - Under the Inuit Impact Benefit Agreement (IIBA) for the Doris Project with the Kitikmeot Inuit Association (KIA), TMAC and the KIA have jointly formed an Inuit Environmental Advisory Committee. This committee reviews the monitoring reports from the Doris Project and provides input on potential impacts to caribou and mitigation and management activities on site.
- Caribou Workshops - TMAC collaborated with the KIA on three caribou workshops. Elders and land users who historically or currently use the Project area attended the three workshops in September 2016, and April and August 2017. Workshop participants identified potential risks to caribou and caribou populations, and mitigation and management measures for the Doris and Madrid-Boston Projects.
- HTO Interviews - TMAC conducted engagement interviews with Hunters and Trappers Associations in 2016 and 2017 to identify concerns related to caribou.

- Monitoring Reports – TMAC used the over twenty years of monitoring that has been conducted for the Windy exploration camp and the Doris Project to examine the real, measured impacts of a camp and mine on caribou.
- Western Science – TMAC reviewed monitoring reports from similar Arctic projects and the scientific literature to examine the likely impacts of industrial developments in the Canadian Arctic.
- Modeling – TMAC used computer modeling of environmental conditions (dust and noise) to examine the likely scale and types of impacts of the Project on caribou.

The following items are discussed in this section:

- the process for identifying potential impacts on caribou;
- the proposed mitigation and management activities for the Existing Doris and proposed Madrid-Boston Projects;
- the characterization of those potential impacts following mitigation; and
- the significance of residual effects on caribou.

9.8.1.1 Caribou Workshops with Elders and Land Users

The Inuit of the Kitikmeot Region have a longstanding relationship with wildlife and the environment as a whole, as is manifested within Inuit Qaujimajatuqangit (IQ). Inuit Elders and land users bring a unique and important knowledge about caribou and the land, including areas near to the Project. Maintaining the capacity of the land to support traditional activities, including hunting, trapping, fishing, and gathering, is essential to the lifestyles of many Inuit. In recent years, concerns about caribou have increased in Nunavut due to a number of factors, including perceptions of increasing predator levels, changing sea ice and weather conditions, access to food, and possible impacts from industrial development.

TMAC has a long history of two-way knowledge transfer with Kitikmeot Inuit about the Hope Bay Project and wildlife in the area. The IIBA between the KIA and TMAC includes the formation of an Inuit Environmental Advisory Committee (IEAC) made up of Inuit Elders and land users chosen by the KIA. TMAC meets with the IEAC regularly to discuss the results of monitoring for the Project and to solicit feedback. TMAC delivers the annual monitoring reports for wildlife to the KIA for technical review and feedback. TMAC also meets with technical experts from the KIA to collaboratively plan wildlife monitoring programs. For example, design of the wildlife camera program (February 2016), design of the waterbird monitoring program (October 2016), and design of the raptor and upland bird programs (November 2017) were all collaboratively developed with the KIA. With the proposed expansion of the Hope Bay Project to include Madrid and Boston deposits, TMAC held a series of caribou workshops with Elders and land users to incorporate their interests and knowledge in developing caribou protection measures for the Hope Bay Project.

The workshops facilitated the exchange of Traditional Knowledge (TK) and western science on the topics of potential Project impacts and risks to caribou, mitigation measures, cumulative impacts, and monitoring. The workshops provided a platform for Elders and land users to share information about caribou and the environment, and contribute to the development of protection measures to avoid or reduce impacts to caribou and other wildlife species. To facilitate reciprocal communication that incorporates TK and western science, the review of protection measures occurred in-person, through group discussions, facilitated activities, and site visits. TMAC was in a unique position to offer the caribou workshops and to demonstrate the caribou protection measures to Elders and land users at the existing

Project. The Doris Project, which began construction in 2008 and achieved commercial production in early 2017, provides a demonstration of how many of the same protection measures have been implemented for many years.

The workshops brought together Inuit Elders and land users, wildlife experts, and TMAC representatives to work together and share knowledge to ensure the protection measures proposed for the development of Madrid-Boston were informed by TK and acceptable to Inuit who know and use the land near the Project. TMAC has and will continue to involve Inuit Elders and land users on the protection measures developed for the Project. This will ensure local Inuit interests, knowledge, and perspectives on risk are reflected in how impacts on caribou are identified and avoided or minimized throughout the life of the Project.

Three Workshops

The multi-day workshops were held over 10 days in September 2016, April 2017, and August 2017, with the second workshop including a site visit to the Doris site, and the third workshop including a visit to the Doris, Madrid and Boston sites. The first workshop initiated engagement with local knowledge holders in the development of the environmental assessment and design of mitigation and management measures for the Madrid-Boston Project. The second workshop was during the review period for the Draft Environmental Impact Statement (DEIS) for Madrid-Boston. The objective for this workshop was to obtain additional input on the potential impacts of proposed mining at Madrid-Boston on caribou, but with a focus on the protection measures needed to keep caribou safe. The third workshop occurred as TMAC was beginning to prepare the Final Environmental Impact Statement (FEIS). The purpose of this workshop was to revisit, discuss, and consider the protection measures that have been developed to protect caribou and other wildlife. Additionally, the final workshop culminated in the discussion and agreement, by consensus, on concluding statements regarding the mitigation measures and monitoring planned for the Madrid-Boston Project. The protection measures are based on the best knowledge and information available from both TK and western science.

Participants

Workshop participants were selected in consultation with the KIA. A number of the participants are members of the IEAC formed under the Hope Bay Project's IIBA that applies to all TMAC activities within the Hope Bay Greenstone Belt, including the development of the Madrid and Boston sites. Knowledge holders were from Omingmaktok, Kingaok, and Cambridge Bay who are or have been active land users in the Project area, and who are recognized within the community as having considerable knowledge of land use and caribou. The workshops were based on group activities designed to foster equitable participation and sharing of information. Two wildlife biologists, a facilitator, an interpreter, and TMAC representatives were also in attendance.

Methods

The caribou workshops were multi-day working sessions, totalling 11 days, and relied on presentations, focus group discussions, resource mapping, brainstorming sessions, group work sessions, other facilitated activities and consensus-building exercises. Additionally, each subsequent workshop reviewed and confirmed the findings of the previous workshop and included presentations and discussion of both how the workshop results were considered within the environmental assessment for the Madrid-Boston Project and how they contributed to the development of protection measures for caribou and other wildlife. The workshops provided the opportunity for the open sharing of information and the development of ideas as a group.

Workshop 1: September 2016

The first workshop was focused on establishing common understandings of current land use activities, knowledge of caribou, potential interactions between caribou and the proposed Madrid-Boston Project, and caribou protection measures. Six Elders and two land users participated in the first workshop. Part of the discussion focused on the assessment of potential impacts on wildlife, how potential impacts were identified and considered, and the protection measures proposed. Participants identified and described risks to caribou, and the protection measures to reduce risks. The protection measures discussed included both those previously identified and currently in use by TMAC (e.g., water quality monitoring, vehicle speed limits, and spill response), as well as some that had yet to be considered (e.g., managing sea can doors and keeping drivers in their vehicles when caribou are present). Ultimately, discussions were focused on the potential for the Project to coexist with caribou and other wildlife. The detailed report on workshop one is in Appendix V2-2A.

Workshop 2: April 2017

The second workshop was attended by five Elders and two land users. The objectives of the second workshop were to demonstrate and review existing caribou protection measures, including a number that are in place at the Doris site and are also proposed for the Madrid-Boston Project. Participants were able to see the application of many of the proposed protection measures during a site visit to Doris (Appendix V2-2B). For example, during the trip to site, workshop participants viewed markers at 250 m from the airstrip and at 2.8 km from a quarry. Caribou may not be present within these distances for aircraft to land or take-off and blasting to occur. Participants also stopped repeatedly along the Doris to Madrid Windy Lake Road to determine how far away a person can hear the Doris Project. The second workshop included further discussion of knowledge about caribou (i.e., behaviour, predation, habitat, migration), reflections about the past concerns of mines and infrastructure on caribou, and caribou protection measures.

During the second workshop, participants agreed with established protection measures and suggested additional protection measures to ensure that caribou can be protected during the construction and operation of the Project. For example, participants reiterated that workers stay in their vehicles when wildlife are observed as getting out of the vehicle will cause animals to feel as though they are being pursued. Participants also noted that caribou are only disturbed by noise if they can see the source of the noise. Additionally, workshop participants indicated that caribou are more likely to be disturbed by a sudden, loud, and irregular noise as opposed to a constant regular noise that is not in view. TMAC's monitoring plans were also discussed during the second workshop. The detailed report on Workshop 2 is in Appendix V2-2B.

Workshop 3: August 2017

The purpose of the third workshop was to revisit, discuss, and consider the mitigation measures and monitoring that have been developed to protect caribou and other wildlife, to visit the Boston and Doris sites as well as locations along the proposed all weather road between Madrid and Boston. It was attended by five Elders and one harvester. The third workshop included presentations, group discussions, facilitated activities, and site visits to support discussions on cumulative impacts, caribou protection measures, protection measures for other wildlife, and monitoring.

The third workshop focused on confirming the results of the past workshops and to continue to develop ideas and reach consensus on risk, caribou protection measures, cumulative impacts, and caribou monitoring. TMAC hosted visits to the Doris and Boston sites and requested that Elders and land users consider what they had seen and been presented, and express their experiences and knowledge on the proposed caribou protection measures.

The workshop was brought to a close with a facilitated activity through which participants decided whether they were able to support and confirm the caribou protection measures proposed by TMAC for the Madrid-Boston Project. The group reached consensus on the workshop conclusions, with participants agreeing that TMAC's proposed caribou protection measures would keep caribou safe. A full account of the results of the third workshop is provided in Appendix V2-3C.

Information and perspectives shared by Elders and land users and the group consensus on potential impacts and risks to caribou and proposed mitigation measures are included throughout the impact assessment for caribou and other wildlife species.

9.8.1.2 Effects Evaluated in the Assessment

Elders and land users identified 18 potential impacts to caribou, which were rated by the workshop attendees in terms of the likelihood that the effect would occur (unlikely, possible, or expected) and the level of impact on caribou (Appendix V2-2A). The level of impact was defined as how many caribou the potential effect could harm (from low to high) and likely impact on the population. Potential effects on caribou and caribou habitat also considered the NIRB guidelines, informed professional judgement, experience at other similar projects in Nunavut, and the scientific literature (Section 9.6). These potential effects are summarized in Table 9.8-1. The 18 potential effects identified by Elders and land users were categorized into the seven potential effects (listed below):

- habitat loss;
- disturbance;
- disruption of movement;
- attraction;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Potential Madrid-Boston and Hope Bay Project effects were evaluated for caribou, considering season, open water vs. sea-ice periods, and mine Phase (i.e., Construction, Operation and Reclamation/Closure Phases).

Habitat loss was identified as a potential effect by the NIRB and will occur in areas where new infrastructure is constructed, including the expansion of the Roberts Bay, Doris site and TIA facilities, and the construction of the new Boston road and Boston facility. Elders and land users rated habitat loss as an expected but low impact effect (Table 9.8-1). This effect will begin during Construction and last through to Post-closure of Madrid-Boston.

Disturbance was evaluated as a potential effect (Table 9.8-1). Elders and land users identified noise from aircraft and the mine site as expected effects with the potential for a high impact on caribou without mitigation because it has the potential to affect many caribou. Elders and land users identified noise from vehicle and truck traffic as an expected effect with the potential for a medium impact on caribou without mitigation. Disturbance due to the presence of people and dust was rated as an expected, but low impact effect because it is likely to affect only a few caribou at a time. These potential effects will begin with Construction, continue through Operation and Closure, and cease in Post-closure.

Table 9.8-1. Risk Matrix of Potential Madrid-Boston Project Effects on Caribou

Level of Impact	Likelihood of Occurrence		
	Unlikely	Possible	Expected
High	Unexpected explosion (accident on surface)	All-weather road altering migration Mine infrastructure and mining activities altering migration Too much pollution (land and water) Accidents due to mis-communications during Operations (involving caribou)	Disturbance from aircraft noise Disturbance from mine site noise Increased hunting pressure
Medium		Caribou drinking tailings water	Disturbance from vehicle/ truck traffic noise Vehicle collisions with caribou
Low	Aircraft accidents (depends on location of caribou) Tailings pond dam failure/ breach		Oil or fuel spills (contamination) Disturbance due to the presence of people Too big a footprint (loss of habitat) Disturbance/ avoidance from dust Caribou running away from predators into the mine site (to avoid predators)

Elders and land users identified the potential for the all-weather road and mine infrastructure to alter caribou migration as a possible effect with a high potential to impact caribou without mitigation because it could affect many caribou (Table 9.8-1). This potential effect is evaluated from Construction through Closure when vehicles will stop traveling on Madrid-Boston roads.

The KIA expressed concern over the potential for caribou to be attracted to the TIA as a source of salt. Elders and land users identified this as a possible, medium impact effect without mitigation (Table 9.8-1). This potential effect would begin during Construction and end at Closure when the TIA is capped with quarried rock.

Elders and land users identified direct mortality due to collisions or accidents as a concern, which was rated as an expected, medium impact effect without mitigation (Table 9.8-1). Elders and land users were concerned about potential effects if caribou run onto the mine site to avoid predators where they could be subsequently injured by vehicles. This was rated as an expected, but low impact effect. Elders and land users identified accidents leading to surface explosions and aircraft accidents as unlikely occurrences, with high and low level of impact, respectively. Finally, Elders and harvesters identified accidents due to miss-communications between personnel during Operations as a possible, medium impact effect. Direct mortality is evaluated from Construction through Closure.

Increased access and harvesting was identified by the Government of Nunavut Department of Environment (GN-DoE) as a potential negative effect during the DEIS review. The perception is that this could occur by hunters using the Madrid-Boston site for logistical reasons and using the proposed road to Boston as a travel route, or by employees at the mine site alerting hunters in Cambridge Bay about the location of caribou or other wildlife. Elders and harvesters identified the potential for increased hunting pressure as an expected, high impact on caribou (Table 9.8-1). This potential effect would begin at Construction and continue into Post-Closure when personnel are no longer on site.

Changes in environmental media quality (e.g., from for dust or contaminants being deposited in the environment and altering the quality of water, soil or vegetation) was identified by the NIRB. Elders

and land users identified pollution of the land and water as a potential effect with the potential for a high impact on caribou without mitigation (Table 9.8-1). Elders and land users also identified a concern around oil and fuel spills resulting in contamination as an expected effect of the Project with a low impact on caribou. Finally, Elders and land users identified a potential tailings pond failure or breach as an unlikely, low impact effect. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Chapter 5), beginning during Construction and extending into Post-closure, and through mitigation and management of fuel, oil and the TIA dams.

9.8.2 Identification of Mitigation and Management Measures for Caribou

As part of the caribou workshops, Elders and land users visited the Doris and Boston sites during April and August, 2017, to examine the site and its potential impacts on caribou and to review the mitigation and management measures for caribou in the field. At the end of the caribou workshops, participants were asked to evaluate the mitigation measures. Elders and land users made a series of suggested additions, and came to consensus on their effectiveness using the following statements:

> *"Mitigation for the existing Doris Project protects caribou."*

and

> *"[With the planned mitigation and monitoring] the risk to caribou associated with Phase 2 are acceptable."*

The following section provides an overview of mitigation measures. The details of the mitigation measures, the outcomes of these workshops, and the workshop conclusions are discussed in detail in Section 9.8.3, where each potential impact on caribou is discussed.

The caribou protection measures proposed by caribou workshop participants are listed in Table 9.8-2, along with TMAC's current mitigation and management plans to demonstrate that each of the proposed management measures are addressed by TMAC. Suggestions made by workshop participants during the second and third caribou workshops are included at the end of Table 9.8-2.

Mitigation applicable to all wildlife species are discussed in Section 9.7. The following sections describe the mitigation and management conducted by TMAC to address potential impacts to caribou, including:

- steps to follow the mitigation hierarchy;
- best management practices; and,
- management for each of the seven potential impacts to caribou.

9.8.2.1 The Mitigation Hierarchy – Avoid, Minimize, Reclamation

The mitigation hierarchy starts with avoidance of potential effects, followed by minimization and reclamation where warranted.

Avoidance

The Hope Bay Project avoids sensitive areas for wildlife. During the planning phase for the Madrid-Boston Project, an environmental sensitivities map was produced that highlighted sensitive environmental features including archaeology sites, fisheries streams, carnivore dens, raptor dens, and special landscape features such as wetlands and eskers that are important habitats for caribou. This map was provided to engineers, who designed the infrastructure such that the Boston road, quarries, pads, laydowns, water pipes, and wind towers avoid sensitive wildlife features. More information on the wildlife sensitivity mapping is available in the Project Description (Volume 3, Chapter 2).

Table 9.8-2. List of Identified Potential Madrid-Boston Effects on Caribou, Protection Measures Identified during the Three Caribou Workshops, and Protection Measures Committed to by TMAC

Mitigation measures proposed during the first caribou workshop			
Level of Impact	**Effect**	**Proposed Protection Measure Identified by Working Group**	**Protection Measure Committed to by TMAC**
	Expected Effects		
High	• Disturbance from aircraft noise	• Use designated flight paths • Raise flight altitude/distance when disturbance of caribou is observed (in addition to minimum distances) • Limit helicopter use during migration • Minimize activity around site during hunting season	Effects of aircraft noise on caribou will be minimized through: • Pilot education to avoid high value areas for caribou such as freshwater crossings by using designated flight paths, • Pilots will maintain 300 m vertically and 600 m horizontally in all seasons away from caribou when safe to do so, • Pilots will maintain 610 m vertically and 600 m horizontally in the calving range during the calving season away from caribou when safe to do so, • Pilots will be limited from approaching caribou in all seasons, not just migration, and • Personnel will be restricted to the Project Development Area unless conducting remote work for the Project.
	• Disturbance from mine site noise	• Limit noise during migration • Limit road activity during migration • Minimize activity around site during hunting season • Limit road use for operation purposes only (no worker "sight-seeing")	Effects of mine site noise on caribou will be limited by: • maintaining equipment to reduce noise, • quarry blasting setbacks for caribou, and • these measures will apply year-round, not just during migration. Effects of the road on migration will be minimized by: • installing crossing ramps on the road at migration corridors identified by Elders, • speed limit of 50 km/h to limit noise and dust from vehicles, • observations of wildlife will be sent to the environment department and disseminated to all drivers, and • vehicles will give caribou the right of way, • the road will only be used for Project activities, no "sight-seeing".
	• Increased hunting pressure	• Increase the size of the "no hunting" zone around the mine site (and communicate to HTOs) • Restrict access to roads by hunters	Minimizing increased access and increased harvest will be accomplished by: • roads will be closed to the public, and • a no hunting policy while personnel are on site, and • note that the *Nunavut Wildlife Act* specifies a 1 km no hunting zone around residences and structures. Only the Nunavut government can expand this area.
Medium	• Disturbance from vehicle/ truck traffic noise	• Enforce speed limit • Establish minimum distance allowed between vehicles	Disturbance from vehicles minimized by: • speed limits will be set to a maximum of 50 km/h and enforced, • observations of wildlife will be sent to the environment department and caribou locations will be disseminated to all drivers, and • wildlife will be given the right of way on all Project roads.

Mitigation measures proposed during the first caribou workshop			
Level of Impact	**Effect**	**Proposed Protection Measure Identified by Working Group**	**Protection Measure Committed to by TMAC**
	• Vehicle collisions with caribou	• Enforce speed limit	Vehicle collisions with caribou will be minimized by: • speed limits will be set to a maximum of 50 km/h and enforced, • observations of wildlife will be sent to the environment department and caribou locations will be disseminated to all drivers, and • wildlife will be given the right of way on all Project roads.
Low	• Oil or fuel spills (contamination)	• Quick response to spills	Response to spills will be managed by: • the Spill Contingency Plan (SCP) is designed to protect worker and public safety and minimize any effects of a spill on the environment, and • the Oil Pollution Prevention/ Oil Pollution Emergency Plan; (OPEP) describes the response to oil spills at the Roberts Bay facility.
	• Disturbance due to the presence of people	• None suggested	Disturbance by the presence of people will be minimized by: • personnel will be restricted to the Project Development Area unless conducting remote work for the Project.
	• Too big a footprint (loss of habitat)	• None suggested	The size of the footprint will be managed by: • the footprint will be minimized through Project design, and • the size of the footprint will be reported.
	• Disturbance/ avoidance from dust	• Control dust on roads (speed limits, dust control)	Dust will be controlled by: • speed limits will be set to a maximum of 50 km/h and enforced, • dust suppressants will be used on Project roads.
	• Caribou running away from predators into the mine site (to avoid predators)	• None suggested	Should caribou enter the Project site, they will be protected by: • caribou observations will be reported and caribou locations will be disseminated to Project personnel and drivers, • speed limits will be set to a maximum of 50 km/h and enforced, • caribou will be given the right of way on all Project roads, • camps and facilities will be kept clean so there are no materials that can entangle caribou, and • buildings and structures will be wildlife-proof so caribou cannot become entrapped.

Mitigation measures proposed during the first caribou workshop			
Level of Impact	**Effect**	**Proposed Protection Measure Identified by Working Group**	**Protection Measure Committed to by TMAC**
	Possible Effects		
	• All-weather road altering migration	• Monitoring of roads during migration • Monitoring of caribou movements near roads and use of crossings • Road crossing built for caribou (located where caribou are known to cross)	Effects of the all-weather road on migration will be minimized by: • building road crossing structures at migration corridors identified by Elders, • the roads will be monitored during migration, observations of caribou will be reported, and • crossing will be monitored using facilities monitoring cameras.
	• Mine infrastructure and mining activities altering migration	• Monitoring of caribou movements	Caribou will be monitored at site: • prior to blasting in quarries to determine that no caribou are nearby and that blasting can proceed, and • along Project roads during migration.
	• Too much pollution (land and water)	• Pollution management	Pollution will be managed by: • the Spill Contingency Plan (SCP) is designed to protect worker and public safety and minimize any effects of a spill on the environment, • the Oil Pollution Prevention/ Oil Pollution Emergency Plan; (OPEP) describes the response to oil spills at the Roberts Bay facility, • dust will be managed using dust suppressants on roads and monitored, • water pollution will be managed through the ML ARD Management, and Site Water Monitoring and Management to meet discharge criteria set in the Project Water Licence, • Water quality will be monitored through the Aquatic Effects Monitoring Program, and • pollution from garbage and wastes will be managed through Landfill and Waste Management plan.
	• Accidents due to miscommunications during operations (involving caribou)	• None suggested	Communications about caribou will be maintained by: • communicating site notifications when caribou are likely to be in the Project area, • communicating site alerts via radio, signage and at morning safety meetings when caribou have been observed near site, and • all observations of caribou will be reported to the ESR department in a timely manner.

Mitigation measures proposed during the first caribou workshop			
Level of Impact	**Effect**	**Proposed Protection Measure Identified by Working Group**	**Protection Measure Committed to by TMAC**
	• Caribou drinking contaminated tailings water	• Full-time monitoring of tailings area for caribou during migration • Regular sampling of water quality in tailings area • Fencing of tailings • Installation of Inuksuk to direct caribou away	Effects from caribou drinking water in the TIA will be minimized by: • monitoring water quality in the TIA through the Aquatic Effects Monitoring Program, • monitoring of the TIA for caribou usage, • exclusion of caribou if water does not meet wildlife guidelines, and • Elders will be consulted on the best placement and usage of Inuksuk to exclude/guide caribou away from the TIA.
	Unlikely Effects		
	• Unexpected explosion (accident on surface)	• None suggested	Explosives management plans will be followed to ensure the safe storage, transport, use and cleanup of explosives for worker and wildlife safety, including: • the Northwest Territories / Nunavut Mine Health and Safety Act and Regulations, • the Quarry Management and Monitoring Plan design criteria such that explosives are safely stored and handled.
	• Aircraft accidents (depends on location of caribou)	• None suggested	Accidents involving aircraft and caribou will be minimized by: • surveying the airstrip prior to takeoffs and landings, and • excluding caribou from the airstrip for their safety.
	• Tailings pond dam failure/ breach	• None suggested	Accidents that could result in the tailings pond/dam failure will be minimized by: • the dam will be designed, maintained and monitored in compliance with the Canadian Dam Safety Standards.
Additional mitigation suggestions made during the Second and Third caribou workshops			
	• Disturbance	• Drivers should stay in their vehicles if they see a caribou.	TMAC agreed with these suggestions and added them to the WMMP.
	• Disruption of Movement	• Elders and land users should direct the placement of road crossing structures in the field.	TMAC agreed with these suggestions and added them to the WMMP.
	• Environmental Media Quality	• If caribou are found to be drinking water from the TIA, then Elders and land users should direct the placement of Inuksuit in the field to direct caribou away from the TIA.	TMAC agreed with these suggestions and added them to the WMMP.
	• Continued Consultation	• Elders and land users should continue to be engaged through the Inuit Environmental Advisory Committee.	TMAC agreed with these suggestions and added them to the WMMP.

Minimize

The Hope Bay Project minimizes potential effects to caribou through Project design, including:

- minimizing the Madrid-Boston footprint;
- clumping infrastructure into a few consolidated footprints;
- minimizing the height of the Boston road and including caribou crossing structures to facilitate caribou movement over the road bed; and
- maintaining equipment to minimize noise that may disturb wildlife.

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding of wildlife;
- open water sea lifts will conform to all applicable laws and regulations;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil and shipboard pollution plans, spill contingency plan and hazardous waste management.

Reclamation

Areas which are no longer needed to carry out Madrid-Boston Project activities will be progressively reclaimed during Construction and Operation. Where practicable, progressive reclamation will be used to achieve the site abandonment goal and closure principles (Volume 3, Chapter 5).

At Reclamation and Closure, all sites will be deactivated and reclaimed in the following manner (Volume 3, Chapter 5):

- Camps and associated infrastructure will be demolished and/or disposed of in approved non-hazardous site landfills.
- Non-hazardous landfills will be progressively covered with quarry rock, as cells are completed. At final closure, the facility will receive a final quarry rock cover which will ensure physical and geotechnical stability.
- Rockfill pads occupied by construction camps and associated infrastructure and laydown areas will be re-graded to ensure physical and geotechnical stability and promote free-drainage, and any obstructed drainage patterns will be re-established.
- Quarries no longer required will be made physically and geotechnically stable by scaling high walls and constructing barrier berms upstream of the high walls.
- Landfarms will be closed by removing and disposing of the liner, and re-grading the berms to ensure the area is physically and geotechnically stable.
- Mine waste rock will be used as structural mine backfill.
- The Doris TIA surface will be covered quarried rock. Once the water quality in the reclaim pond has reached the required discharge criteria, the North Dam will be breached and the flow returned to Doris Creek.

- The Madrid to Boston All-Weather Road and Boston Airstrip will remain in place after Reclamation and Closure. Peripheral equipment will be removed. Where rock drains, culverts, or bridges have been installed, the roadway or airstrip will be breached and the element removed. The breached opening will be sloped and armoured with rock to ensure that natural drainage can pass without the need for long-term maintenance.
- A low permeability cover, including a geomembrane, will be placed over the Boston TMA. The contact water containment berms will be breached and the liner will be cut to prevent any water collecting. The balance of the berms will be left in place to prevent localised permafrost degradation.

9.8.2.2 Mitigation Measures to Address Potential Impacts on Caribou

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- the Project was designed to avoid important habitats for a variety of species, including caribou habitat, raptor nests, carnivore dens, wetlands and special landscape features (eskers);
- minimize disturbance to vegetation communities;
- infrastructure will avoid sensitive caribou habitats such as water crossings, where possible; and
- minimize the size of the Project footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on caribou includes:

- construct and maintain equipment to minimize the production of noise – Volume 4, Chapter 3;
- monitor and adaptively manage noise – Volume 4, Chapter 3;
- pilot education about the potentially adverse effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed;
- management of equipment and activities to minimize disturbance to caribou (Table 9.8-3);
- as suggested by caribou workshop participants during the second caribou workshop, if drivers observe caribou and stop their vehicles, they will remain in the vehicles to avoid disturbing caribou;
- fixed wing aircraft will keep a minimum height above ground of 610 m except when landing and taking off;
- take-offs and landings of fixed wing aircraft will be suspended when caribou are on or within 250 m of the airstrip;
- helicopters will keep a minimum separation from caribou of 300 m vertically or 600 m horizontally;
- blasting will be halted when caribou are within 2.8 km of quarries or other blasting locations (rock cuts); and
- should an analysis of the Beverly/Ahiak caribou range indicate that the calving or post-calving range of that herd overlap the Project site, then additional mitigation and management would be conducted to limit disturbance to caribou, replacing the measures in Table 9.8-3 with the enhanced measures listed in Table 9.8-4.

Table 9.8-3. Caribou-specific Protection Measures during All Seasons

Activity/ Location	Monitoring Method	Trigger		Mitigation
		# of Animals	Distance	
1) Project Site	All personnel	1+ animals	Visible from footprint areas	1. Environment Department notified. 2. Environment Manager informs personnel who need to be aware of caribou – drivers.
2) On-site roads	Drivers	1+ animals	On or within 500 m of the road	1. Ongoing Mitigation • Speed limits of 50 km/hr or less • Wildlife is given the right of way and drivers stay in vehicles if stopped • Signs posted indicating wildlife has right of way 2. Environment Department notified. 3. Environment Manager informs personnel who need to be aware of caribou – drivers. 4. Drivers evaluate distance from the road and caribou behaviour and react following the Driver Flow Chart (Section 9.8.3.3; Figure 9.8-23)
3) Quarry blasting	Pre-blast checks	1+ animals	Line of sight to 2.8 km	1. Cessation of blasting until animals move >2.8 km from quarry or the line of sight from the quarry high point, whichever is closer.
4) Helicopter	Pilots	1+ animals	300 m	1. Helicopter flights avoid animals by as large a margin as possible, with a minimum of 300 m vertically and 600 m horizontally when safe to do so.
5) Airstrip	Air traffic personnel	1+ animals	250 m	1. In the case of caribou near the airstrip(s), observations are performed. If the risk of interaction with a plane exists, then flights will be held. If caribou remain in the area, then procedures for moving them off the runway are followed. 2. GN-DoE are contacted for guidance when unusual situations arise not covered by established procedures, to ensure an agreed course of action is undertaken incorporating animal welfare as a prime objective.
6) Regional monitoring	Helicopter pilots and field personnel	Groups of caribou	15 km	1. Environment Department notified; 2. Environment Manager informs personnel who need to be aware of caribou – drivers and pilots.

Table 9.8-4. Additional Caribou-specific Protection Measures during the Calving Period (June 5 to June 20) should the Calving Range Overlap the Project Site

Activity/Location	Monitoring Method	Trigger		Mitigation
		# of Animals	Distance	
1) Project Site	Site staff (incidental observations)	3-50 ♀ with calves	Visible from footprint areas	1. Environment Department notified; 2. Environment Manager informs personnel who need to be aware of caribou – drivers and pilots; 2. Stop heavy mobile equipment traffic within 250 m of the observed caribou, except at plant site; 3. Traffic to proceed slowly (<20 km/hr).
		>50 ♀ with calves	Visible from footprint areas (<2 km)	1. Actions above, plus 2. Wildlife monitors to conduct periodic site monitoring to evaluate if caribou are still in the area and when activities can resume.
2) Quarry blasting	Pre-blast checks	1+ ♀ with calve(s)	Line of sight from quarry to 4 km	1. Cessation of blasting until animals move >4 km from quarry or the line of sight from the quarry high point, whichever is closer; 2. Monitoring of caribou behaviour in response to quarry blasting if safe to do so.
3) Helicopters	Pilots	1+ animals	calving range	1. Helicopter flights will avoid animals by as large a margin as possible, with a minimum of 610 m vertically and 600 m horizontally when safe to do so.
4) Regional monitoring	Helicopter pilots and field personnel	1+ ♀	calving range	1. Environment Department notified; 2. Environment Manager informs personnel who need to be aware of caribou – drivers and pilots. 3. Helicopters will avoid caribou to the extent possible, and by a minimum of 610 m vertically and 600 m horizontally when safe to do so.
		1+ ♀ with calve(s)	15 km from site	
	Collar reports*	Any	-	1. Environment Department notified; 2. Environment Manager informs personnel who need to be aware of caribou – drivers and pilots.
		Any	-	

**a total of 50 animals observed at once is used as a guide to indicate that an aggregation of caribou have been observed.*
***collar reports will supplement other mitigation responses, if available and provided on a frequent enough basis to be useful for this purpose. Distances for actions related to data from collar reports will depend on frequency of data dissemination to TMAC.*

Mitigation for Disruption to Movement

Mitigation and management to reduce the potential for disruption of movement to caribou include:

- Sealift resupply in open water avoids potential interaction with the Island caribou migration between the mainland and Victoria Island and in Melville Sound.
- Roads will be constructed with as low a road height as possible.
- Snow management on roads will occur for efficiency and safety of operations.
- Caribou will be given the right of way on all Project roads should caribou be observed on or near the road.
- As suggested by caribou workshop participants during the second caribou workshop, Elders and land users will select the locations where caribou crossing structures will be installed on roads.
- A speed limit of 50 kph on roads will reduce noise disturbance and avoidance of the road, and road crossing by caribou.
- Extra vigilance along the all-weather road during times of migration to ensure that caribou can travel to key seasonal habitats.

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for caribou include:

- A speed limit of 50 kph on all Project roads;
- Caribou and other wildlife will be given the right-of-way on all roads;
- Clean Project sites will be maintained, where any equipment or materials that could entangle or entrap wildlife are safely stored;
- As suggested during the second caribou workshop, all sea can doors will be kept closed when not being accessed to prevent access to materials and entanglement risk; and
- Survey the airstrip prior to aircraft landing or departure to ensure there are no caribou within 250 m that may be disturbed and/or run on to the runway.
- If caribou are residing on or within 250 m of the airstrip and do not move off on their own, then a hierarchy of progressive procedures for safely directing animals away from hazardous areas (e.g., camps and airstrip), and bears from the mine site will be implemented in consultation with the GN Wildlife (SOP Bear Notification & Responses) by the Wildlife Response Team (WRT).

Mitigation for Increased Access and Harvest

Mitigation and management to reduce the potential for increased access and harvest of caribou include:

- no connection of all-weather roads to any communities;
- all Project roads closed to the public;
- a policy prohibiting hunting by Project staff and contractors while on site;
- when caribou are observed on or near the Project site, the Environment Manager will be notified, who will in turn notify employees that need to know (drivers, pilots) but will not broadcast the information to all employees; and

- by law (*Nunavut Wildlife Act*, Section 11.(2)(f); 2003), nobody can hunt within 1.6 km of Project infrastructure.

Mitigation for Attraction

Mitigation and management to reduce the potential for caribou to be attracted to the Project include:

- All buildings will be wildlife-proof.
- Implement a policy of no wildlife feeding.
- Monitor reclaimed water quality at the TIA and exclude caribou if caribou are drinking the water.
- Consider the use of inuksuit to deter caribou from the TIA in consultation with the IEAC if caribou are observed drinking the water and the water does not meet wildlife guidelines.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of caribou to altered environmental media include:

- The use of fuels and hazardous chemicals are managed as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, Annex V1-7, Package P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15).
- Water quality is managed through the Water Management Plans: Hope Bay Project Doris-Madrid Water Management Plan (P4-7), Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18).
- Dust and air quality is managed through the Air Quality Management Plan (V8-2).
- Fuels and chemicals are stored in wildlife-proof buildings.
- Cyanide destruction inside the mill.
- With approval from the local Conservation Officer to ensure compliance with the *Nunavut Wildlife Act*, use measures to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.8.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for caribou were discussed with Elders and land users during the second and third caribou workshops in April and August, 2017. Proposed monitoring to determine potential effects on caribou were discussed as well as monitoring activities used to trigger mitigation measures. Elders and land users agreed that these monitoring measures should continue.

Workshop participants also listed additional monitoring activities that they would like to see for caribou, such as weather monitoring, vegetation monitoring, and water quality monitoring (Table 9.8-5). These monitoring programs already exist for the Project, but are described as separate monitoring plans in the DEIS.

An overview of monitoring activities proposed by Elders and land users for caribou and where they can be found in the FEIS are summarized in Table 9.8-5. Each of these plans is an extension of the existing monitoring programs for the Doris Project.

Table 9.8-5. Monitoring for Caribou Proposed for the Project

Topic Area Identified by Caribou Workshop Participants	Monitoring Program
Weather	Elders and land users requested that monitoring for caribou include monitoring for weather to look at extreme weather events, including: • frequent weather changes, and • seasonal thaws/freezing periods. **1. Weather Monitoring Program** TMAC operates their two standard weather stations all year round (Doris and Boston), and operates a micro met station in Doris lake during the summer used for calculating lake evaporation. The Doris station (close to the active camp) measures all standard meteorological parameters and the Boston station measures most of the standard meteorological parameters, including: • wind speed and direction (10 m height); • air temperature and relative humidity; • solar radiation; • total precipitation; and • barometric pressure. These data are used to track average weather and extreme weather events.
Noise	Elders and land users agreed that noise monitoring should be continued for the Project. **1. Noise Monitoring Program** Noise monitoring will be conducted at least once per Project phase; construction, operations and closure during spring and summer. Spring sampling will correspond to the northern migration of the Dolphin and Union herd and to nesting by raptors and emergence from dens by bears. Summer sampling will correspond to nesting and rearing periods for wildlife in the Project area. Sampling will be conducted at a variety of distances from the Project to capture potential effects on wildlife, including <1 km, 1 km, >2 km, 5 km, 12 km, and 15 km.
Water Quality	Elders and land users requested that monitoring for caribou include monitoring for water quality, including: • water quality in the development area, • monitoring rivers from lakes with fish close to mine site, and • water quality in the TIA. **1. Aquatic Effects Monitoring Plan (AEMP)** The AEMP (Package P4-18) outlines the Aquatic Effects Monitoring Program that will be carried out during all phases of the Project. The AEMP will include the following: • monitoring the freshwater environment at locations potentially affected by the Project and at reference areas well away from Project activities; • monitoring freshwater water quality, sediment quality, and aquatic biology. **2. Marine Environmental Effects Monitoring (EEM) Program** The EEM established under the Metal Mining Effluent Regulations (MMER) outlines the monitoring program in the marine environment that will be carried out during all phases of the Project. The Marine EEM Program will include the following: • monitoring the marine environment at locations potentially affected by the Project and at reference areas well away from Project activities; • monitoring marine water quality, sediment quality, and aquatic biology.

Topic Area Identified by Caribou Workshop Participants	Monitoring Program
Soil and Vegetation Quality	Elders and land users requested that monitoring for caribou include monitoring for changes to soils and caribou food due to dust deposition: • effects of dust on soil quality, • what caribou is feeding on, vegetation growth, and food quality and quantity. **1. Air Quality Monitoring Program (AQMP)** The most accurate way to measure the amount of dust deposition and its effects on soil and vegetation is to measure dust directly. Dust monitoring will be conducted as part of the AQMP during construction and operations, including: • summer dust fall measurements at six locations upwind and downwind of the Project; • winter snow core measurements at the same locations; and • air quality monitoring of suspended particles at one location near Doris Mountain during Construction and Operations. **2. Vegetation Monitoring** TMAC will be monitoring dust deposition and water quality during the life of the Project. As requested by the KIA during the technical review of the Phase 2 DEIS, TMAC will collect and analyse 15 composite sedge samples in 2018 to derive baseline metal composition in sedges. In the future, based on dust deposition and water quality measurements, TMAC will consider future monitoring of sedge samples in consultation with the KIA. Future monitoring would evaluate to what degree, metals from dust deposition and water are accumulating in sedges.
Caribou	Caribou monitoring will evaluate the predicted effects of the Hope Bay Project on caribou and help guide mitigation and management of the Project. Elders and land users requested that monitoring be conducted for: • population of caribou, • presence in Project area, • number of caribou sightings by people in camps, and • Whether caribou drink water from the TIA. The caribou monitoring program is described in the *Hope Bay Project Wildlife Mitigation and Monitoring Plan* (WMMP; V8-3) and includes the following monitoring activities: **1. Monitoring the population of caribou** Population monitoring for caribou is the responsibility of the Government of Nunavut (GN), who conducts periodic population surveys and tracks caribou movement using satellite collars. As part of the Doris Project, the regional population of caribou was monitored using aerial surveys. Following discussions with the GN and KIA, aerial surveys were ceased after 2010 and instead the Project entered into a Memorandum of Understanding (MOU) to provide financial support to the GN to conduct regional, herd scale monitoring. To date, TMAC has contributed funds and logistical support (accommodations at Doris) to support the caribou collaring program. **2. Monitoring if caribou avoid the Project (zone of influence) using cameras** Starting in 2011, the Project monitored for whether caribou are avoiding the Doris Project using motion-triggered wildlife cameras. This program was re-designed and updated in collaboration with the GN and KIA in February, 2016. Future monitoring includes extending this program to the Madrid and Boston sites. **3. Monitoring if caribou avoid crossing the Boston road** During the DEIS review, the GN requested that TMAC conduct an analysis of collar data to determine if caribou are avoiding crossing Project roads. This analysis will be conducted following construction of the Boston road for the Project.

Topic Area Identified by Caribou Workshop Participants	Monitoring Program
	During spring and fall migration, when data indicates that the majority of road crossing events occur, TMAC will conduct additional monitoring to evaluate if caribou are near the road and guide mitigation. TMAC will continue to engage with the IEAC to identify locations where caribou are more likely to cross the Boston road. During migration, TMAC will conduct height of land surveys during spring and fall migration to examine if caribou are present up to 4 km from the road (the expected maximum sighting distance from hill tops). Survey methods will be refined with the IEAC prior to construction. Surveys will examine 1) if caribou are present, 2) caribou reactions to vehicles, 3) compliance with road rules to stop when caribou are near the road. Should height-of-land surveys determine that caribou are turning around and moving away from the road, then TMAC will work with the IEAC to evaluate if the design and execution of snow track surveys is required and or acceptable to monitor caribou tracks as they approach the road. The survey transects and complete study design would be developed in consultation with the GN and IEAC. Results of the survey would be used to evaluate if and what kind of mitigation may be required for traffic on the AWR. **4. Monitoring and reporting the size of the Project footprint** The area of habitat loss for caribou is described in Section 9.8.3.1 of the FEIS within the Project Development Area (PDA), which is the Project footprint plus a buffer area. The area of the constructed footprint will be measured in each year of Construction and Operations and reported every three years in the WMMP report. **5. Reporting wildlife observations in the Project area** All Project personnel are required to report incidental observations of wildlife. These observations are collected and reported each year for the Doris Project in the WMMP report. This monitoring and reporting will continue for Madrid-Boston. Observations of caribou near the camp areas and in the laydown areas are also made using wildlife cameras placed in all major infrastructure locations and reported in the WMMP report. These observations of caribou are used to trigger mitigation. Should vehicle drivers observe caribou (or other wildlife) on the all season road then they give the animal the right of way and allow them to cross or exit the road. Likewise, if helicopter pilots observed caribou, then they avoid those caribou (Section 9.8.2.2). **6. Reporting wildlife incidents** All Project personnel are required to report any wildlife incidents or mortalities. These observations are reported immediately to the GN and KIA and collected and reported in the annual WMMP report. This monitoring and reporting will continue for Madrid-Boston. Should a wildlife incident occur, then TMAC conducts an investigation into the cause and adaptively manages Project activities to reduce the chance of a similar incident occurring in the future. **7. Caribou use of the Tailings Impoundment Area** During the review of the Doris North Type A water licence in April, 2016, the KIA requested monitoring and mitigation should caribou be attracted to the TIA. TMAC will monitor the TIA area using wildlife cameras and by recording incidental observations of caribou. If caribou are using the area, then TMAC will use inuksuit to dissuade caribou from the TIA. Elders and land users indicated that they would like to be involved in setting up the inuksuit and TMAC agreed to have Elders and land users lead the installation of Inuksuit. **8. Local-area scans prior to blasting** Prior to blasting in Project quarries and as part of road construction, the blasting manager conducts a series of local-area scans for personnel and wildlife to ensure their safety during the blast. Should any caribou be observed within 2.8 km of the Project site, then the blast is held off until caribou leave the area.

Topic Area Identified by Caribou Workshop Participants	Monitoring Program
Harvest	Elders and land users requested that monitoring for caribou include monitoring for harvesters, including: • hunters from communities. **1. Incidental Observations** As part of the Wildlife Mitigation and Monitoring Plan (WMMP; V8-3) incidental observations of harvesters on the land will be reported to the Environment Manager, along with a record of harvesters who have stopped at the camps to visit or for emergencies. This information will be reported to the KIA and GN.
Predators	Elders and land users requested that monitoring for caribou include monitoring for predators, including: • bears, • predation events, and • the number of predators. Overall, the monitoring of predator populations is the responsibility of the GN. TMAC monitors for predators in the Project area as described in the *Hope Bay Project Wildlife Mitigation and Monitoring Plan* (WMMP; V8-3) and includes the following monitoring activities: **1. Monitoring with Wildlife Cameras** Starting in 2011, monitoring the area surrounding the Doris Project has occurred through the use of motion-triggered cameras. This program was re-designed and updated in collaboration with the GN and KIA in February, 2016. This monitoring records the number of predators such as bears and wolves in the Project area and whether these animals are attracted to or avoid the Project site. Future monitoring includes extending this program to the Madrid and Boston sites. Cameras are also used to monitor whether predators are attracted to the Project camps and the waste management facility. **2. Reporting wildlife observations in the Project area** All Project personnel are required to report incidental observations of wildlife including bears and wolves and any predation events. These observations are collected and reported in each year for the Doris Project in the WMMP report. This monitoring and reporting will continue for Madrid-Boston.

9.8.2.4 Herd Management Plans

There are four management plans for caribou that could apply to the Project area. Based on areas of importance identified in those plans, it is apparent that the Project is located outside of key areas for caribou, or that mitigation and management conducted at the Doris Project and included in the Madrid-Boston FEIS will address management concerns in plans. The four plans and how TMAC is addressing issues in those plans are discussed below for:

1. the KIA Mobile Caribou Protection Measures,
2. the Draft Dolphin and Union Caribou Management Plan,
3. the Beverly Qamanirjuaq Caribou Management Plan, and
4. the 2016 Draft Nunavut Land Use Plan.

Kitikmeot Inuit Association Mobile Caribou Protection Measures

On May 5, 2016, the KIA Board adopted a resolution to support its initiative for mobile caribou protection measures, stating:

> *i) Support for reasonable mobile protection measures for concentrations of caribou, including calving caribou, where they may be, irrespective of the season;*
>
> *ii) KIA commitment to lobby responsible agencies and proponents to bolster their investments in caribou monitoring, information sharing, and enforcement in order to ensure caribou are appropriately protected; and*
>
> *iii) Support for the development of research initiatives geared to identifying adaptive management approaches that allow for the co-existence of caribou and development in the Kitikmeot Region.*

The Hope Bay Project will meet these mobile caribou protection measures resolutions by doing the following:

- Implementing the WMMP that provides reasonable measures for protection and monitoring of caribou, triggering actions for where and when caribou are within the Project area. The WMMP is applied year round, and includes modifying operational activities such as quarry blasting, vehicles on the all-weather road, helicopters and fixed wing aircraft when caribou are nearby.
- Engage with Inuit Elders and land users, through regular involvement of the IEAC on monitoring programs, and specific to this project caribou risk assessment workshops. Workshop participants agreed that this monitoring program was sufficient for protection of caribou.
- Engage with responsible agencies, including working with the KIA and the GN-DOE through the NIRB Environmental Assessment process to review and where necessary adjust mitigation and monitoring for caribou to avoid serious and irreversible harm to caribou.
- Supporting research initiatives for caribou, including:
  - Support for GN DOE caribou research through a Memorandum of Understanding. TMAC has contributed towards the purchase of satellite collars for Dolphin and Union caribou and provided in-kind support to install the collars, including camp space and helicopter fuel.
  - Supporting basic research being conducted through Polar Knowledge Canada.

The Dolphin and Union Management Plan

The *Management Plan for the Barren-ground Caribou (Rangifer tarandus groenlandicus), Dolphin and Union population, in Canada* (Environment and Climate Change Canada 2017a) was developed in response to the Island caribou being listed designated as Special Concern under the federal *Species at Risk Act*. Threats were evaluated following an international standard approach (IUCN) by local communities, organizations and government agencies in a meeting in Kugluktuk (March 2016) and a follow-up meeting in Cambridge Bay (January 2016). Mining and roads are identified as low impact activities for the herd, sixth and seventh in importance after changes to sea ice and predation (both rated with high impact), harvest, parasites and disease, climate change, and icing events (rated medium to low impact).

1. Changes to sea ice affecting migration
   - IUCN Threat #4.3 Shipping Lanes (High Impact)

Increased ice-breaking marine traffic in the Northwest Passage has the potential to block caribou movements or result in more drownings during their seasonal migration between Victoria Island and the mainland.

- IUCN Threat #11.1 Habitat Shifting and Alteration (Medium - Low Impact)

  Climate change is leading to longer open-water seasons and thinner ice during fall migration, which has the potential to block caribou movements or result in more drownings.

2. Predation and competition
   - IUCN Threat #8.2 Problematic Native Species (High - Low Impact)

     Communities indicate that predation from wolves has increased over the last 10-20 years and until recently Inuit actively controlled the numbers of wolves. Community members and GN biologists have reported more wolves on Banks and Victoria islands. Community members also report that bald eagles, a predator of calves, are increasing.

     TK holders identified muskox as a source of food and land competition for caribou.

     Research indicates that snow geese, Ross's geese and greater white-fronted geese have increased substantially and are altering the forage availability in the Queen Maud Gulf area, which may alter winter forage for caribou.

3. Harvest
   - IUCN Threat #5.1 Hunting and Collecting (Medium – Low Impact)

     Some committee members felt that harvest should be rated as high-low impact due to uncertainty in the current harvest levels, while others argued that it should be medium-low because the herd is largely inaccessible to harvesters.

4. Parasites, diseases and insect harassment
   - IUCN Threat #8.1 Invasive Non-native* Alien Species (Medium - Low Impact)

     Committee members felt that parasites, disease and insect harassment pose a moderate threat due to climate change and warmer temperatures which can allow the introduction of new diseases or parasites. Communities have reported an increase in diseased caribou.

5. Other habitat changes due to climate change
   - IUCN Threat #11.1 Habitat Shifting and Alteration (Medium - Low Impact)

     Increased temperatures are leading to increased vegetation growth and diversity, but effects of vegetation change on caribou are complex and not clearly understood.

6. Icing events
   - IUCN Threat #11.4 Storms and Flooding (Medium – Low impact)

     Icing events caused by freezing rain or freeze-thaw events, appear to be more common, making it more difficult for caribou to crater and reach their food in winter.

7. Mining
   - IUCN Threat #3.2 Mining and Quarrying (not including roads) (Low Impact)

     The effect of mines was rated as low, but there were concerns over habitat loss, caribou being displaced from their winter range, and increased access for hunting.

8. Roads
    - IUCN Threat #4.1 Roads and Railroads (Low Impact)

      Roads were identified as having a small effect on caribou, but there was concern over the Gray's Bay all season road and the [former] TMAC winter road between Cambridge Bay and Doris[1] interrupting caribou movement and increasing hunter access.
9. Flights
    - IUCN Threat #4.4 Flight Paths – Scheduled Flights (Low Impact)

      The committee determined that flights at high elevation were unlikely to disturb caribou if there were at high elevation, except when landing and taking off.
    - IUCN Threat #6.3 Work and Other Activities (Negligible Impact)

      Low level flights may disturb caribou, particularly during the calving season, in calving areas.
10. Other threats

      The committee determined that several other threats would have "unknown, negligible or no direct effect" on caribou, including airborne pollutants, recreation activities, house and urban areas, utilities, solid wastes, oil and gas drilling and war//civil unrest.

The management plan identifies five management objectives, which TMAC is contributing to and meeting.

Objective 1: Adaptively co-manage Dolphin and Union Caribou using a community-based approach.

- Although TMAC has no authority for caribou management, TMAC works closely with the communities through the IEAC, and has engaged Elders and land users through the caribou workshops to examine community concerns about Island caribou. This information was included in the FEIS and follow-up activities and adaptive responses to unexpected impacts in the WMMP.

Objective 2: Communicate and exchange information on an ongoing basis between parties using a collaborative and coordinated approach.

- TMAC is committed to continuing a two-way sharing of information with communities through the IEAC and directly with the KIA. TMAC is obligated to provide annual reports that include information on impacts on caribou to the NIRB. All reporting is coordinated to report on similar topics on a timely basis to allow for additional adaptive responses should they be necessary to avoid serious or irreversible harm to caribou.

Objective 3: Collect information to fill knowledge gaps on Dolphin and Union Caribou using IQ and TK, community monitoring and scientific methods.

- TMAC works with the GN DOE through a Memorandum of Understanding to conduct scientific research and exchange information on caribou. TMAC funds the purchase of GPS satellite collars for Island caribou and provides support in the form of camp accommodations and fuel for GN DOE to put the collars on caribou. That research initiative can be reviewed on a regular basis to address changing information needs about Project effects.

Objective 4: Minimize disturbance to habitat (particularly sea ice crossings) to maintain the ability of Dolphin and Union Caribou to move freely across their range.

- TMAC has voluntarily committed to conducting Project sea lifts during the open water season to avoid impacts to ice crossings, including early season ice that does not qualify as ice-breaking.

Objective 5: Ensure management is based on population status so future generations can benefit from sustainable harvesting opportunities.

- TMAC does not have authority to manage caribou harvest; however TMAC will work with the management authorities to support their harvest management directives should they be related to or influenced by Project operations.

The Dolphin and Union management plan identifies key issues where industrial activities may affect caribou, and the Project's WMMP has mitigation and management directly related to each of those key issues for each of these key issues (Table 9.8-6).

Table 9.8-6. Key Issues for Industry identified in the Dolphin and Union Management Plan and TMAC Mitigation to Manage these Issues

Impact Identified in Management Plan	TMAC Mitigation
1. Impacts to caribou movements	o TMAC is conducting open water shipping so that the sea lifts do not interrupt the migration of Dolphin and Union caribou on the sea ice. o TMAC is designing the Boston all weather road to allow movement across the road, including low road height and crossing ramps in locations identified by Elders.
2. Research into impacts	o TMAC is working with the GN DOE to conduct primary research on caribou movement by funding satellite collars for the Dolphin and Union herd. o TMAC shares monitoring data with the KIA, GN DOE and NIRB annually. o TMAC is funding primary research in a POLAR-funded research program.
3. Disruption of migration especially sea crossing	o TMAC is conducting open water shipping so that the sea lifts do not interrupt the migration of Dolphin and Union caribou on the sea ice.
4. Displacement from winter foraging sites	o TMAC manages the noise and dust produced by the Project to limit disturbance to caribou, including: surveys and blasting management when caribou are nearby, vehicle management on the AWR, helicopter and fixed wing management.
5. Entanglement risk	o TMAC has strict waste management protocols to reduce the chance of entanglement. o During the second caribou workshop, participants suggested that TMAC keep the sea can doors at the waste management facility closed at all times, which TMAC has implemented.
6. Aircraft management o Low level flights o Disturbance effects	o Fixed wing aircraft must maintain 610 m elevation except during takeoff and landing. o Fixed wing takeoffs and landings are managed if caribou are within 250 m of the airstrip. o Helicopters must maintain 300 m vertical or 600 m horizontal separation from caribou.
7. Road management o direct mortality o changes to caribou movements	o TMAC has a variety of management for roads, including speed limits and giving wildlife the right of way to manage direct mortality. o The AWR is designed to limit the height and include crossing points to promote movement across the road.

Beverly Qamanirjuaq Management Plan

The Beverly caribou herd is managed through the *Beverly and Qamanirjuaq Caribou Management Plan 2013-2022* (BQCMB 2014). This plan describes the processes for conducting a vulnerability assessment of the herd and conducting monitoring activities to support the vulnerability assessment. The Plan also provides management direction for harvest based on the vulnerability level of the herd, and for industrial development.

The key management guidance for industrial development are listed below. The Project complies with these management objectives.

1) Calving and Post-Calving Areas

The plan calls for protection of calving and post-calving areas, and not allowing any development in these areas, including mineral tenures, federal land use permits and Inuit land use licences.

Inuit TK, Elders and land users in the caribou workshops and western science agree that the Hope Bay Project is outside of both the calving and post-calving areas for the Beverly herd. See Section 9.8.3.1 for more information on the location of calving and post-calving ranges.

2) Roads

The intent of the plan is to minimize harvest from new roads, but limiting the construction of all-season roads, no new winter roads in calving and post calving, and limiting public access. The concern is that new all season roads that connect to settlements will allow for new harvest opportunities of caribou.

The design and management of the Hope Bay Project addresses this management objective. The Project is not connected to a settlement by an all-season road and there is no plan to build a winter road from Cambridge Bay to the Hope Bay site. The all season road is therefore not accessible by people from Cambridge Bay with wheeled vehicles, only by snow machine. The gravel surface of the AWR does not facilitate travel by snow machines. Hence, the road would not provide any new access to the Beverly caribou range. See Section 9.8.3.6 for more information on access to the site.

3) Other Management

The Plan identifies additional management that may be applicable to the Project, including protection of seasonal movement corridors.

TMAC has used Inuit TK and information from Elders and land users in the caribou workshops to assess if the Project will alter seasonal movements of caribou. The Project does not interact with any identified water crossings or key movement corridors for the Beverly herd. In addition, the design of the all-weather road will manage possible disruption of movement – the road surface will be low so caribou can see over the road and easily cross, and TMAC will work with Elders to identify the location of and install crossing structures for caribou. With these measures, seasonal movement of caribou should not be affected by the Project. See Section 9.8.3.3 for more information on management for moving caribou.

Draft Nunavut Land Use Plan

The Draft Nunavut Land Use Plan (DNLUP, NPC 2016) identifies areas of Nunavut important to caribou (Figure 9.8-1). The Project complies with the NPC important caribou areas, including:

1. Calving and Post-calving areas

   The DNLUP identifies calving and post-calving areas (Figure 9.8-1). The Project does not overlap with the calving or post-calving areas of any herd, including the Dolphin and Union herd, which calves on Victoria Island, and the Beverly/Ahiak herd which calves to the east of the Project in the QMGMBS. See Section 9.8.3.1 for more information on the location of calving and post calving areas using a variety of mapping techniques.

2. Rutting areas

   The DNLUP identifies rutting areas as important (Figure 9.8-1). None of these areas overlap the Project site.

3. Spring Migration, Summer Areas, and Fall Areas

   The DNLUP identifies areas for spring migration, summer and fall (Figure 9.8-1), and all those areas are to the south, and outside of the RSA.

4. Four Special Management Areas are identified in the DNLUP:

   - Caribou sea ice crossing - Hope Bay sea lifts will occur during the open water season, and will not break ice, so there will be no effect on sea ice crossings.
   - Freshwater crossing – The closest crossing to the Project is the sea ice crossing between the islands at the mouth of Elu Inlet. This crossing is approximately 15 km from the nearest Project infrastructure (Roberts Bay) and will not be affected by the Project.
   - The proposed Hiukitak Conservation Area – This conservation area surrounds the Hiukitak Rover valley, over 50 km south of the Project, and will not interact with the Hope Bay Project.

Due to the location of the Project and the mitigation and management conducted for the Doris project, the Project addresses the areas of concern identified in the DNLUP.

9.8.3 Characterization of Potential Project-related Effects

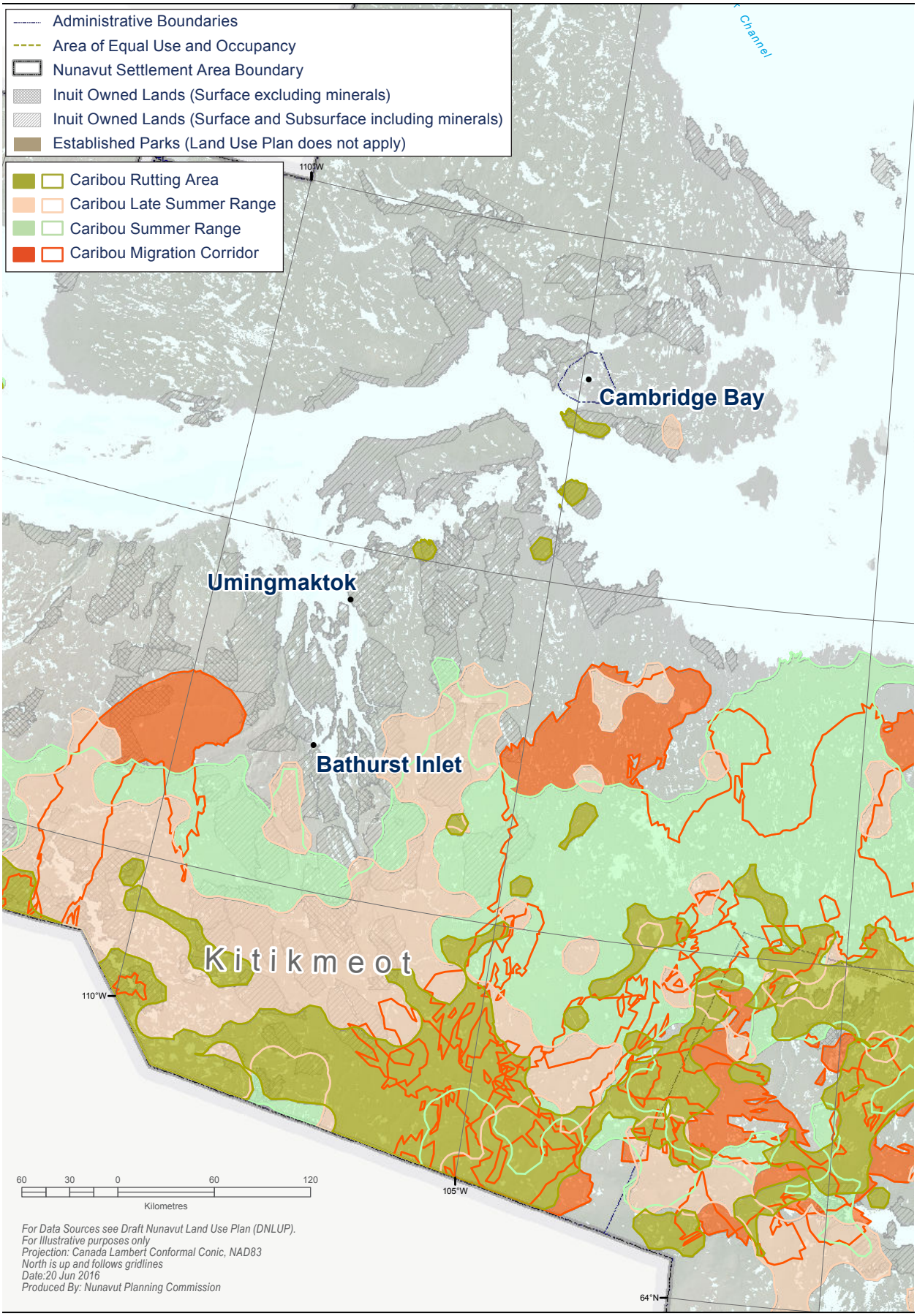
Potential effects of the Project on caribou identified in Section 9.6 and from the caribou workshop are evaluated in this section.

9.8.3.1 Habitat Loss

In the first caribou workshop (September 2016), Elders and land users identified that one of the expected effects of the Project will be caribou habitat loss. Habitat loss will occur in areas where new infrastructure is constructed, including the expansion of the Roberts Bay facilities, Doris site and TIA facilities, and the construction of the Madrid North, Madrid South, Boston road and Boston facility. Elders and land users rated habitat loss as an expected, low impact effect, anticipated to affect few caribou.

Figure 9.8-1

Draft 2016 Nunavut Land Use Plan
Important Caribou Areas



In the second and third caribou workshops (April and August 2017), Elders and land users visited the Doris site, Roberts Bay laydown, road to Windy Lake, Boston site and the road route connecting Doris to Boston to evaluate if the Project will interact with any important caribou habitats. Workshop Participants identified travel routes as important caribou habitats and identified 14 potential sites for constructing caribou crossing structures on the Boston road (discussed in Section 9.8.3.3). Workshop participants also evaluated the existing mitigation at Doris and the proposed mitigation for the Madrid-Boston Project.

As described in the environmental setting (Section 9.2.6.2), the Project is located in the winter range of the Island caribou (Dolphin and Union herd). The Project is also located at the northern edge of the fall range and in the winter range of the Mainland caribou (Beverly and Ahiak sub-populations). Considering them as separate herds, Beverly caribou were formally spending the winter to the south, near treeline, but are now widely distributed above and below the treeline and in the Project area, and the tundra-wintering Ahiak caribou do occur in the Project area during winter.

This assessment considers whether the Project will impact important caribou habitats identified by TK, the NIRB, and Elders and land users. Inuit TK and caribou workshop participants identified important habitat areas preferred by caribou and where they are more likely to be found. Inuit TK and the NIRB identified special landscape features such as eskers, upland areas used for insect relief and nadlok (water crossings). Inuit TK and the NIRB also identified calving areas as important for caribou. The assessment evaluates whether the Project overlaps with these areas.

This assessment also evaluates the loss of general foraging habitat for caribou outside of the important caribou habitats identified above, by comparing the seasonal range area lost due to the Project. To be cautious, the area considered "lost" in this assessment is larger than the actual proposed Project footprint. The area lost is measured within a Project Development Area (PDA), which is the proposed footprint of Madrid-Boston plus a 100-m buffer around roads and an average buffer of 250 m around other infrastructure to allow for small relocations during final engineering and site works. The PDA used for the assessment is three times larger than the planned footprint of the Project.

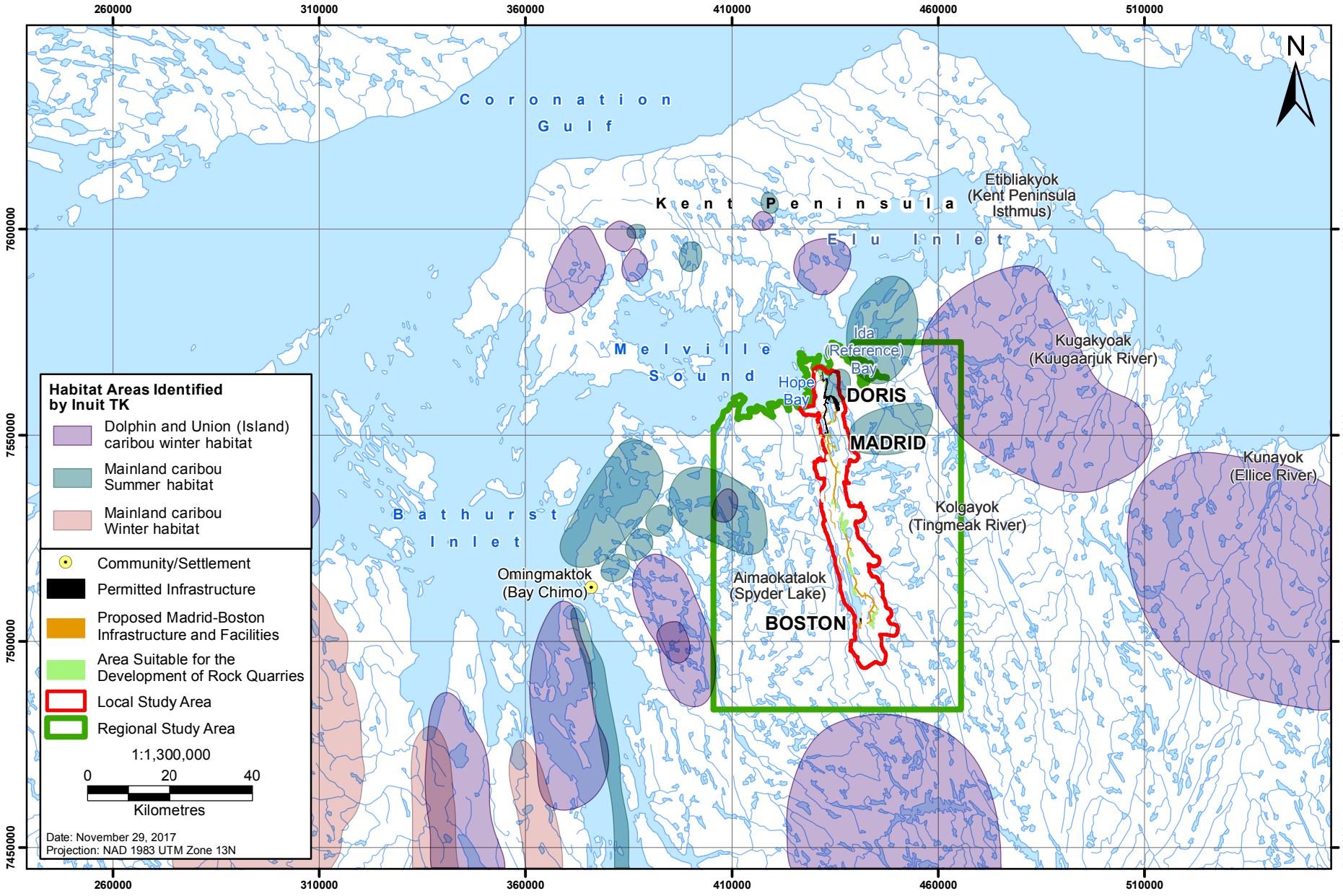
Mitigation includes avoidance of important habitats. During the planning phase for the Madrid-Boston Project, an environmental sensitivities map was produced that highlighted sensitive environmental features including archaeology sites, fisheries streams, carnivore dens, raptor dens, and special landscape features such as wetlands and eskers that are important habitats for caribou. This map was provided to engineers, who designed the infrastructure such as the Boston road, quarries, pads, laydowns, water pipes, and wind towers to avoid sensitive wildlife features. More information on the wildlife sensitivity mapping is available in the Project Description (Volume 3). Mitigation also includes avoidance of freshwater crossings, where possible, and clumping of Project infrastructure to minimize the Project footprint.

Centres of Habitat Use Identified by Inuit TK

Inuit TK for the Project area was compiled by the KIA and reported in: *Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* (Banci and Spicker 2016). Contemporary caribou knowledge and land use information was also collected from Elders and land users during caribou workshops.

The Inuit TK report identifies several important areas for Island caribou during the winter and Mainland caribou during the summer, including Kilingoyak (the Kent Peninsula), an area south of Etibliakyok (Kent Peninsula isthmus), the Kugyoak and Kunayok areas (Perry and Ellice Rivers) in the Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS), a large rocky area inland from Omingmaktok, and the Huikitak River valley south west of Aimaokatalok (Spyder Lake) (Figure 9.8-2; Banci and Spicker 2016).

Figure 9.8-2
Caribou Habitat Identified by Inuit TK



HB-23-479

During the first caribou workshop, resource mapping was conducted. Participants identified important habitats where caribou are observed more frequently and movement paths of caribou on the mainland that aligned with those identified in the TK report. During the second and third caribou workshops, participants discussed these areas and whether they overlapped with the Project site. The three areas discussed as being good caribou habitat were the Kent Peninsula, the area south of the Kent Peninsula isthmus (approximately 50 km east of the Project), and the Huikitak River valley (approximately 50 km south of the Project) (Figure 9.8-2). The KIA is developing plans to establish a conservation area along the Huikitak River (NPC 2016).

Satellite collar data corroborates both TK and workshop participant information, with centres of occupation for Dolphin and Union caribou in the Huikitak River valley and south of the Kent Peninsula. However, few collared caribou were observed wintering on the Kent Peninsula (Figure 9.8-3).

Overall, Madrid-Boston and the Hope Bay Project will not interact with the habitats identified by Inuit TK or by Elders and land users in the caribou workshops.

Calving and Post-Calving Areas

Inuit TK collected by the KIA and through caribou workshops held by TMAC identified calving areas for the Island (Dolphin and Union) caribou as being on Victoria Island and the Project will not interact with these area.

Calving areas for Mainland caribou (Beverly and Ahiak sub-populations) were identified by TK as generally to the east of the Project in the Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS), including Kunayok (Ellice River), Kolgayok (Tingmeak River), Kugakyoak (Kuugaarjuk River), Haloakhiokvik, Aoulativikyoak (Whitebear Point), and south of the Kent Peninsula isthmus at Etibliakyok (Banci and Spicker 2016). Some Inuit reported observing calving or post-calving caribou on the Kent Peninsula, Bathurst Inlet area, and entire inland areas south of the Kent Peninsula (Banci and Spicker 2016).

In the caribou workshops, Elders and land users identified the same areas as calving grounds, with Island caribou calving on Victoria Island and Mainland caribou calving in the QMGMBS. Harvest during the summer is conducted by boats, typically in the Kugyoak and Kunayok areas (Perry and Ellice Rivers).

Satellite collar data agrees with TK and land user information, showing that calving and post-calving areas of Mainland caribou are located in the QMGMBS approximately 250 km to the east of the Project (Figure 9.8-4). The nearest, western edge of the calving and post-calving range is approximately 125 km to the east of Madrid-Boston. At the request of the GN DOE, TMAC used satellite collar data to map the calving and post-calving areas for the Beverly and Ahiak caribou as two separate populations using kernel density estimators. In roughly 15 years of available data, in no year did the calving or post-calving area of either population overlap the Project area (Figures 9.8-5 and 9.8-6). Therefore, the Project is not expected to interact with the calving or post-calving areas of either the Island or Mainland caribou herds and no effect on these areas is predicted due to the Project.

Eskers

The NIRB requested that TMAC evaluate whether the Project would interact with any eskers. Inuit TK identified eskers as important for caribou, but did not identify any specific eskers important to caribou in the RSA. A review of the Ecological Land Classification (ELC) data for the Slave Geological Province (Matthews, Epp, and Smith 2001) indicates that eskers are uncommon and confined to the southern half of the RSA (Figure 9.8-7). The ELC data indicates that the Project PDA overlaps with two isolated

fragments of esker, the first stretching approximately 300 m north into Aimaokatalok (Spyder Lake) from the Boston site and the second near the road route approximately 2 km north-east of the Boston site.

In the third caribou workshop, Elders and land users visited the Doris and Boston sites and surveyed these areas and the proposed Boston road by helicopter, evaluating the area for caribou habitats and movement pathways. Workshop participants identified only one esker feature, the one identified by ELC on the Boston road near Aimaokatalok.

The identified sections of esker will not be directly affected by the Madrid-Boston or combined Hope Bay Project (Figure 9.8-7). Therefore, no direct effects are expected from Madrid-Boston on eskers.

Hills used for Heat and Insect Avoidance

The NIRB requested that TMAC evaluate whether the Project would overlap with hills and upland areas that may be used for heat and insect avoidance. Inuit TK indicates that hills and rock outcrops, where the wind is stronger, are used for heat and insect relief by caribou. The Inuit TK report did not identify any specific hills or landscape features in the RSA that may be important to caribou for insect relief (Banci and Spicker 2016).The Ecological Land Classification (ELC) data for the Slave Geological Province (Matthews, Epp, and Smith 2001) indicated that the area to the west of Madrid-Boston and the coastline to the west of the site has high relief compared to many areas of Nunavut, with many rocky outcrops, hills and linear dikes (Figure 9.8-8).

Generally, the Hope Bay greenstone belt where Madrid-Boston and Hope Bay Project are located is in a low-lying area of lower relief than the surrounding area in the RSA (Figure 9.8-8). Therefore, it is not expected that Madrid-Boston or the Hope Bay Project will remove any hills or elevated areas that are important to caribou for heat and insect avoidance. Should any rock outcrops or elevated areas be removed through development, the area removed is negligible compared to the abundance of hills and elevated features occurring in the RSA.

Nadlok (Water Crossings) and Movement Areas

Nadlok (water crossings) identified as being used by the Dolphin and Union (Island) caribou are discussed in Section 9.8.3.3, which evaluates the potential for disruption of movement.

Foraging Habitat

Foraging habitat includes any habitat that caribou may use on a seasonal basis that is not included in special landscape features (calving or post-calving ranges, eskers, upland areas or water crossings) or movement corridors. Island caribou (Dolphin and Union herd) use the Project area during the winter, when their range overlaps the Project in most years. Figure 9.8-9 shows the winter range of all years combined and the annual winter ranges as shaded, overlapping polygons. Mainland caribou (Beverly and Ahiak sub-populations) overlap the Project area during fall, when the Project is at the northern edge of their range, and during winter. Formerly, during winter, the Beverly sub-population was largely located to the south near treeline but their winter range has been expanded northward in recent years to include areas above the treeline and near the Project. The tundra-wintering Ahiak caribou occupy the Project site in winter during most years and there is some indication that their range is moving farther north as well (Figures 9.8-10 to 9.8-12).

Seasonal foraging habitat was mapped using Habitat Suitability Modeling, which rated foraging quality based on vegetation communities identified in the Ecosystem Mapping (EM) produced for the LSA and Ecological Land Classification (ELC) for the Slave Geological Province within the RSA (Matthews, Epp, and Smith 2001). Detailed methods for habitat suitability modeling are provided in the Habitat Suitability Baseline (Rescan 2011h) and summarized in the environmental setting for caribou (Section 9.2.6.2).

Figure 9.8-3
Dolphin and Union (Island) Caribou Collar Distribution During Winter, 1999-2004 and 2015-2017

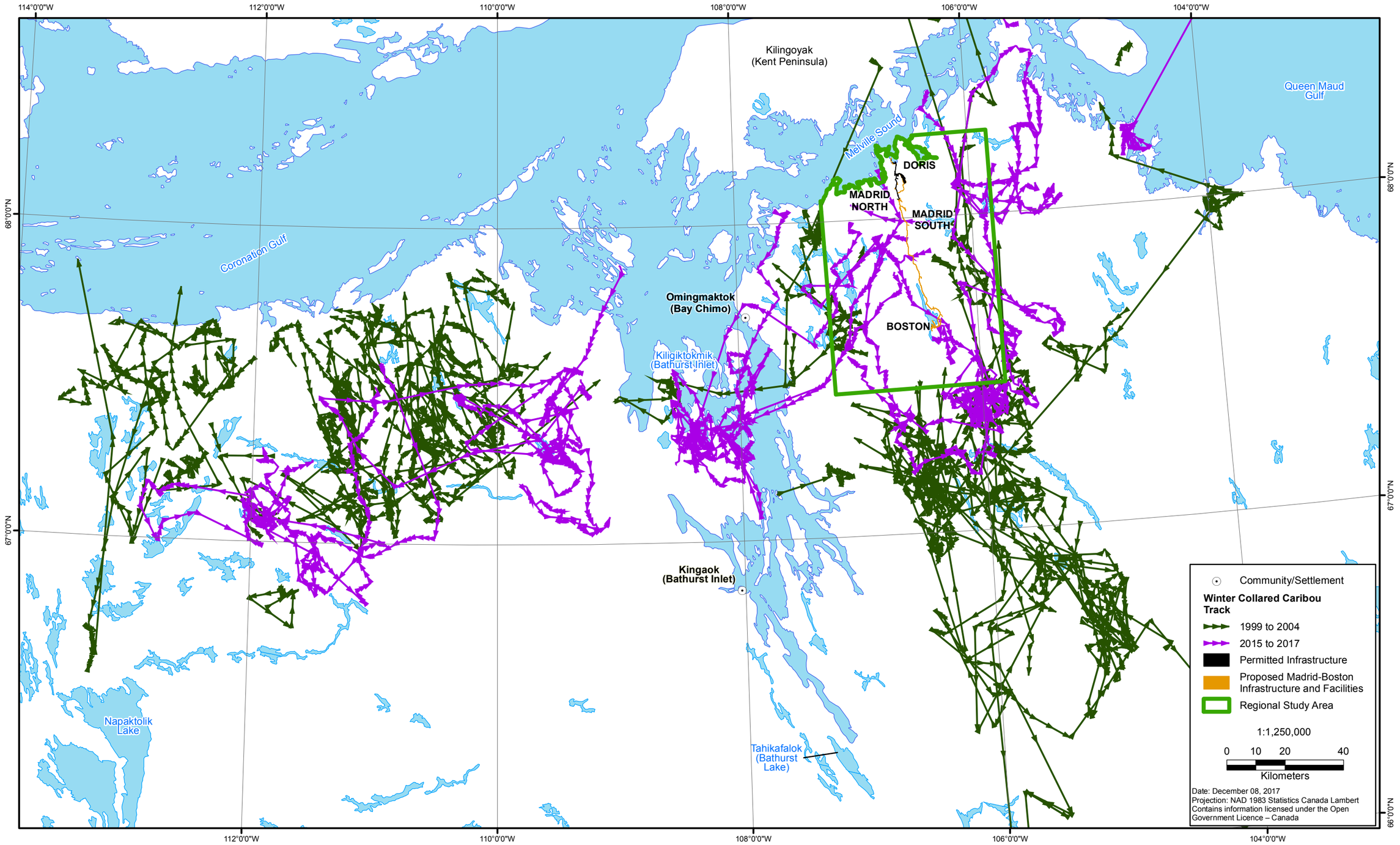
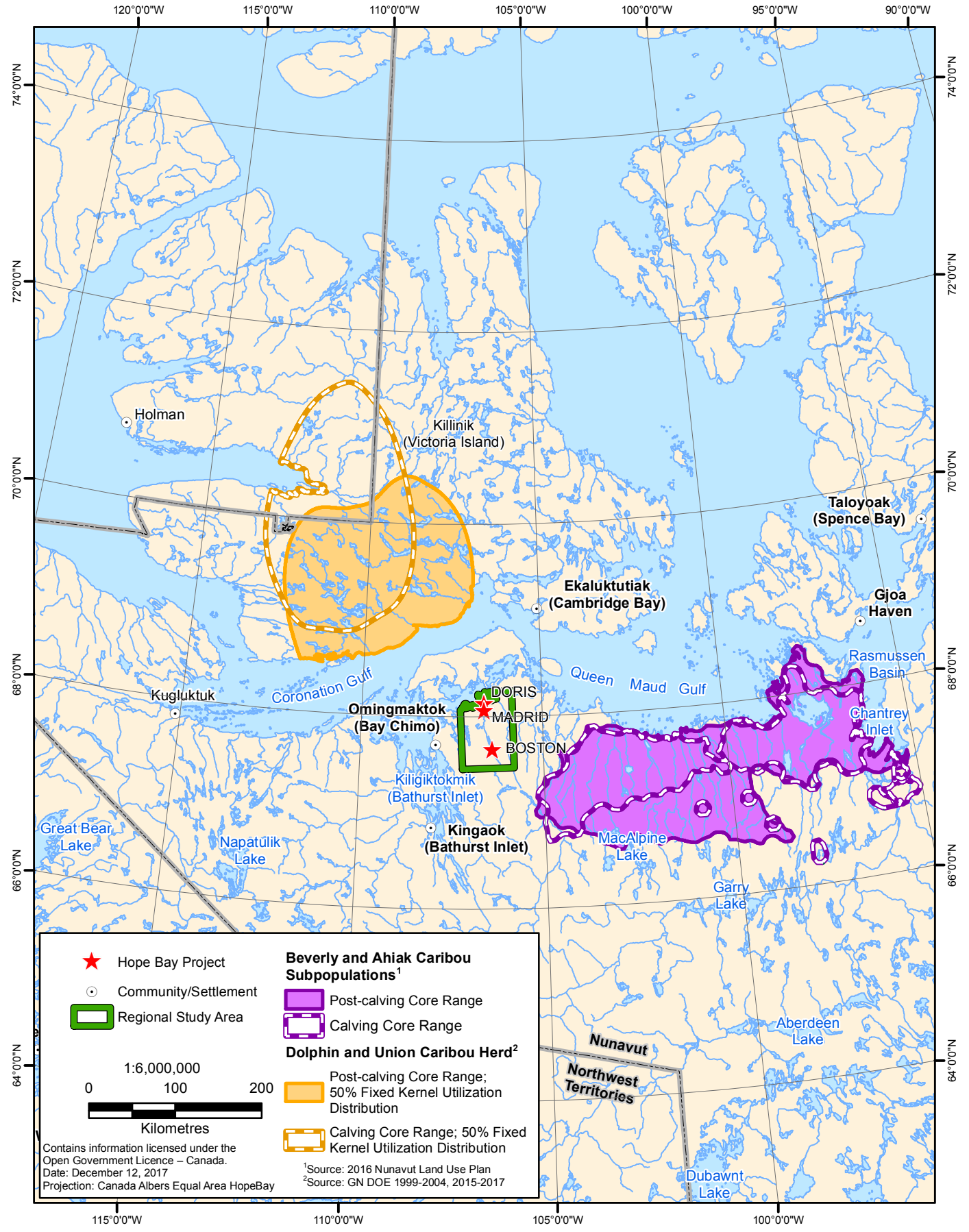


Figure 9.8-4

Calving and Post-calving Areas for the Dolphin and Union (Island) Caribou Herd, and Beverly and Ahiak (Mainland) Caribou Subpopulations



Habitat suitability modeling rated summer, fall (rut), and winter habitat for caribou using a four-class system of high, moderate, low, and nil. The Project PDAs were overlain on habitat suitability maps and the area of good quality habitat (high and moderate habitat combined) is reported relative to the LSA and RSA, as well as seasonal and total annual ranges of the caribou herds (Table 9.8-7). To calculate the amount of good-quality habitat within the RSA using the best possible data, the results of habitat suitability mapping based on the ecosystem mapping in the LSA was combined with the suitability mapping produced with the ELC mapping in the RSA. The total area within the PDAs was also calculated and represented as a portion of the seasonal and total range for each herd.

Table 9.8-7. Seasonal and Annual Herd Ranges for the Beverly and Ahiak sub-populations and the Dolphin and Union Herd

	Size of Range (ha)[1]		
Range	Beverly	Ahiak	Dolphin and Union
Summer	9,822,214	12,440,815	n/a
Fall	10,928,856	14,768,775	n/a
Winter	18,013,435	17,153,125	6,364,200
Annual	27,570,234	30,409,044	19,227,700

[1] Range is represented by the 95% kernel UD using pooled, available collar data, which includes 2001 to 2017 for the Beverly and Ahiak sub-populations and 1999-2004 and 2015-2017 for the Dolphin and Union herd.

Island Caribou (Dolphin and Union herd)

The calving, post calving, summer and fall ranges of the Island caribou (Dolphin and Union herd) are on Victoria Island and do not interact with the Project. The Island caribou spend their winter on the mainland, including within the Project area and migrate north-south in spring and fall, including through the Project area.

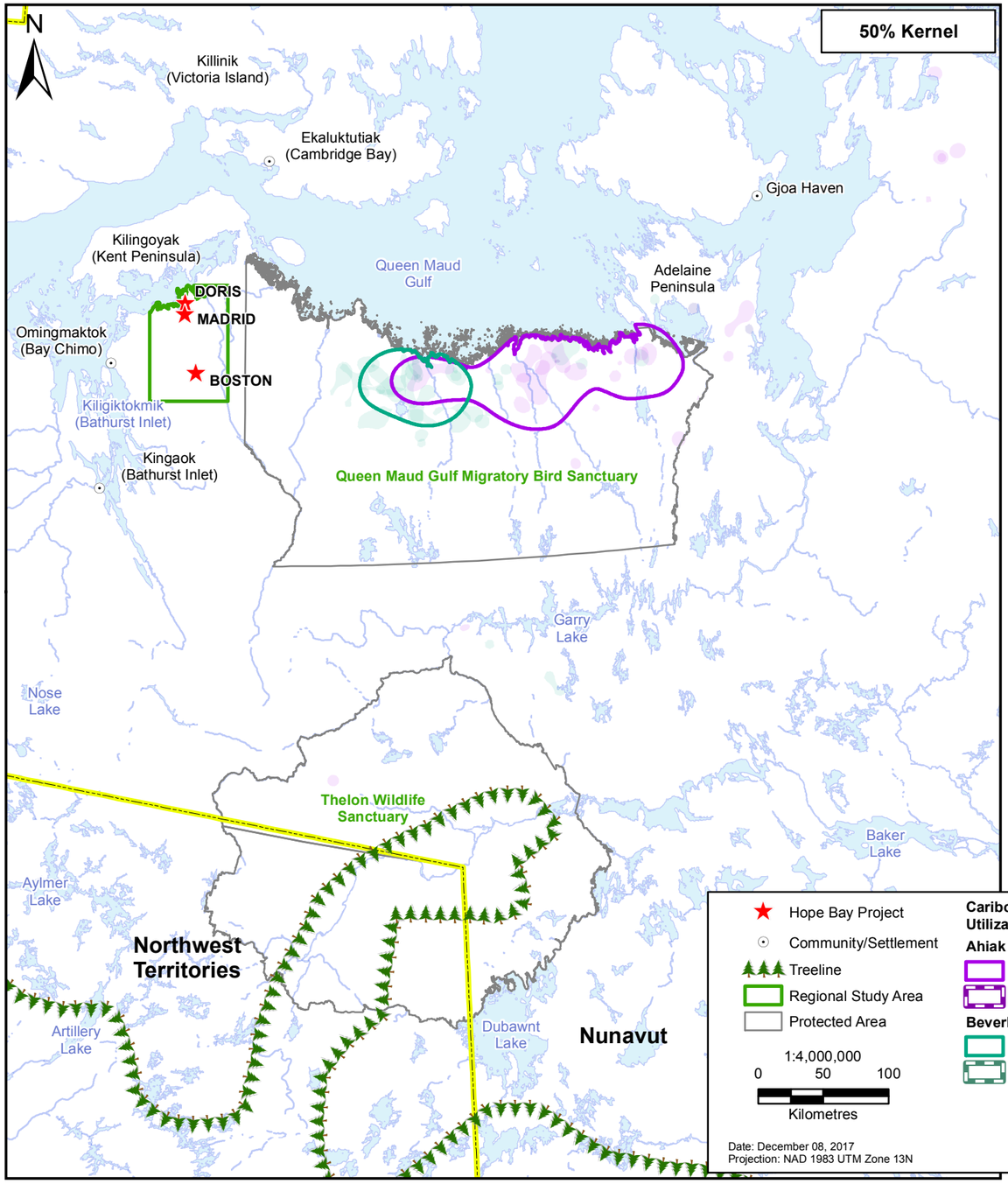
The total area of good quality winter habitat that is predicted to be lost within the PDA of Madrid-Boston is 1,801 ha, which is 9.1% of the good quality habitat available in the LSA and 0.8% of what is available in the RSA (Table 9.8-8). To put this habitat loss in perspective, it represents 0.028% of available higher value habitat in the winter range and 0.009% in the annual range (Tables 9.8-9).

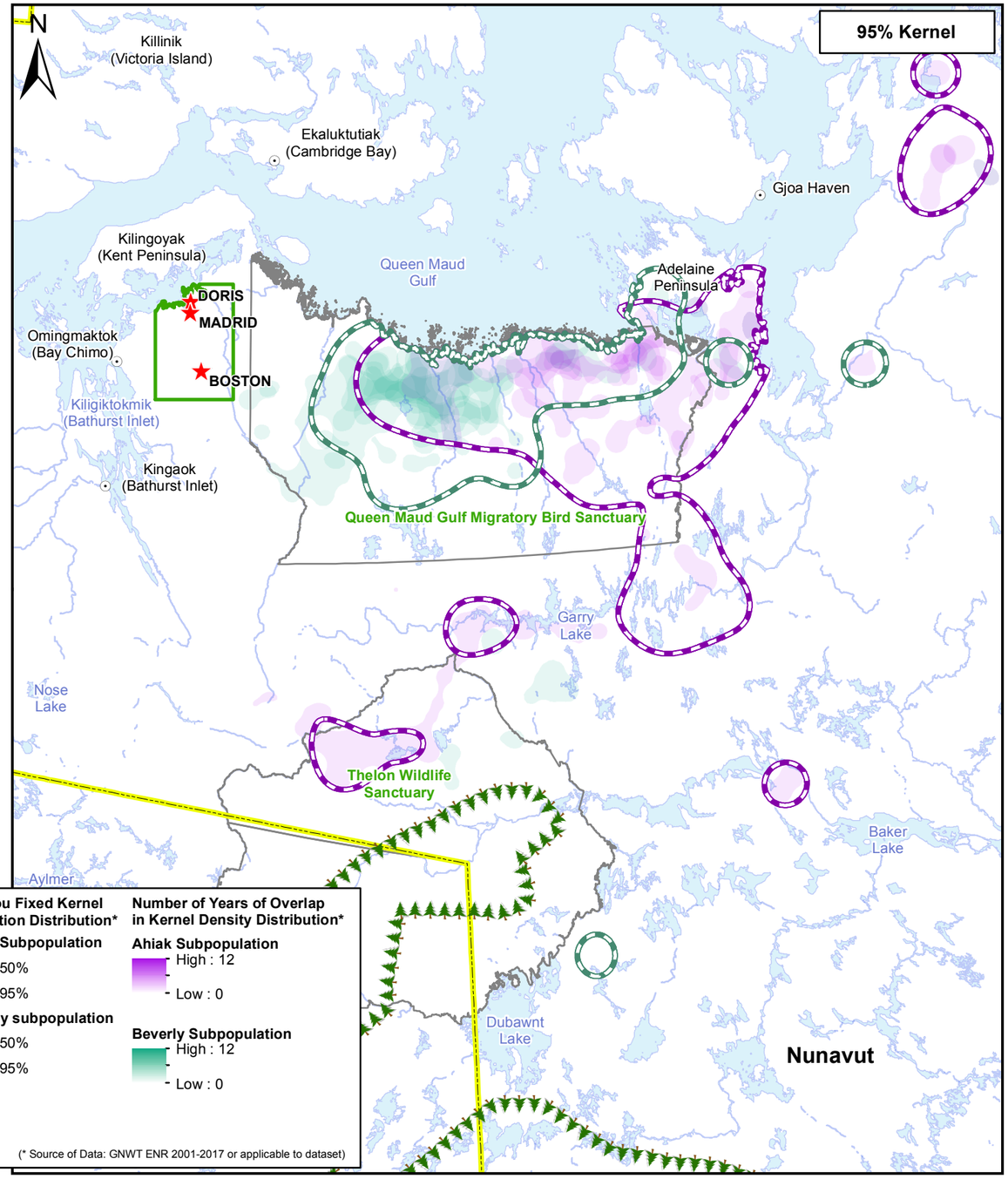
Table 9.8-8. Area of Good Quality Habitat and Total Habitat Loss due to Madrid-Boston and Hope Bay Project in the LSA and RSA

	Habitat Lost (ha)			LSA (%)[1]			RSA (%)[2]		
Season/Area	Doris[3]	Madrid-Boston	Total	Doris[3]	Madrid-Boston	Total	Doris[3]	Madrid-Boston	Total
Summer	169	3,572	3,741	0.4	7.6	8	<0.1	0.8	0.9
Fall	26	1,059	1,086	0.2	7.4	7.6	<0.1	0.3	0.4
Winter	73	1,801	1,875	0.4	9.1	9.5	<0.1	0.8	0.8
Total Area	517	4,189	4,706	0.9	7.4	8.4	0.1	0.9	1.0

[1] Total area of LSA = 56,340 ha. Areas of high-quality summer, fall, and winter habitat in LSA are 46,835 ha, 14,332 ha, 19,782 ha, respectively.
[2] Total area of RSA = 491,823.9 ha. Areas of high-quality summer, fall, and winter habitat in RSA are 420,608 ha, 302,692 ha, and 227,934 ha, respectively.
[3] Doris refers to the Approved Project, including the Doris Project and Madrid North and South, which are already permitted for a bulk sample

Figure 9.8-5
Calving Distribution of the Beverly and Ahiak (Mainland) Caribou Subpopulations, per Year





Hope Bay Project
Community/Settlement
Treeline
Regional Study Area
Protected Area

1:4,000,000
0 50 100
Kilometres

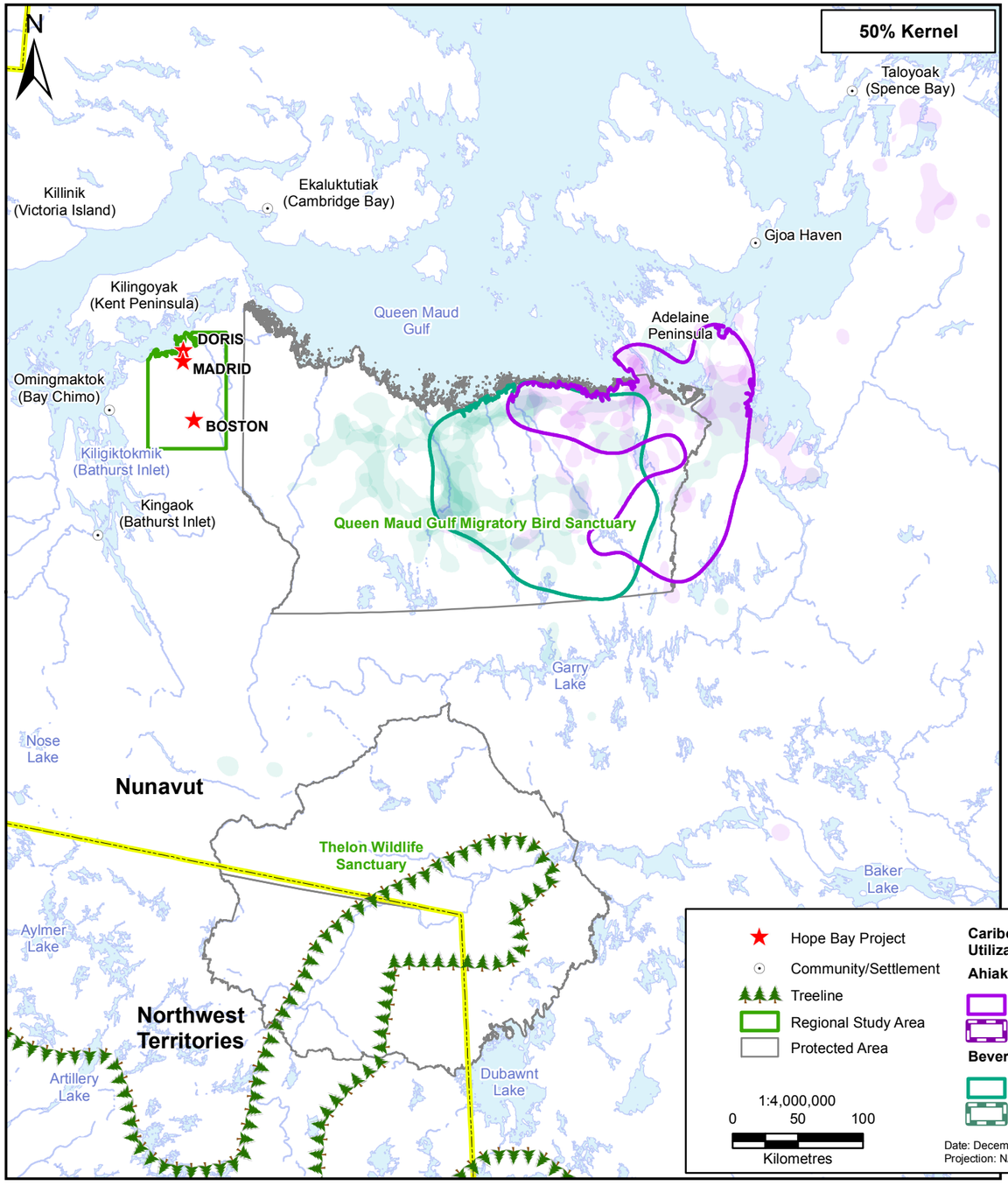
Date: December 08, 2017
Projection: NAD 1983 UTM Zone 13N

Caribou Fixed Kernel Utilization Distribution*
Ahiak Subpopulation
50%
95%
Beverly subpopulation
50%
95%

Number of Years of Overlap in Kernel Density Distribution*
Ahiak Subpopulation
High : 12
Low : 0
Beverly Subpopulation
High : 12
Low : 0

(* Source of Data: GNWT ENR 2001-2017 or applicable to dataset)

Figure 9.8-6
Post-calving Distribution of the Beverly and Ahiak (Mainland) Caribou Subpopulations, per Year



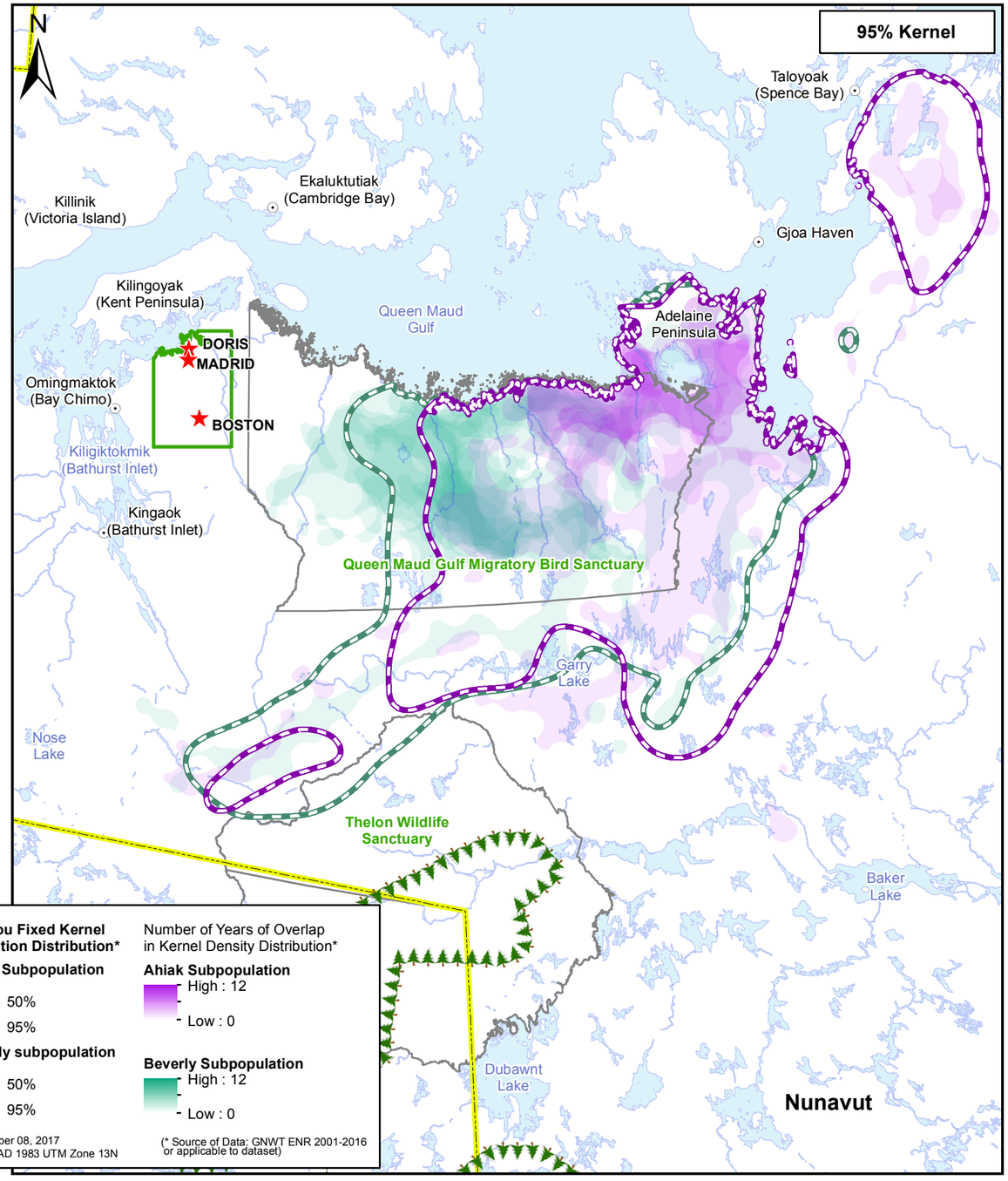


Figure 9.8-7
Eskers that May be Used as Caribou Habitat in the RSA

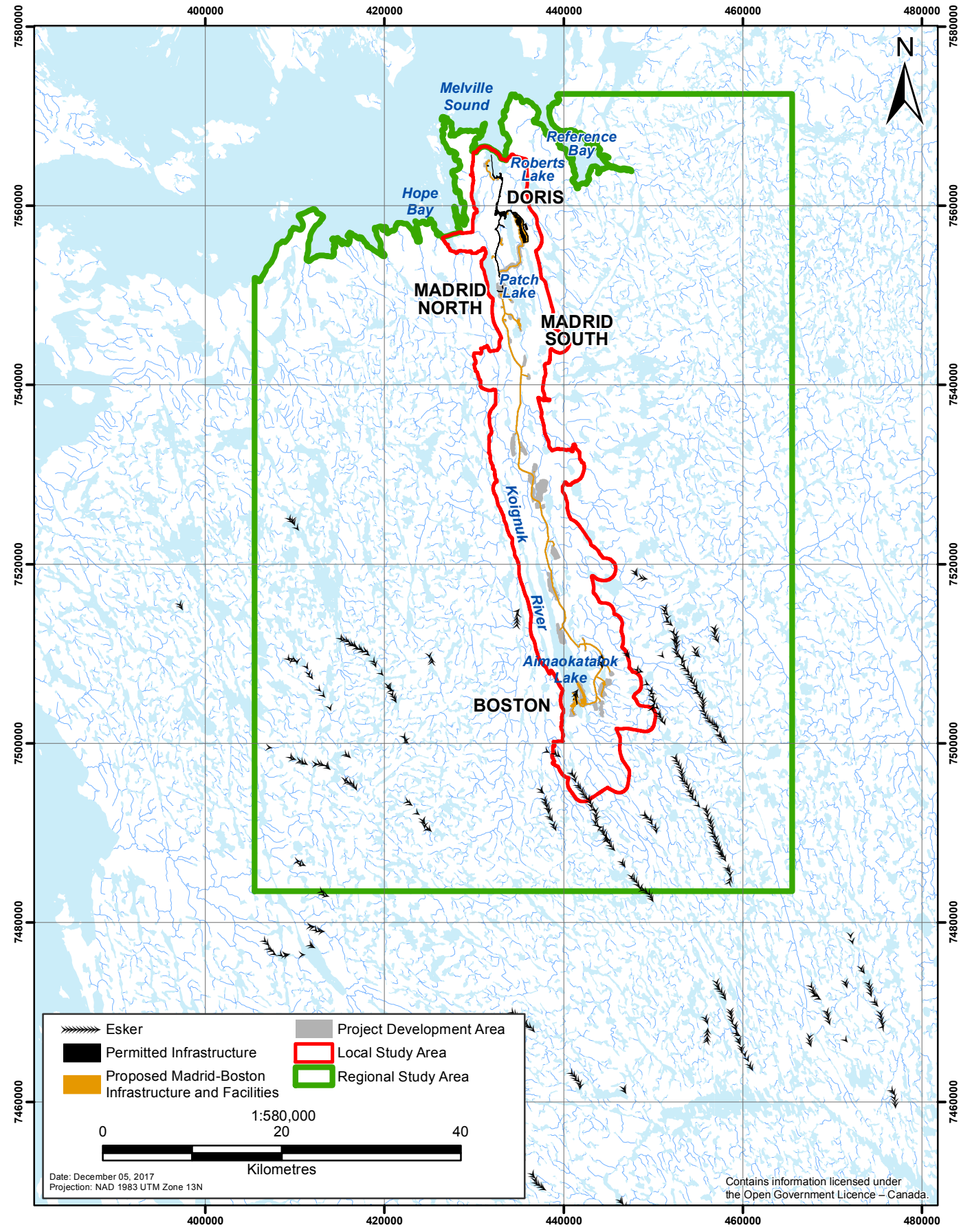


Figure 9.8-8
Hills and Upland Areas used for Heat and Insect Avoidance

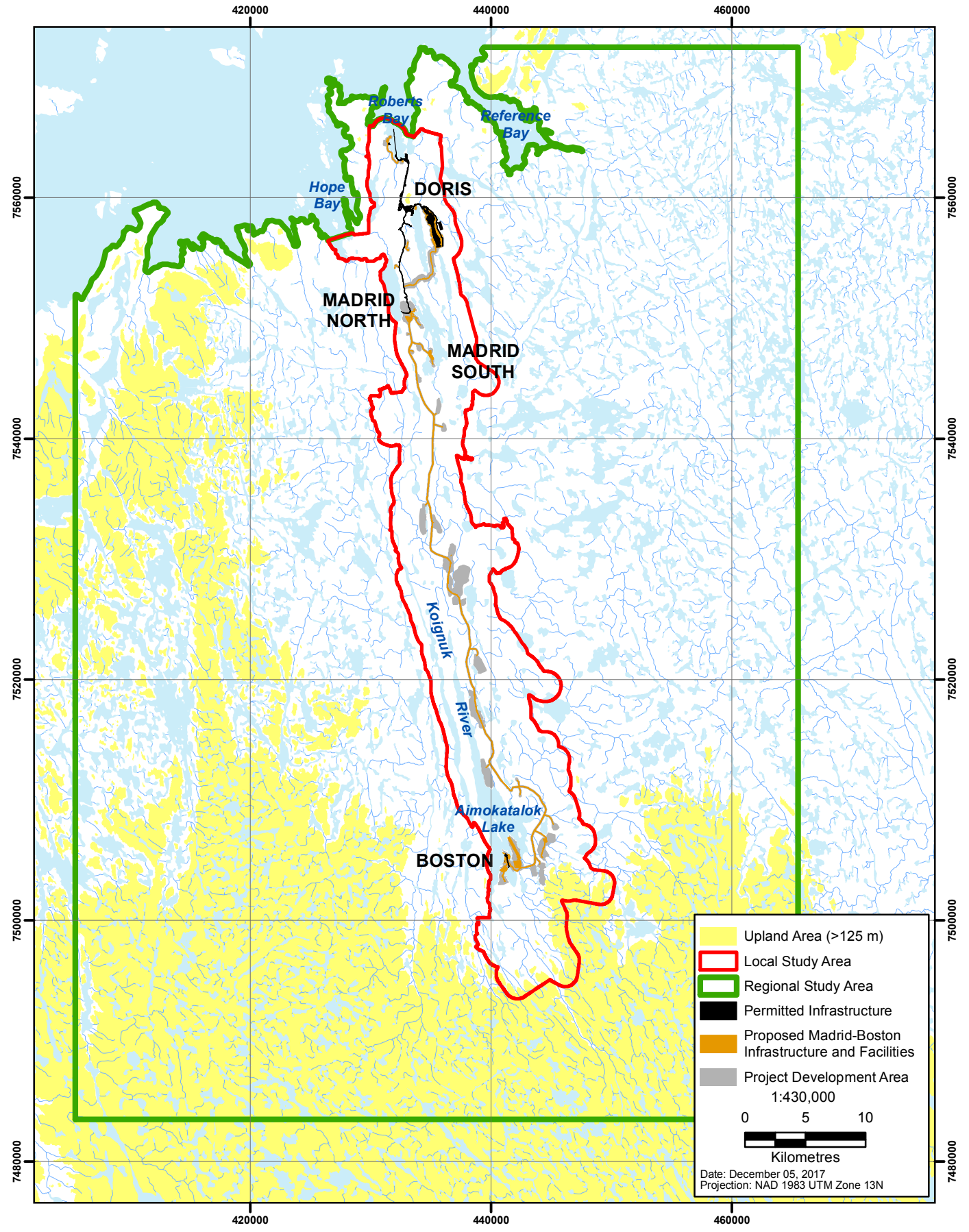
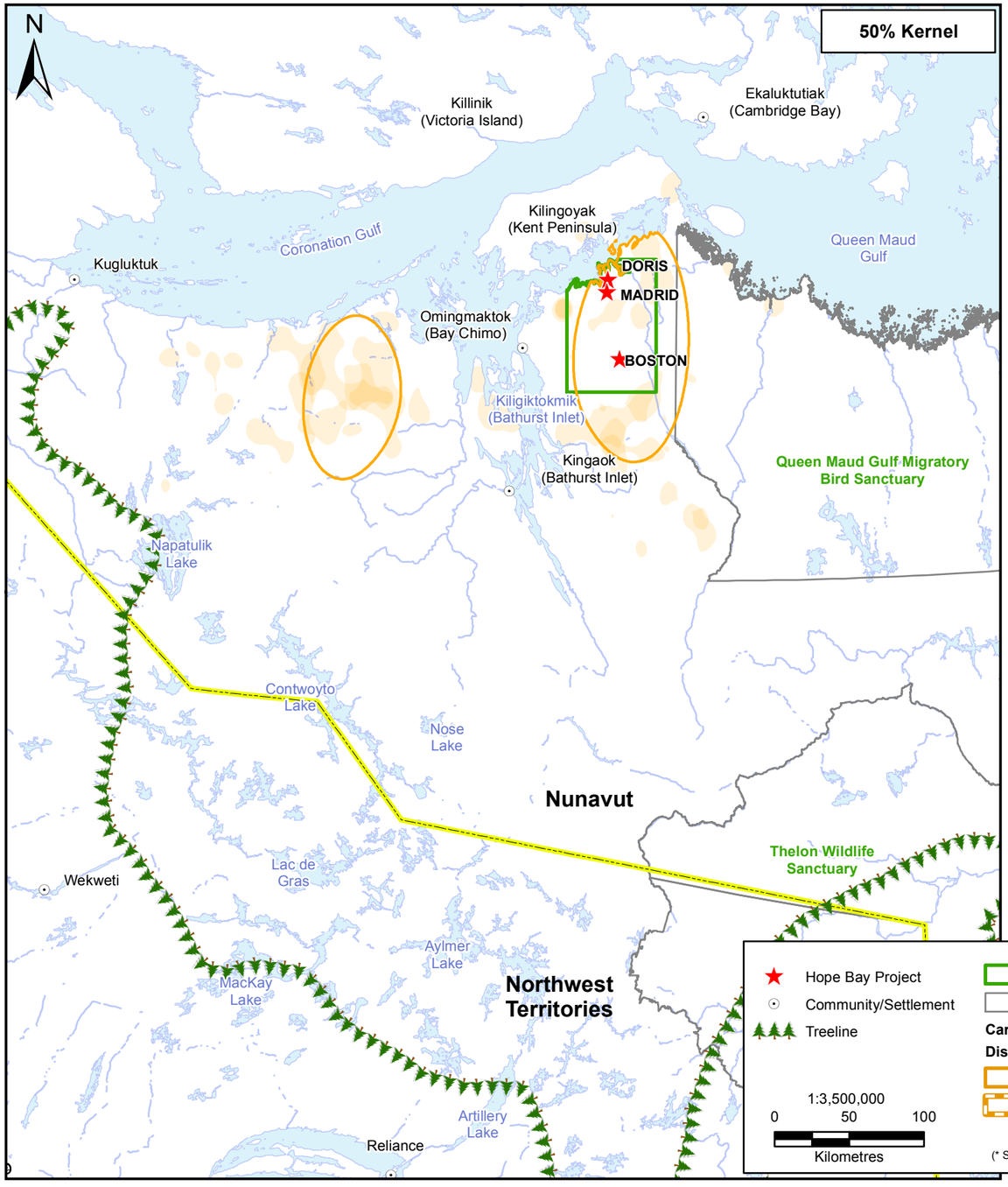
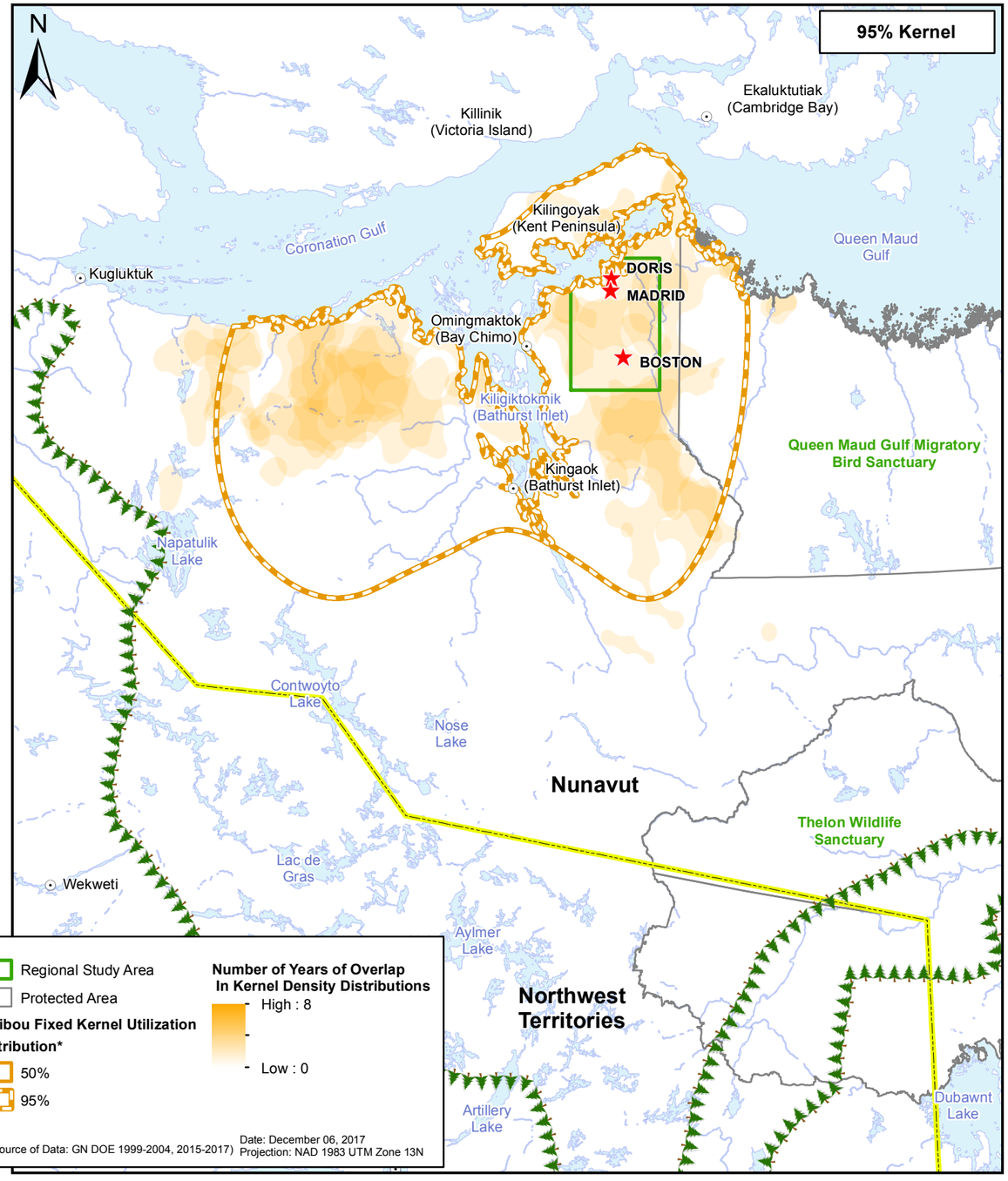


Figure 9.8-9
Winter Distribution of the Dolphin and Union (Island) Caribou Herd, per Year





Hope Bay Project
Community/Settlement
Treeline

Regional Study Area
Protected Area

Caribou Fixed Kernel Utilization Distribution*
50%
95%

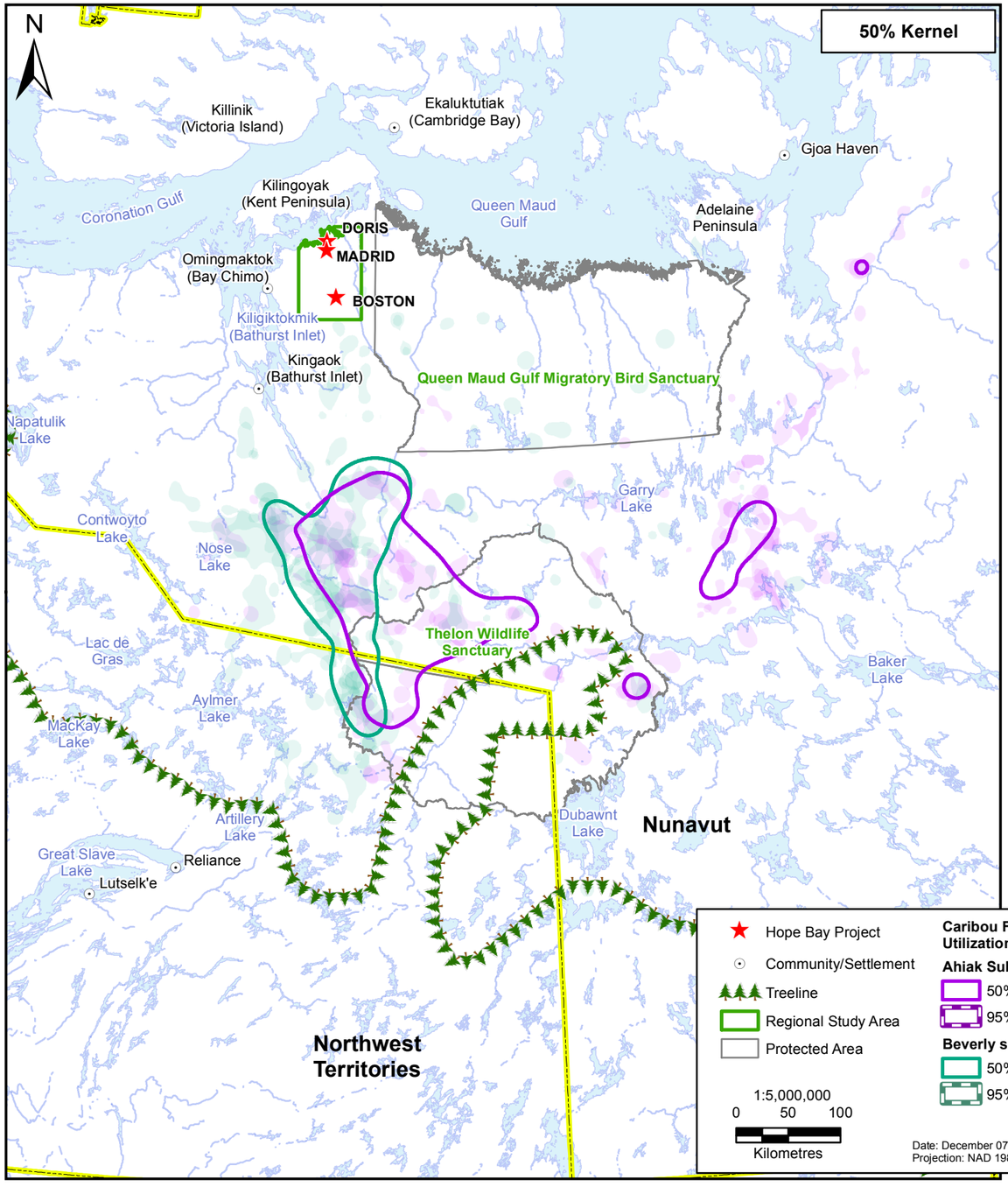
Number of Years of Overlap In Kernel Density Distributions
High : 8
Low : 0

1:3,500,000
0 50 100
Kilometres

(* Source of Data: GN DOE 1999-2004, 2015-2017)

Date: December 06, 2017
Projection: NAD 1983 UTM Zone 13N

Figure 9.8-10
Summary Distribution of the Beverly and Ahiak (Mainland) Caribou Subpopulations, per Year



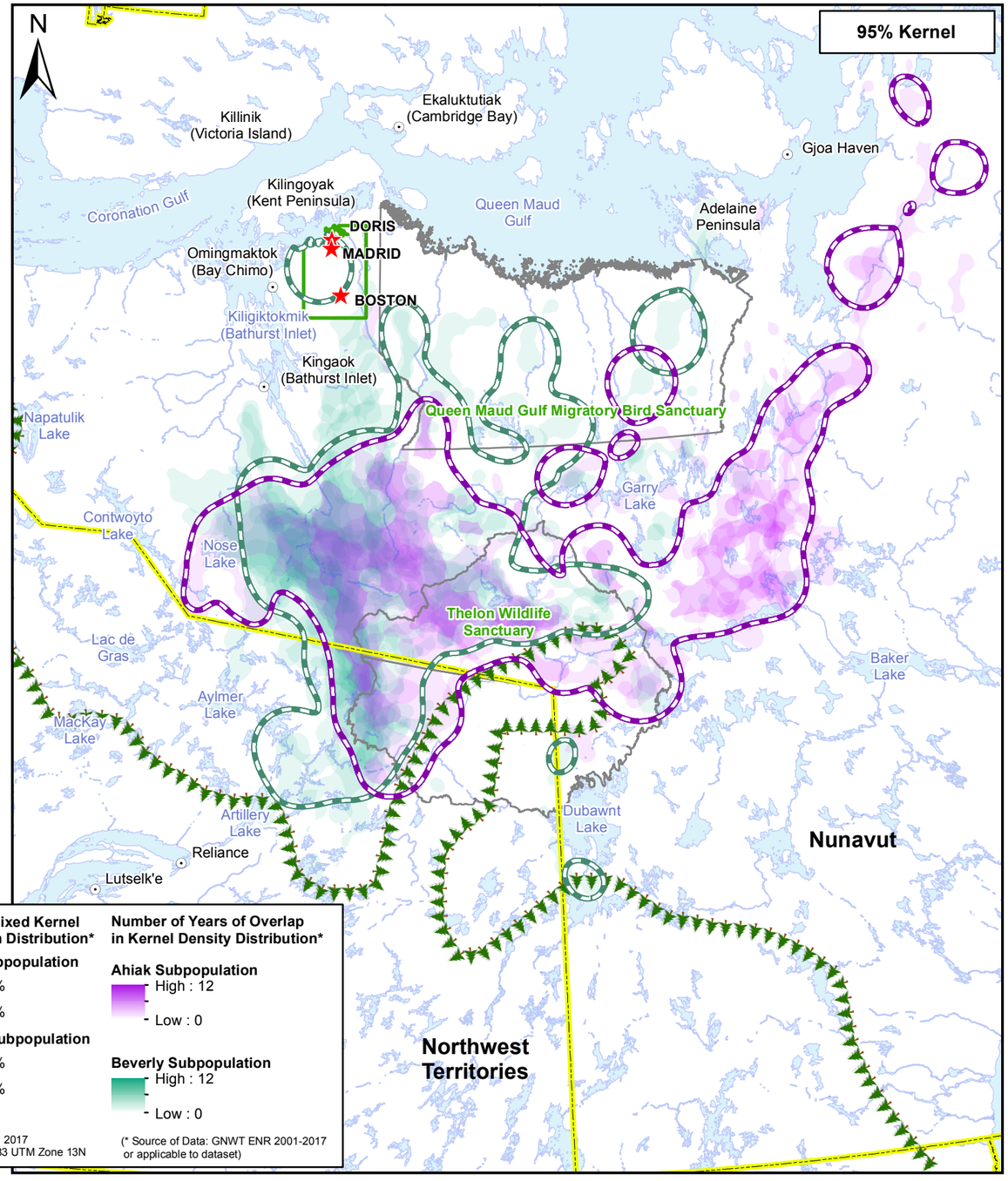
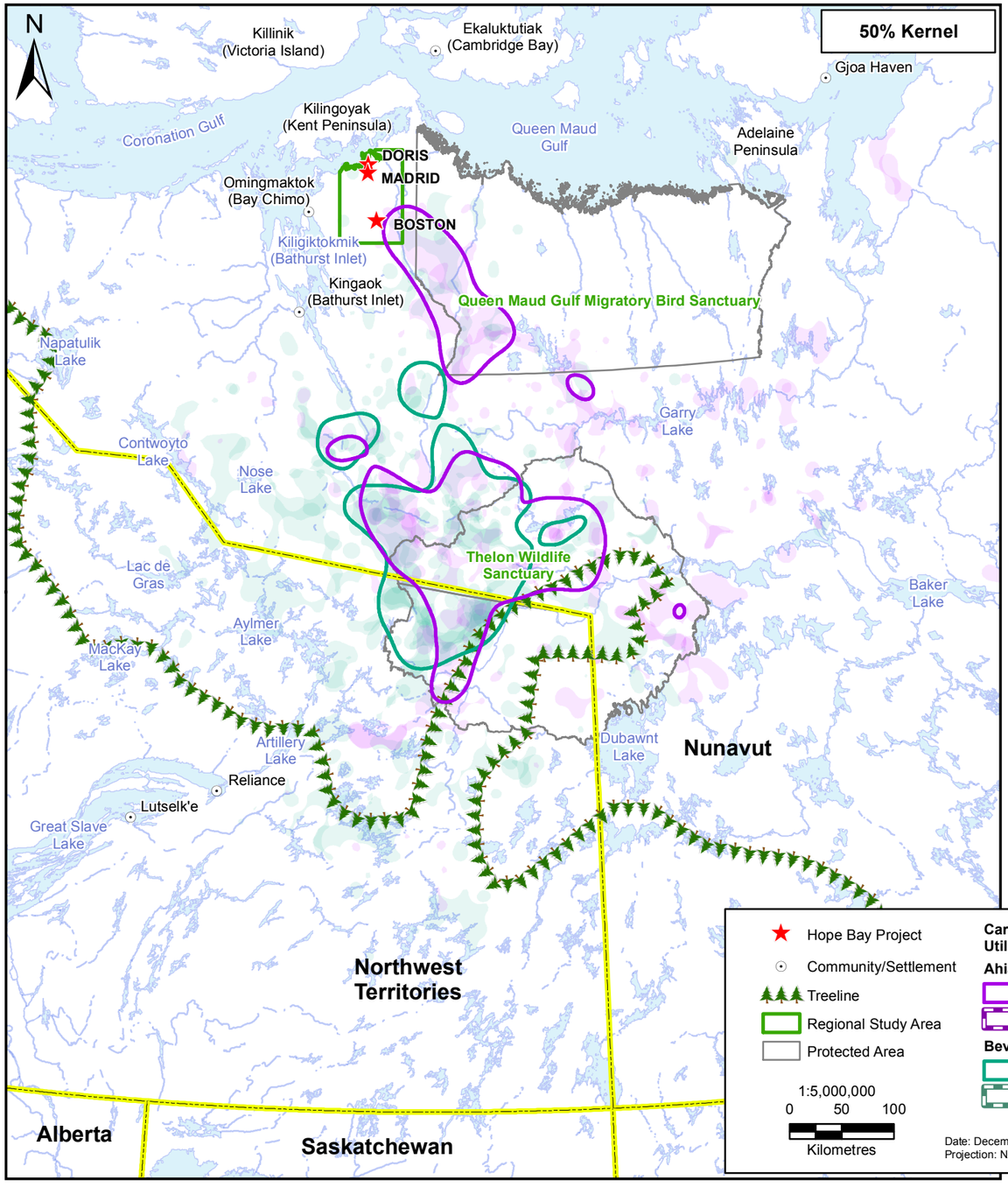
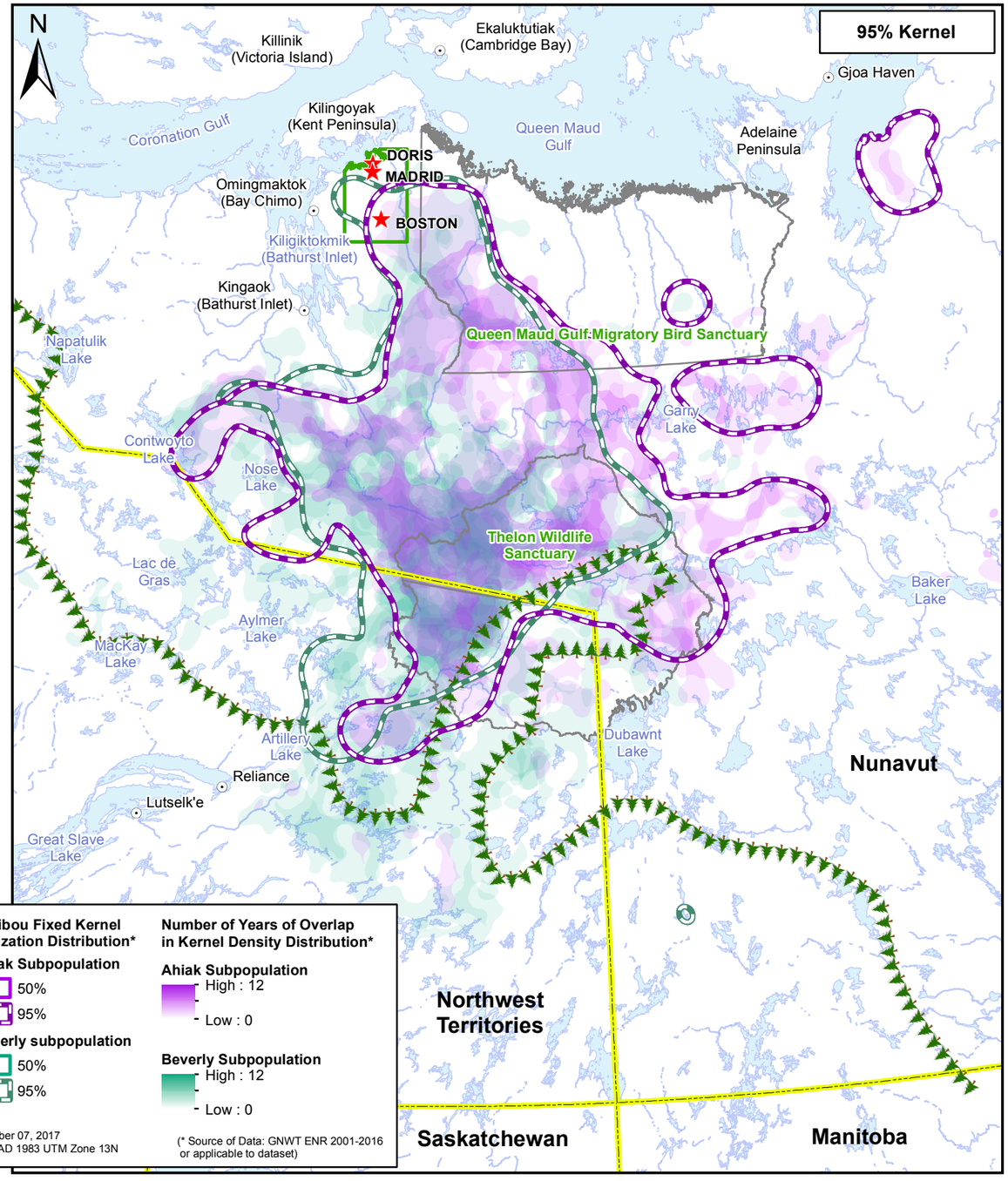


Figure 9.8-11
Fall Distribution of the Beverly and Ahiak (Mainland) Caribou Subpopulations, per Year





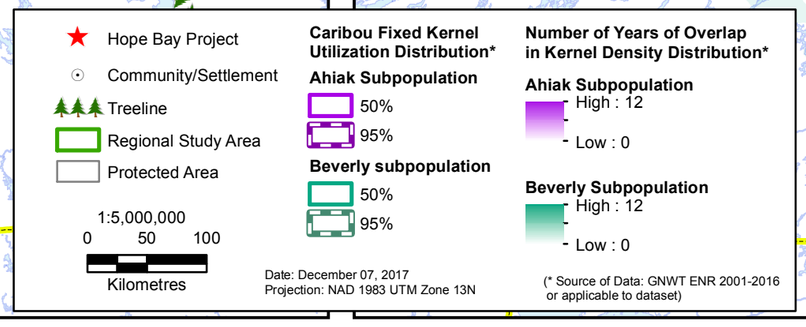
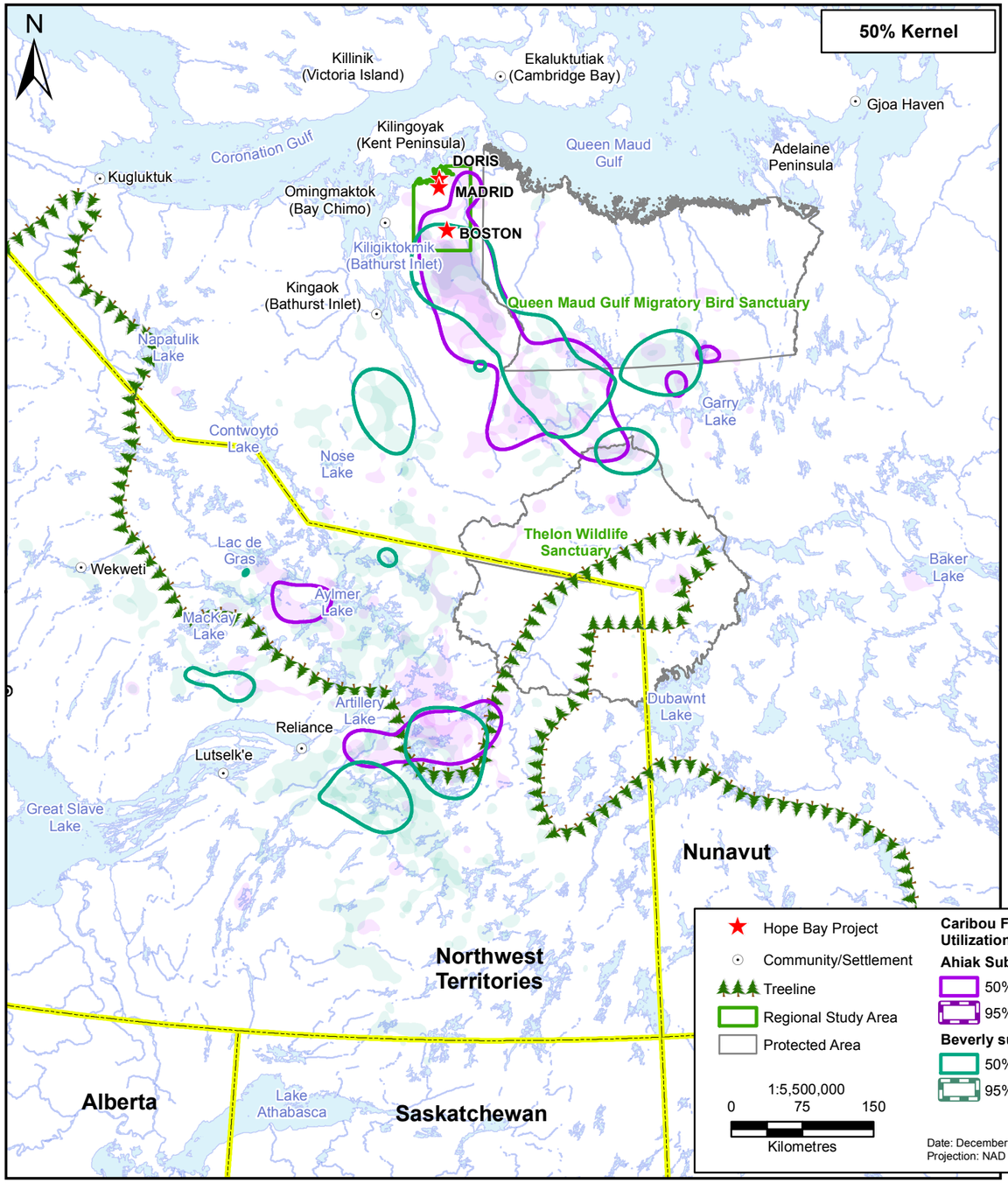


Figure 9.8-12
Winter Distribution of the Beverly and Ahiak (Mainland) Caribou Subpopulations, per Year



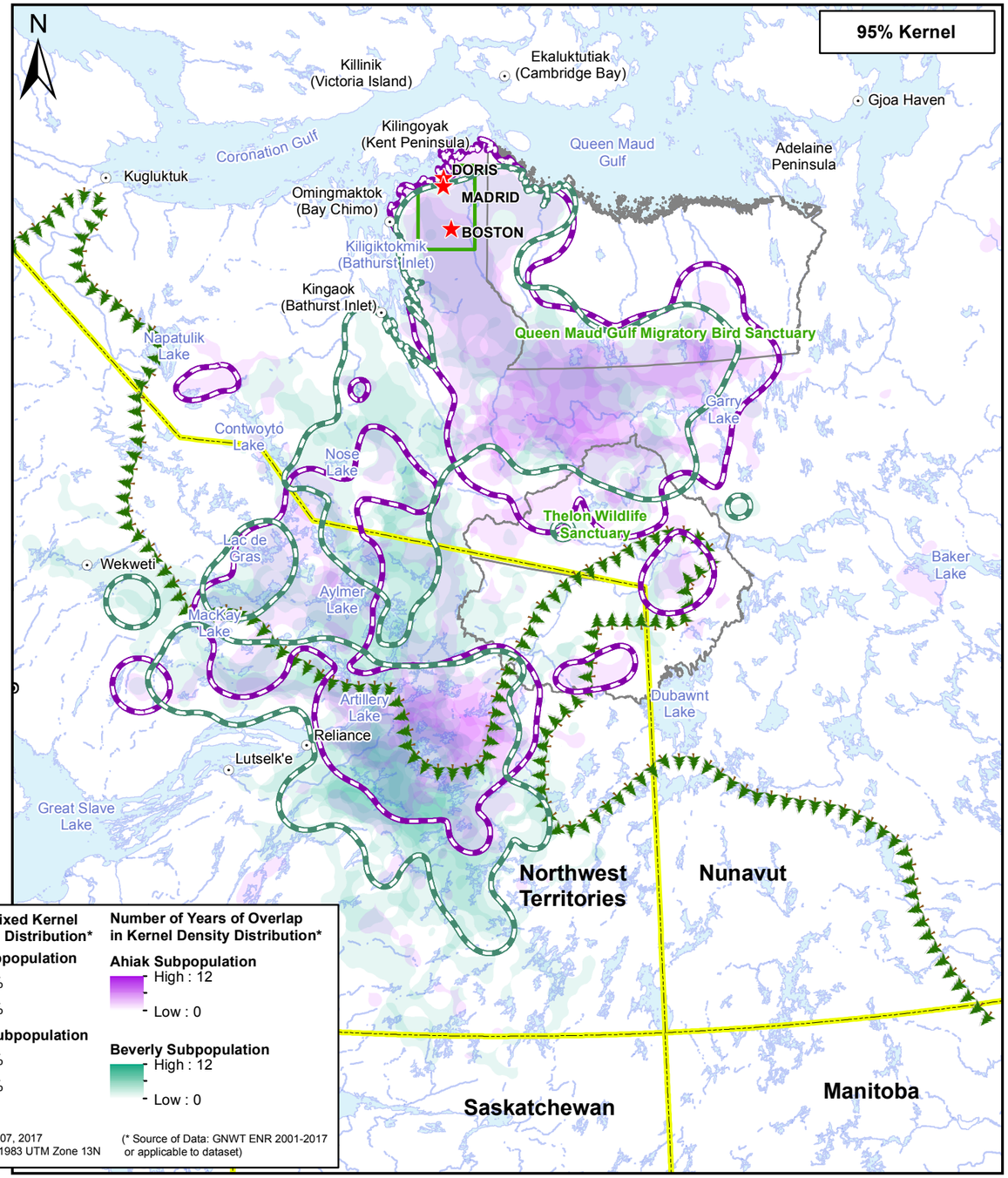


Table 9.8-9. Area of Good Quality Habitat and Total Habitat Loss due to the Madrid-Boston Project and Hope Bay Project Relative to Seasonal Ranges of the Dolphin and Union Herd

Season/Area	Habitat Lost (ha)			Winter Range (%)			Annual Range (%)		
	Doris[1]	Madrid-Boston	Total	Doris[1]	Madrid-Boston	Total	Doris[1]	Madrid-Boston	Total
Winter	73	1,801	1,875	0.001	0.028	0.029	0.0004	0.009	0.010
Total Area	517	4,189	4,706	0.008	0.066	0.074	0.003	0.022	0.024

[1] Doris refers to the Approved Project, including the Doris Project and Madrid North and South, which are already permitted for a bulk sample

The total area of good quality winter habitat lost due to the Hope Bay Project (the combination of the Permitted Project and Madrid-Boston) is 1,875 ha, which represents 9.5% of the good quality habitat available in the LSA, 0.8% of that in the RSA, 0.029% of that in the winter range, and 0.010% in the annual range (Tables 9.8-8 and 9.8-9).

The total area lost within the PDA of Madrid-Boston is 4,189 ha, which is 0.066% of the habitat in the winter range and 0.022% in the annual range (Table 9.8-9). For the Hope Bay Project, the total area lost in the PDAs is 4,709, which is 0.074% of the habitat in the winter range and 0.024% in the annual range. This amount of loss represents a small proportion that is unlikely to result in an adverse effect on the Dolphin and Union caribou herd.

The size of individual year winter ranges varied over time as well as the spatial distribution of areas used, based on available collar data (Figure 9.8-9; Table 9.8-10). There has been no overlap between the Doris PDA and the winter range of Dolphin and Union caribou based on available collar data but animals have been recorded on cameras during winter. Based on collar data, from 1999 to 2004, there was no overlap between the Project PDA and the areas used by Dolphin and Union caribou in the winter, whereas in the last two winters (2015-2016, and 2016-2017), there has been a small amount of overlap (0.2% of the winter range; Table 9.8-10). The change in the amount of overlap in recent years is likely the result of the locations where caribou were collared, because the collaring team in 2015 and 2016 was based out of the Doris camp.

Table 9.8-10. Individual Annual Winter Ranges for Dolphin and Union Caribou and Overlap with Madrid-Boston

Year*	Winter Range (Ha)*	PDA Overlap (Ha)	%
1999	1,519,643	0	0
2000	848,501	0	0
2001	644,480	0	0
2002	743,919	0	0
2003	502,467	0	0
2015	1,263,706	2,308	0.18
2016	1,385,593	2,977	0.21

** Winter ranges are calculated across two calendar years (i.e., December 8 to April 16). For the purposes of display, only the one year is used in the table, representing the year for data from December 8 to 31 (i.e., 1999 represents data from December 8, 1999 to April 16, 2000). The range is represented by the 95% kernel distribution.*

Mainland Caribou (Beverly sub-population)

The calving and post-calving ranges of the Beverly caribou are east of the Project in the QMGMBS. Following the post-calving period, they disperse west and south to their summer range, the northern tip of which overlaps the Boston site. During fall, the herd travels south towards the winter range but the northern edge of the winter range overlaps the Project in some years.

The area of good quality summer habitat in the Project PDA is 3,572 ha, which is 7.6% of the good quality habitat in the LSA and 0.8% of that in the RSA (Table 9.8-8). This area is 0.036% of the Beverly summer range and 0.013% of the annual range calculated as good quality habitat and total habitat (Tables 9.8-6 and 9.8-11). The area of good quality fall habitat in the Madrid-Boston PDA is 1,059 ha, 0.010% of that in the fall range, and 0.004% of the annual range (Tables 9.8-6 and 9.8-11). The area of good quality winter habitat in the Project PDA is 1,801 ha, 0.010% of that in the winter range, and 0.007% of the annual range (Tables 9.8-6 and 9.8-11).

The area of good quality summer, fall, and winter habitat predicted to be lost due to the Hope Bay Project (the combination of the Permitted Project and Madrid-Boston) is 3,741 ha, 1,086 ha, and 1,801 ha, representing 0.9%, 0.4%, and 0.8% of the good quality habitat available in the RSA. These areas represent 0.038%, 0.010%, and 0.010% of the summer, fall, and winter ranges of the Beverly caribou herd and a maximum of 0.014% of the annual range.

The total area lost within the PDA of Madrid-Boston is 4,189 ha, which accounts for 0.023% to 0.043% of the seasonal ranges for Beverly caribou and 0.015% of the annual range. For the Hope Bay Project, the total area lost in the PDAs is 4,709, representing from 0.026% to 0.048% of the seasonal ranges and 0.017% of the annual range (Tables 9.8-6 and 9.8-11).

The loss of good quality and total habitat represents a small proportion of the habitat available to the Beverly caribou herd in the RSA and winter range, and unlikely to adversely affect this caribou herd.

The size of individual year Beverly seasonal ranges Project varied over time, as well as the spatial distribution of areas used, based on available collar data (Figures 9.8-4 and 9.8-5, Figures 9.8-10 to 9.8-12; Table 9.8-12). There has been no overlap between the Phase 1 PDA and any of the seasonal ranges of Beverly caribou in any year, and only a small amount of overlap in the winter range (0.03 to 0.04%) in recent years (2014-2015, and 2015-2016; Table 9.8-12). This result suggests that the seasonal ranges of Beverly caribou are variable but have not been shifting towards the Project over time.

Mainland Caribou (Ahiak sub-population)

The calving and post-calving ranges of the Ahiak caribou are east of the Project in the QMGMBS. The Ahiak caribou spend the summer, fall and winter on the tundra, which includes the Project area in most years. The area of good quality habitat lost due to the Project is 3,572 ha (summer), 1,059 ha (fall), and 1,801 ha (winter), which is 0.029%, 0.007% and 0.010% of the summer, fall, and winter ranges, respectively (Tables 9.8-6 and 9.8-13).

The area of good quality summer, fall, and winter habitat predicted to be lost due to the Hope Bay Project (the combination of the Permitted Project and Madrid-Boston) is 3,741 ha, 1,086 ha, and 1,801 ha, representing 0.9%, 0.4%, and 0.8% of the good quality habitat available in the RSA. These areas represent 0.030%, 0.007%, and 0.011% of the summer, fall, and winter ranges of the Ahiak caribou herd and a maximum of 0.012% of the annual range (Tables 9.8-6 and 9.8-13).

The total area lost within the PDA of Madrid-Boston is 4,189 ha, which accounts for 0.024% to 0.034% of the seasonal ranges for Ahiak caribou and 0.014% of the annual range. For the Hope Bay Project, the total area lost in the PDAs is 4,709, representing from 0.027% to 0.038% of the seasonal ranges and 0.015% of the annual range (Tables 9.8-6 and 9.8-13).

Table 9.8-11. Area of Good Quality Habitat and Total Habitat Loss due to the Madrid-BostonProject and Hope Bay Project Relative to Seasonal Ranges of the Beverly Caribou Sub-population

	Habitat Lost (ha)			% of Summer Range			% of Fall Range			% of Winter Range			% of Annual Range		
Season	Doris[1]	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total
Summer	169	3,572	3,741	0.002	0.036	0.038	-	-	-	-	-	-	0.001	0.013	0.014
Fall	26	1,059	1,086	-	-	-	0.0002	0.010	0.010	-	-	-	0.0001	0.004	0.004
Winter	73	1,801	1,875	-	-	-	-	-	-	0.0004	0.010	0.010	0.0003	0.007	0.007
Total Area	517	4,189	4,706	0.005	0.043	0.048	0.005	0.038	0.043	0.003	0.023	0.026	0.002	0.015	0.017

[1] *Doris refers to the Approved Project, including the Doris Project and Madrid North and South, which are already permitted for a bulk sample.*

Table 9.8-12. Individual Annual Seasonal Ranges for Beverly Caribou Sub-population and Overlap with Madrid-Boston

	Seasonal Ranges*																	
	Winter***			Spring Migration			Calving			Post-calving			Summer			Fall Migration		
Year**	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%
2002	53,388	0	0	131,654	0	0	-	-	-	-	-	-	-	-	-	-	-	-
2003	24,495	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	137,772	0	0	139,184	0	0	-	-	-	200,466	0	0	557,552	0	0	157,623	0	0
2006	3,153,021	0	0	3,035,780	0	0	267,673	0	0	774,809	0	0	1,720,369	0	0	3,237,990	0	0
2007	3,343,683	0	0	3,278,095	0	0	282,183	0	0	992,357	0	0	2,241,479	0	0	3,520,378	0	0
2008	4,957,762	0	0	7,782,926	0	0	779,436	0	0	1,413,450	0	0	2,797,008	0	0	5,216,548	0	0
2009	4,716,670	0	0	5,057,568	0	0	384,698	0	0	1,062,367	0	0	3,332,376	0	0	5,626,635	0	0
2010	1,752,774	0	0	3,962,824	0	0	273,866	0	0	1,042,447	0	0	1,409,153	0	0	2,616,662	0	0
2011	1,913,815	0	0	2,574,742	0	0	231,752	0	0	842,294	0	0	1,002,245	0	0	1,593,161	0	0
2012	4,948,965	0	0	3,971,719	0	0	316,282	0	0	1,051,262	0	0	2,158,381	0	0	3,574,834	0	0
2013	2,462,413	0	0	464,258	0	0	-	-	-	279,016	0	0	462,121	0	0	441,412	0	0
2014	3,322,112	0	0	3,065,005	0	0	287,723	0	0	767,068	0	0	1,842,938	0	0	2,777,604	0	0
2015	4,752,876	1,270	0.04	3,857,512	0	0	359,526	0	0	1,128,139	0	0	1,135,176	0	0	2,712,410	0	0
2016	4,338,570	3,068	0.03	2,507,775	0	0	304,190	0	0	3,115,774	0	0	2,469,546	0	0	3,485,030	0	0
2017	-	-	-	2,418,125	0	0	174,029	0	0	1,967,648	0	0	836,783	0	0	815,004***	0	0

** The range is represented by the 95% kernel distribution. Blank cells represent years where there were not sufficient data to generate ranges.*
*** Winter ranges are calculated across two calendar years (i.e., November 1 to April 14). For the purposes of display, only the one year is used in the table, representing the year for data from November 1 to December 31 (i.e., 2002 represents data from November 1, 2002 to April 14, 2003)*
**** represents the partial fall range in 2017 as collar data is current only to October 2, 2017.*

Table 9.8-13. Area of Good Quality Habitat and Total Habitat Loss due to the Madrid-Boston Project and Hope Bay Project Relative to Seasonal Ranges of the Ahiak Caribou Sub-population

	Habitat Lost (ha)			% of Summer Range			% of Fall Range			% of Winter Range			% of Annual Range		
Season	Doris[1]	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total	Doris	Madrid-Boston	Total
Summer	169	3,572	3,741	0.001	0.029	0.030	-	-	-	-	-	-	0.001	0.012	0.012
Fall	26	1,059	1,086	-	-	-	0.0002	0.007	0.007	-	-	-	0.0001	0.003	0.004
Winter	73	1,801	1,875	-	-	-	-	-	-	0.0004	0.010	0.011	0.0002	0.006	0.006
Total Area	517	4,189	4,706	0.004	0.034	0.038	0.004	0.028	0.032	0.003	0.024	0.027	0.002	0.014	0.015

[1] *Doris refers to the Approved Project, including the Doris Project and Madrid North and South, which are already permitted for a bulk sample*

This represents a small proportion that is unlikely to result in an adverse effect to the Ahiak caribou herd.

The size of individual year Ahiak caribou seasonal ranges Project varied over time, as well as the spatial distribution of areas used, based on available collar data (Figures 9.8-4 and 9.8-5, Figures 9.8-10 to 9.8-12; Table 9.8-12). There has been a nominal amount of overlap between the Phase 1 PDA and seasonal ranges of Ahiak caribou, which only occurred during the winter of 2015-2016 (47 ha; Table 9.8-14). Overlap between the Project PDA and seasonal ranges of Ahiak caribou have been limited to the fall range in 2014 (0.01%) and the winter range in 2014-2015 and 2015-2016 (0.04 to 0.07%; Table 9.8-13). This result suggests that the seasonal ranges of Beverly caribou are variable but have not been shifting towards the Project over time.

Summary of Habitat Loss Effects on Caribou

TMAC has followed the mitigation hierarchy by first avoiding sensitive areas. TMAC designed Madrid-Boston to avoid environmentally sensitive sites for wildlife and vegetation, as described in the Project Description (Volume 3). Sensitive habitats for a variety of wildlife species, including caribou, were mapped and provided to Project engineers who altered the Boston road route and infrastructure location, including quarries, waste rock piles, access roads, tailings dry stack and Project ponds to avoid important habitats. These included important sites identified by Inuit TK, freshwater and ice crossings for caribou, eskers used by caribou for movement, upland areas used for insect or heat relief, wolf and wolverine dens, raptor nests, waterfowl habitat, and sensitive wetland ecosystems. TMAC also avoided the impacts of habitat loss by lumping and minimizing the overall size of the Madrid-Boston footprint through Project design. TMAC will also report the size of the footprint every three years in the WMMP report.

During the third caribou workshop, Elders and land users surveyed the Boston site and the Boston access road for important caribou habitats. No important habitat features were identified by Elders and land users at the Boston site. Movement areas were identified and recorded where they cross the proposed Boston road, and are proposed locations for installation of crossing structures. Other mitigation to minimize effects of the Project on habitat quantity and quality includes Project design to cap the TIA and Boston dry stack tailings at closure to manage dust and dust management on Project roads and airstrips during operations.

The Madrid-Boston Project will not interact with any special habitat features, including calving and post-calving areas, eskers, and hills or upland areas used for heat and insect avoidance. Some loss of foraging habitat will occur for all caribou herds that might interact with the Project, but this area will be very small, less than 0.05% for seasonal ranges and 0.02% for the annual ranges.

During the first caribou workshop, Elders and land users identified that habitat loss was an expected impact of the Project, but with a low risk to caribou herds. After reviewing the Project site, existing mitigation measures, and proposed Madrid-Boston mitigation, Elders and land users agreed by consensus that:

> *"Mitigation for the existing Doris Project protects caribou."*

And

> *"The mitigation for Phase 2, as agreed to by consensus by the group, will protect caribou."*

The Project will not remove any special habitat features, including calving areas, post-calving areas, eskers or upland areas. The area of foraging habitat is small, compared to either the seasonal or total

herd ranges. However, given the importance of caribou to northern communities and concerns over the status of barren-ground caribou populations across the Canadian Arctic and the fact that habitat loss will result in a small, but measurable effect on caribou habitat, this potential effect was rated as a residual effect for both Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak sub-populations) and a cumulative effects assessment was conducted (Section 9.9).

9.8.3.2 Disturbance

Introduction

Elders and land users at the caribou workshop held in September, 2016, identified noise from aircraft and the mine site as expected impacts of the Project. Workshop participants rated the risk to caribou from disturbance as having the potential for a high impact on caribou without mitigation because noise disturbance has the potential to affect many caribou.

Noise from vehicle and truck traffic was considered an expected, medium scale impact on caribou without mitigation. Disturbance due to the presence of people and dust was rated as an expected effect with a low impact on caribou without mitigation because the participants felt that it had the potential to affect few caribou. This potential effect begins at Construction, continues through Operation and Closure, and ceases in Post-closure.

Through discussions with Elders and land users, the KIA and the GN, potential sources of disturbance for caribou were identified as 1) the noise and sight of helicopters, 2) the noise created by the operating mine site, 3) noise from blasting in quarries, 4) noise from Project roads, and 5) dust from the TIA. The mitigation and potential impacts of each of these sources of disturbance is discussed in the following section.

As part of the caribou workshops Elders and land users reviewed the mitigation conducted for the Doris Project to address noise disturbance, and the proposed mitigation for the Madrid-Boston Project. During the second and third caribou workshops, Elders and land users visited the operating Doris mine and the areas of the proposed Madrid and Boston sites and evaluated the existing mitigation measures in the field, including each of the sources of disturbance discussed earlier.

The potential impact of disturbance on caribou, after mitigation has been applied, was evaluated using information from TK, Elders and land users in the caribou workshops, and the results of long-term monitoring of the Doris Project. In addition, a scientific literature review was conducted of industrial projects in similar environments. Finally, noise and dust modeling for the Project were reviewed. Sources of information for estimating the response of caribou to disturbance included:

1. Caribou workshops where Elders and land users visited the site and evaluated the effects of the Doris Project on caribou.
2. A description of the mitigation measures used at the Doris Project and proposed for the Madrid-Boston Project, evaluated by Elders and land users during the caribou workshops, including mitigation for aircraft, mine site noise, quarry blasting noise, vehicles, and dust.
3. Monitoring from the Doris Project to determine if caribou are avoiding the site, resulting in a Zone of Influence (ZOI) surrounding the site:
    - aerial survey study surrounding the Windy Exploration camp from 1996 to 2005;
    - wildlife camera study surrounding the Doris Project from 2012 to 2015; and
    - satellite collar analysis surrounding the Doris Project from 2015 to 2017.

Table 9.8-14. Individual Annual Seasonal Ranges for Ahiak Caribou Sub-population and Overlap with Madrid-Boston

	Seasonal Ranges*																	
	Winter***			Spring Migration			Calving			Post-calving			Summer			Fall Migration		
Year**	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%	Range (Ha)	PDA Overlap (Ha)	%
2006	674,473	0	0	420,638	0	0	-	-	-	471,769	0	0	580,708	0	0	906,616	0	0
2007	519,975	0	0	704,486	0	0	-	-	-	280,114	0	0	624,063	0	0	707,243	0	0
2008	410,716	0	0	428,374	0	0	-	-	-	-	-	-	176,223	0	0	400,607	0	0
2009	823,659	0	0	1,011,308	0	0	94,389	0	0	221,883	0	0	600,431	0	0	954,896	0	0
2010	2,080,152	0	0	1,541,643	0	0	158,658	0	0	447,222	0	0	867,375	0	0	1,823,237	0	0
2011	985,069	0	0	294,908	0	0	-	-	-	-	-	-	249,426	0	0	331,193	0	0
2012	4,232,593	0	0	1,790,343	0	0	222,037	0	0	474,388	0	0	903,870	0	0	1,899,343	0	0
2013	1,238,553	0	0	2,005,522	0	0	202,402	0	0	515,600	0	0	1,206,809	0	0	751,456	0	0
2014	4,976,943	2,012	0.040	4,017,104	0	0	202,873	0	0	902,240	0	0	2,421,002	0	0	4,904,764	591	0.012
2015	4,617,268	3,401***	0.074	4,633,346	0	0	257,485	0	0	398,598	0	0	1,576,143	0	0	3,141,439	0	0
2016	3,593,853	0	0	4,146,485	0	0	892,499	0	0	4,346,436	0	0	3,011,921	0	0	2,352,907	0	0
2017	-	-	-	4,485,661	0	0	983,586	0	0	3,765,465	0	0	2,008,327	0	0	1,354,828***	0	0

** The range is represented by the 95% kernel distribution. Blank cells represent years where there were not sufficient data to generate ranges.*

*** Winter ranges are calculated across two calendar years (i.e., November 1 to April 14). For the purposes of display, only the one year is used in the table, representing the year for data from November 1 to December 31. (i.e., 2006 represents data from November 1, 2002 to April 14, 2003)*

**** represents the partial fall range in 2017 as collar data is current only to October 2, 2017.*

4. A literature review of monitoring studies from other Arctic projects, including mining, oil and gas operations, roads, and military operations.
5. Predictions of noise levels using modeling:
   - facility noise;
   - aircraft noise; and,
   - blasting noise.
6. Predicting effects on caribou using a spatial (GIS) analysis to measure:
   - indirect habitat loss;
   - encounter rate and residency time; and
   - disturbance of important habitats.

These information sources were then used to evaluate the potential impacts of disturbance, after mitigation has been applied, for each caribou herd that interacts with the Madrid-Boston Project.

The Views of Elders and Land Users during Caribou Workshops

During the caribou workshops Elders and land users considered noise from vehicle and truck traffic to be an expected, medium scale impact on caribou without mitigation. Disturbance due to the presence of people and dust was rated as an expected effect with a low scale of impact without mitigation on caribou because the participants felt that it had the potential to affect few caribou.

During the second and third caribou workshops (April and August, 2017), Elders and land users reviewed the proposed mitigations to manage disturbance to caribou. Workshop participants also conducted two site visits (April and August, 2017) to experience for themselves the scale of disturbance due to the existing Doris Project and to evaluate proposed mitigation in the field. The site tours included visits to several Project facilities (Figure 9.8-13):

- Roberts Bay Laydown;
- Roberts Bay Dock;
- Doris Main Quarry;
- Doris Camp (generator facility, mill, and underground portal);
- Doris vent raises;
- Tailings Impoundment Area (TIA)
- TIA quarry;
- Windy Camp; and
- several listening locations along the Doris to Windy Camp road.

This section describes the results of the site visits and workshop participants' views on the impacts of the existing Doris Project and future Madrid-Boston Project on caribou. The following section describes the specific mitigation measures to limit disturbance to caribou, and the suggestions, views and conclusions reached by Elders and land users about their effectiveness.

During the April 2017 site visit, the weather was clear, with a temperature of -15° C, and no wind; excellent conditions for sound propagation. The August 2017 site visit was held under low wind conditions (<5 kn) and warm temperatures of +15° C, which were good conditions for sound propagation.

Roberts Bay Laydown: Workshop participants visited the Roberts Bay Laydown in April 2017. Elders and land users noted that the only noise they could hear was the small power generator at the recycling facility. Workshop participants also noted that some sea can doors were left open and requested that they be closed. TMAC agreed and this mitigation for wildlife attractants is discussed in Section 9.8.3.4.

Roberts Bay Dock: The caribou workshop participants discussed caribou and sea ice conditions at the Roberts Bay Dock (Plate 9.8-1). Elders and land users indicated that they could not hear the generator from the Laydown area, approximately 300 m away.



Plate 9.8-1. Caribou workshop participants visiting the Roberts Bay Dock. Note that the Roberts Bay generator was not audible, 300 m away.

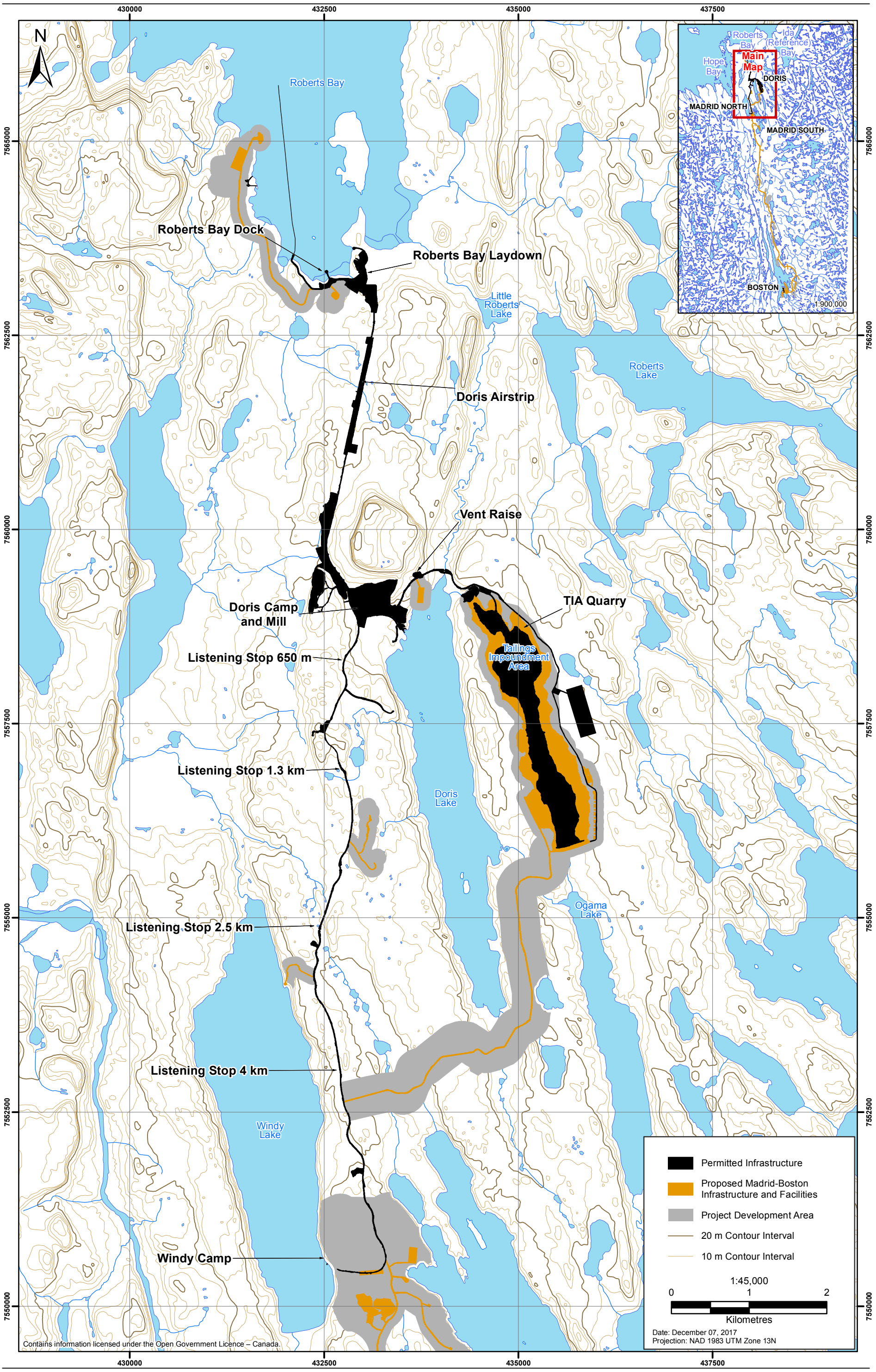
Doris Airstrip: Workshop participants then visited the Doris Airstrip and reviewed the proposed mitigation to delay or cancel flights if caribou are within 250 m of the airstrip. Elders and land users agreed that this mitigation would keep caribou safe from disturbances.

Doris Camp and Mill: Workshop participants visited the Doris Camp and Mill. Participants noted that they could have a conversation immediately adjacent to the Doris power generators and that the mill made no discernable noise. More information on mitigation measures is in the following section.

Vent Raise: One of the workshop participants had worked at the Lupin mine during the 1970s and was concerned that the vent raises at Lupin, which supply fresh heated air to the underground, were very noisy. The workshop participants visited the Doris vent raise during the second caribou workshop in April, 2017 to evaluate the noise it produces. Workshop participants noted that the Doris vent raise was very quiet, unlike those at Lupin, and were unlikely to disturb caribou.

Tailings Impoundment Quarry: Workshop participants visited the location of the TIA explosives facility and TIA quarry during August, 2017, and interviewed the head of blasting operations. From the TIA quarry on a hilltop approximately 2.2 km from the Doris Camp, there was no discernable noise from the Doris operations. More information on blasting mitigation measures is in the following section.

Figure 9.8-13
Caribou Workshop Site Visit Locations at the Existing Doris Project



Windy Camp: Workshop participants visited the now closed Windy Camp. There was no discernable noise or disturbance from Doris operations at this site.

Listening Stops: During April, 2017, workshop participants stopped along the Doris to Windy road at four locations, at 650 m, 1.3 km, 2.5 km, and 4 km from the Doris Camp (Plate 9.8-2). The Doris site was audible at only the 650 m location, where the power generators were clearly audible. During the listening period a haul truck exited the underground portal and dumped a load of ore adjacent to the mill, but this was not audible. Also during this period, a loader worked to feed ore into the mill. The loader operation and engine were not audible, but its backup beeper was audible. No Project activities were audible at 1.3 km, 2.5 km, or 4 km. It should be noted that the conditions during the April site visit were excellent for sound transmission, with cold (-15° C) still air, hard packed spring snow and clear skies.



Plate 9.8-2. Caribou workshop participants at the four listening stops along the Windy Road, at 650 m, 1.3 km, 2.5 km and 4 km from Doris site. Note that Doris site could be heard from only 650 m.

After discussing risk to caribou and reviewing the mitigation measures in the field, Elders and land users Workshop participants also considered and identified general statements about the Project. Also during the site visits, caribou workshop participants experienced the Doris Project first hand and agreed with the following statements:

"Mitigation for the existing Doris Project protects caribou."

Importantly, after Elders and land users visited the Doris site, reviewed the mitigation measures and discussed at length the potential impacts of the Project on caribou, they concluded that caribou would

not be adversely affected if they reside in the Hope Bay area. Elders and land users agreed with the following statements:

> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

and

> *"[With the planned mitigation and monitoring] the risk to caribou associated with Phase 2 are acceptable."*

Workshop participants reviewed the mitigation proposed for the Madrid-Boston Project, which is discussed in the following section.

Project Activities and Mitigation to Reduce Disturbance

The mitigation measures for aircraft, the mine site, quarry blasting, vehicles and dust are discussed in the following sections.

A) Aircraft

Aircraft are an integral component of any mining and exploration project. A Bombardier Q400 (Dash 8) and Hercules C-130 will be used to transport personnel to and from the site, ship perishable supplies such as food, and certain Project material. Nunavut residents are transported to site via Dorniers, twin otters or other similar aircraft. Project fuel and the majority of Project equipment will be shipped to site on the annual sea lift. Transport by fixed wing aircraft is an already-permitted activity. The Project will increase the frequency of fixed wing aircraft flights to four per week.

Standard mitigation measures for fixed wing aircraft in Nunavut include maintaining a minimum flight level of 610 m, except during takeoff and landing. If caribou are on the airstrip, or within 250 m of the airstrip, then flights will be re-directed or cancelled until the caribou move off. If caribou become resident or habituated to the airstrip, then they may be moved off using standard techniques for their own safety.

Helicopters will primarily be used as part of the exploration program and are an already-permitted activity under the Hope Bay Regional Exploration Project (NWB Type B Water Licence 2BE-HOP1222). Currently, exploration helicopters are based out of the Doris site and the Boston camp and are used to move exploration drills to targets in the Hope Bay Belt and to transfer crew to the drills. Drilling will primarily be conducted during winter, using ground-based transportation equipment suitable for working on snow. Helicopter supported will be used if the drilling program cannot be completed during the winter. The primary drill targets are generally within 2 km of the existing Doris site and planned Madrid-Boston roads, including at the existing underground workings north east of Doris Mountain, approximately 1.5 km west of the Doris runway, Madrid North and South, at on the rock outcrops south of the Boston camp.

Helicopters will sling drill supplies and move crews from a location on an all-weather road that is as close as possible to the drill site, instead of from Doris or Boston camps. A small amount of helicopter activity will be required specifically for the Project to complete compliance monitoring tasks such as water quality monitoring.

Helicopter noise will be minimized year-round through:

- pilot education to avoid high value areas for caribou, such as freshwater crossings;
- avoiding caribou by 300 m vertically or 600 m horizontally;
- avoiding caribou by 610 m vertically or 600 m horizontally in the calving range during the calving season; and
- pilots will adaptively manage their setbacks from caribou if disturbance to caribou is observed.

The vertical setback of 300 m was proposed by Frank Miller and Anne Gunn (F. L. Miller and A. 1981)) based on observational research, and has remained a standard mitigation measure in the Canadian Arctic for caribou outside of sensitive areas, such as calving and post-calving areas.

The vertical setback of 610 m is a common distance used for vertical separation between helicopters and sensitive wildlife features, including calving and post calving caribou (K. Poole and Gunn 2016) and salt licks in British Columbia (BC FLNRO 2015). The *Management Plan for the Barren-ground Caribou (Rangifer tarandus groenlandicus), Dolphin and Union population, in Canada* (Environment and Climate Change Canada 2017a) makes the following suggestions for flight regulations:

> *"It has been suggested that flights should be at high altitude over calving areas or should not be allowed at all where caribou are calving (Species at Risk Committee 2013; First Joint Meeting for Dolphin and Union Caribou Management Plan 2015; Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Second Joint Meeting for Dolphin and Union Caribou Management Plan 2016)."*

Elders and land users evaluated fixed wing and helicopter management activities in the field. Workshop participants visited the Doris airstrip and viewed stakes that had been placed at 250 m from the airstrip. Should caribou be observed within 250 m of the airstrip, then flights are delayed until caribou move off.

Elders and land users also witnessed a landing Hercules C-130 from the Doris camp. The aircraft was descending towards the airstrip about 2 km ahead, and was approximately 500 m above and 500 m to the side of where the workshop participants were standing. From that location, the four engine Hercules aircraft was inaudible.

During the third caribou workshop at the Boston camp, participants were also exposed to helicopter overflights at 300 m and 600 m to demonstrate the noise levels experienced by caribou under standard mitigation measures.

At the conclusion of the third caribou workshop, Elders and land users agreed by consensus that mitigation for aircraft was appropriate and:

> *"Mitigation for aircraft will keep caribou safe."*

B) Mine Site Noise

The Doris site is currently the primary industrial site at the Project location. With Madrid-Boston, the activities at Doris will continue, with similar, but smaller facilities at Madrid North, Madrid South and Boston. The Doris site includes the Doris camp (accommodations and kitchen facilities), diesel generators, the mill, and workshop and maintenance facilities.

The primary source of noise at the Doris site is the power generation equipment. Design mitigation includes the installation of large mufflers to reduce the noise produced by the generators (Plate 9.8-3). The Doris mill is encased in a large building, insulated to contain noise and maintain an internal temperature above freezing. The maintenance garage and other equipment shops are likewise enclosed inside insulated buildings to contain noise and warmth. The mine workings are underground.



Plate 9.8-3. Elders and land users view the mufflers for the Doris power generators.

Elders and land users visited the Doris site during the second caribou workshop in April 2017. During this site visit, workshop participants visited the diesel generators (Plate 9.8-3), the plant site and underground portal. Workshop participants were able to have a conversation adjacent to the operating diesel generators and noted that the Doris mill did not produce any audible noise.

During the site visit, workshop participants witnessed the standard level of activity at the Doris site, which was in full operations, including the operating generators and mill and an excavator moving ore into the mill. Intermittent activities included an underground haul truck bringing ore to the surface through the portal approximately every 10 to 20 minutes, and a pickup truck moving maintenance crews around the site.

During the second caribou workshop the knowledge holders stressed *"that caribou are more likely to be disturbed by a sudden, loud and irregular noise, particularly one to which they have a direct line-of-sight. A constant, regular noise is not likely to impact caribou, especially if the source is not in view of the animal."*

Following the site visits as part of the caribou workshops, Elders and land users agreed by consensus that mitigation was appropriate and that:

> *"Mitigation for the existing Doris Project protects caribou"*

C) Quarry Blasting Noise

The Doris Project and Madrid-Boston Project are underground mines that do not require extensive open pits. The Project will expand quarries to produce material for pads and the Boston road during Construction, and to a limited degree during Operation to re-surface the road and expand pads periodically. The road is designed to avoid rock outcrops as much as possible, so little blasting is expected as part of road construction.

Blasting in quarries is relatively infrequent, with most blasting occurring during Construction. During the operation of the Doris Project, the mitigation to reduce disturbance to caribou has evolved following feedback from the Inuit Environmental Advisory Committee (IEAC), the KIA and the GN. Initially, blasting was paused should a total of 25 caribou be observed within 1.5 km of the quarry prior to a blast. Following review of the mitigation, the trigger was changed to a single caribou within line of sight from the quarry. This distance was further updated in 2015 based on the distance where modeled blasting noise reached a pressure value at which caribou and other ungulates are reported to not react to blasting-type noises (96 dBA L-peak; Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006) , which corresponds to 2.8 km from the blast site.

This mitigation was reviewed by Elders and land users during the caribou workshops. Workshop participants indicated that caribou are unlikely to react to a loud noise if they do not also have a visual stimulus. Hence, caribou located behind rock outcrops or on the far side of hills should not be affected by blasting noise. This is important at the Project site, because the geography of the Hope Bay Belt is dominated by linear dikes with flat areas of heath tundra and sedge meadows in between (Plates 9.8-4 and 9.8-5). Quarries are located in exposed areas of suitable rock and offer a vantage point to survey for caribou.



Plate 9.8-4. Typical geography of the Hope Bay Belt with exposed linear dikes of volcanic rock separated by lakes and sedge meadows.



Plate 9.8-5. Elders and land users visit the site of the TIA quarry. Note Doris Mountain and the hills in the background are 2.4 km from the quarry.

Elders and land users interviewed the blasting manager responsible for all above-ground blasting at the Project site (Plate 9.8-6). The blasting manager highlighted that the rules surrounding blasts are in place to protect Project personnel under the Nunavut Mines Act. Prior to blasting, the blasting manager performs a series of 360° checks, using binoculars from the top of the rock outcrop where the quarry is located for personnel, 24 hours before blasting and again at 6 hrs, 4 hrs, 2 hrs, and immediately prior to blasting. If any caribou or other wildlife are observed during these checks, including grizzly bears, muskox or other large mammals, then the blast is postponed.



Plate 9.8-6. Elders and land users interview the Project blasting manager at the TIA quarry.

A view-shed analysis was conducted to determine how far and how much area an observer can see from the top of each proposed quarry rock outcrop. This analysis indicated that an observer can see a minimum of 2.8 km from each quarry outcrop, except in some cases where a linear hill feature is in the way. These linear hills are typically at least 2 to 2.5 km from the quarry, so there is little impeded area within 2.8 km of the quarries (Figure 9.8-14; Plate 9.8-4). Given that Elders and land users stated that caribou are unlikely to be disturbed by noise from blasts when they are behind hills, then this method is deemed acceptable.

Following the site visits as part of the caribou workshops, Elders and land users agreed by consensus that mitigation was appropriate and that:

> *"Mitigation for blasting will keep caribou safe."*

D) Vehicles

Elders and land users identified "disturbance from vehicle/ truck traffic noise" as an expected effect of the Project, with medium impact on caribou. Vehicles will be in operation on the all season road between Boston and Doris. Mitigations to reduce the potential impact of vehicle noise include:

- speed limits will be set at 50 km/h and enforced;
- all caribou will be reported to the Environment Manager; and
- vehicles will give caribou the right of way on Project roads.

Noise and dust from vehicles is directly related to the speed of the vehicle (Norman et al. 2016; Zambon, Roman, and Benocci 2017) since the majority of noise and dust are produced by the tire contact with the road. By limiting the speed limit, the amount of noise and dust will be significantly reduced.

Monitoring, reporting and stopping for caribou on or adjacent to the road will allow animals to cross the road, and will reduce disturbance to caribou. During the caribou workshops, Elders and land users reviewed the proposed road mitigation measures and witnessed their implementation during two site visits. Elders and land users indicated that the sight of a person is alarming to caribou, but the sight of a vehicle is generally not alarming unless it is moving quickly. As a result, workshop participants proposed an additional mitigation measure, which was added to the WMMP:

- Project personnel will remain in their vehicles when caribou are observed near the road and vehicles are stopped.

Following the review of the mitigation measures, and adding that personnel should stay in their vehicles, workshop participants agreed by consensus that the mitigation was appropriate and that:

> *"Mitigation for roads and road use will keep caribou safe."*

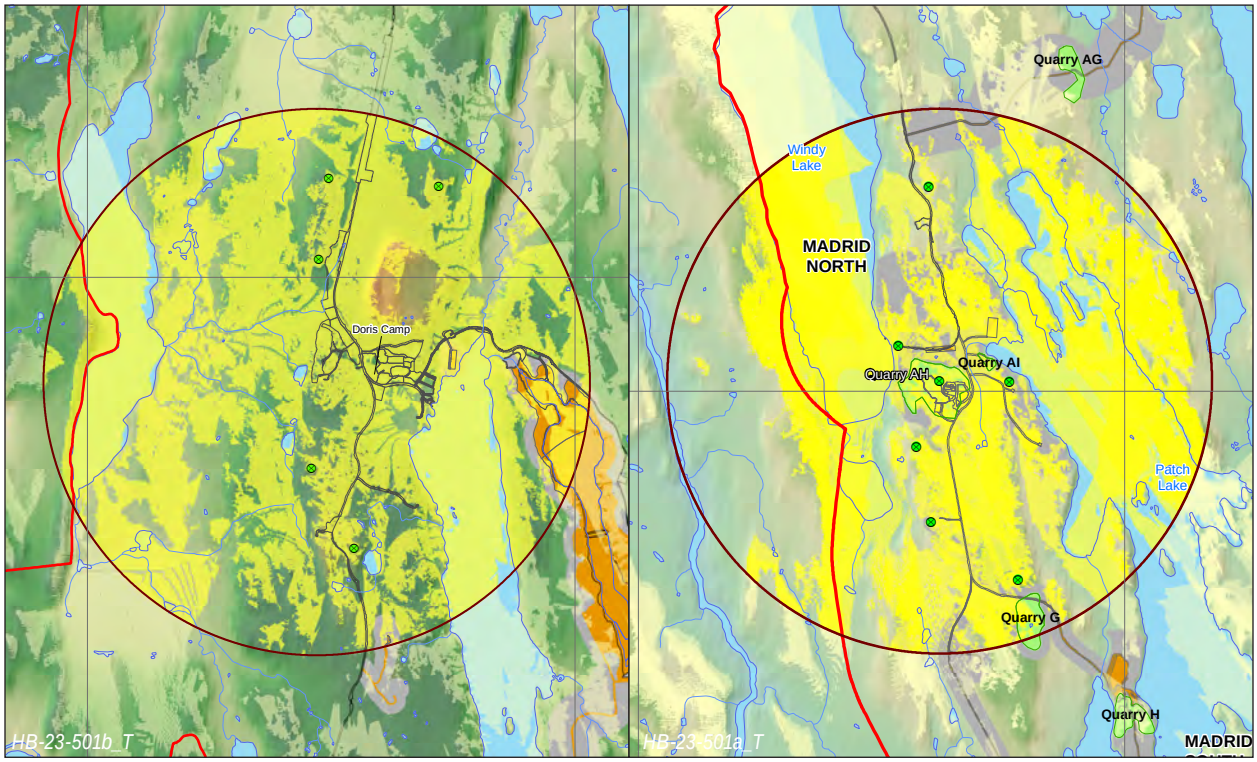
One workshop participant noted that it was good to see the Doris site and how the written mitigation measures are being implemented. The Elder noted that "even though there is no written mitigation for small animals like sic sic (Arctic ground squirrel), the bus driver during the tour of the TIA steered to avoid a sic sic on the road, so it was good to see that the mitigation is being implemented for all wildlife species, even the little ones."

Figure 9.8-14

View-Sheds Shaded in Yellow within 2.8 km circle from Existing Doris Quarry and Proposed Madrid-Boston Quarries

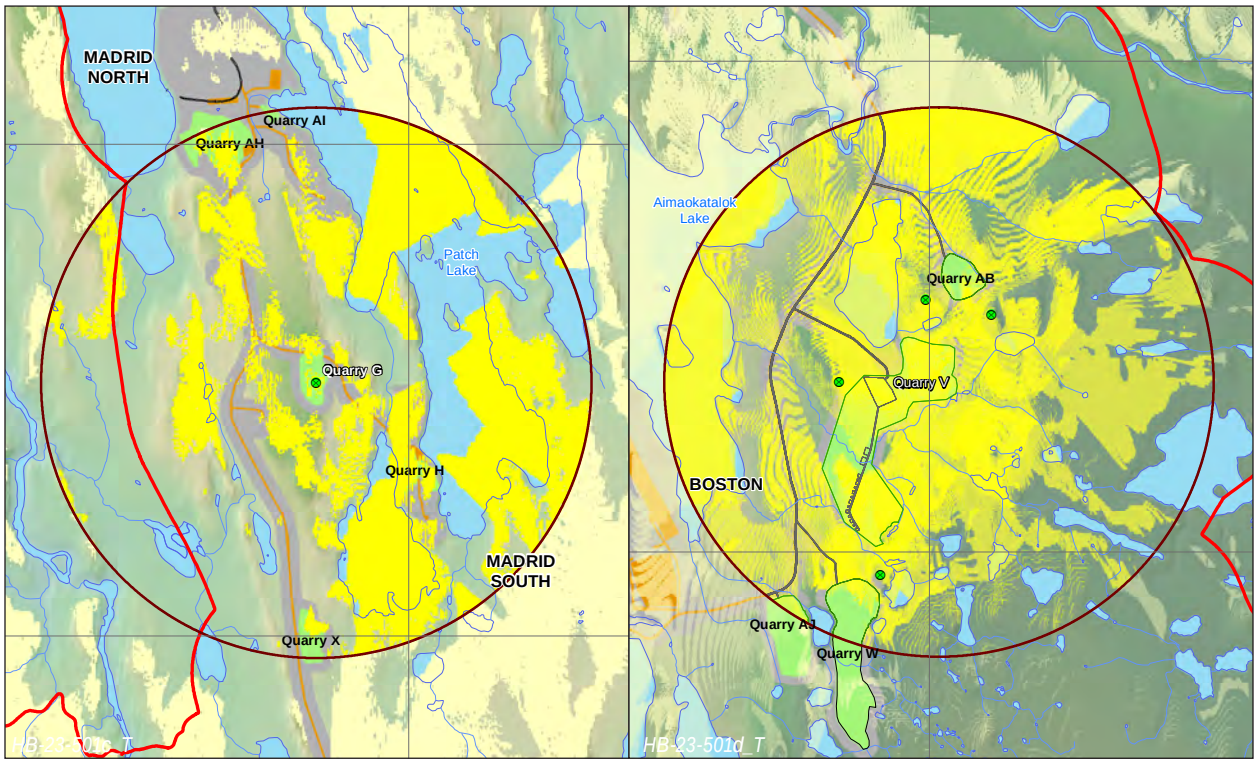
Doris Main Quarry

Madrid Quarry 3



Madrid Quarry G

Boston Quarry V



Viewpoint
Viewshed
Local Study Area
Camp

Permitted Infrastructure
Proposed Phase 2 Infrastructure and Facilities
Project Development Area
Area Suitable for theDevelopment of Rock Quarries

1:50,000
0 1 2
Kilometres

Date: May 04, 2017
Projection: NAD 1983 UTM Zone 13N

E) Dust

Elders and land users identified "disturbance / avoidance from dust" as an expected result of the Project, but with low risk of impact on caribou. The Project is an underground mine with limited handling of waste rock on the surface, which reduces the amount of dust that will be produced. Sources of dust from the Project include: 1) the existing Roberts Bay to Windy Lake roads, and 2) the proposed Boston road. Secondary sources of dust include: 1) the Doris Tailings Impoundment Area (TIA), 2) the Boston tailings dry stack, and 3) the waste rock storage, incinerators and facilities sites.

During Construction and Operations, dust will be managed using standard Arctic mining methods, including:

- speed limits will be set at 50 km/h and enforced; and
- dust suppressants will be used on the roads and the airstrip as needed.

At Closure, vehicle traffic will cease on the Project roads, activities will stop at the camp sites, facilities will be decommissioned, and both the Doris TIA and Boston dry stack tailings site will be capped to prevent fugitive dust. Potential effects of dust on wildlife and fish are evaluated in the human health and ecological risk assessment (Volume 6, Chapter 5) and summarized in Section 9.8.3.7, while effects on aquatic ecosystems were assessed in the aquatics effects assessment (Volume 5, Section 4.5.4.8) which concluded that there would be no significant effects on these ecosystems.

Following the review of the mitigation measures for dust, workshop participants agreed by consensus that mitigation was appropriate and that:

> *"Mitigation for roads and road use will keep caribou safe."*

Results of Monitoring Caribou Response to the Doris Project

During the last 20 years of activity in the Hope Bay Greenstone Belt, with first an exploration camp at Windy Lake and then the active Doris mine, there have been numerous monitoring programs to determine whether caribou are avoiding the Project site, including: 1) aerial surveys, 2) wildlife camera monitoring, and 3) analysis of GPS satellite collars on caribou. This section presents the results of these monitoring programs to determine if caribou have avoided either the Windy exploration camp, or the active Doris Project.

The results of these three separate analyses indicate that there is no detectible effect of the Project on the density of caribou near the Project, compared to control areas at a greater distance from the Project. These results generally agree with the views of Elders and land users that the mitigation and management at the Project site will protect caribou in the Project area.

A) Aerial Survey Monitoring 1996 to 2005

Mineral exploration in the Hope Bay Greenstone Belt was based out of the Windy exploration camp from the mid-1990s until 2010. The camp supported helicopter-based exploration using several standard diamond drilling units. An exploration camp has typically has significantly greater helicopter usage than operating mines. Exploration camps typically use two to four helicopters with continuous operation to move diamond drills. In contrast, operating mines conduct most diamond drilling from all season roads or with winter vehicles suitable to the tundra and have considerably lower helicopter usage. Helicopters are one of the most wide-ranging noise sources at a mining camp. Thus, if caribou were avoiding a noise disturbance from helicopters, a zone of influence would be predicted for the Windy exploration camp.

Multiple aerial surveys for caribou were conducted each year between 1996 and 2010. An analysis was conducted using aerial survey data collected from 1996 to 2005 to examine if there was a detectible ZOI around the Windy exploration camp and its helicopter-based drilling program (Rescan 2011c). After 2006, there were generally too few caribou observed in the region to be included in the analysis.

The analysis methods are described in Section 9.2.6.3. Overall, neither a logistic analysis using the presence or absence of caribou nor a count-based analysis of caribou abundance found a ZOI for caribou. A power analysis based on the patterns/relationships between the observed habitat variables and distance to infrastructure is conducted. Based on a predicted zone of influence of 4 km and odds ratio of 4.2 (so that for every one caribou within the ZOI there are approximately 4.2 outside the ZOI), and a total of 770 transects observed, the power to detect a ZOI steadily climbs from 0.84 with 50 of the observed transects occupied with caribou to 1.00 with 340 of the observed transects occupied with caribou. The analysis showed that over 100 of the observed transects were occupied, providing a power of approximately 0.91.

However, the study design did not include survey transects at distances of less than 1.5 km of Windy camp, and so if a ZOI were to occur within 1.5 km of the camp, this design would not be able to detect it. In conclusion, caribou did not avoid the Windy camp at greater than 1.5 km during the period of 1996 to 2005.

B) Camera Monitoring 2012 to 2016

Construction of the Doris Project commenced in 2008, including the Roberts Bay laydown, the airstrip, Doris camp, and Windy road. From 2012 to 2016, caribou were monitored in the area surrounding the Doris Project using motion-triggered cameras. Over the years, 44 to 59 cameras were placed on the tundra between zero to over 20 km from the Doris Project, and photos were downloaded twice per year. An analysis was conducted to determine if caribou were avoiding the Doris Project and is described in Section 9.2.6.3, which summarizes the monitoring results of the Doris Project WMMP program for caribou (ERM 2016b).

This re-analysis indicated that there is no absolute difference in camera encounter rates within 4 km of the Project compared to control sites at a greater distance. A power analysis was conducted using a Fisher Exact test and, which indicated that power was relatively low to detect small changes in caribou density near the Project, with 80% power to detect an odds ratio of five (four times more caribou in control areas).

To be conservative, the FEIS analysis makes the assumption that no caribou occur in the ZOI. This is an over-estimate of the effect of the ZOI, since the camera program indicates that caribou continue to use the area near the Project.

C) Satellite Collars 2015 to 2017

TMAC has a Memorandum of Understanding with the GN, where TMAC provides funding and in-kind support for regional monitoring programs for caribou, including the installation of satellite collars. Satellite collars using GPS technology were placed on Dolphin and Union caribou in 2015 and 2016. TMAC conducted an analysis to determine if caribou were avoiding the Doris Project during winter.

Data from Dolphin and Union caribou collared between 1999 and 2004 to the south of the Hope Bay belt indicated that collared caribou remained south of the Project in the Huikitak River valley system and so these data cannot be used for estimating a ZOI. During 2015 and 2016 the GN deployed new GPS collars while based at the Doris Project. These collars were place on animals closer to the Doris Project than

the older collars, and so provided data on winter habitat use near the Doris Project that are suitable for a ZOI analysis.

The analysis calculates kernel densities in a 250 m grid and examines the probability of caribou occurrence by habitat type. First, amount of data that is available was evaluated. Within 15 km of the Project site, there were only 72 collar points. It requires 25 to 50 points to calculate a kernel density for a habitat type. As a consequence, there is not enough data within a biologically realistic area to examine ZOI and the analysis was suspended until such time as more data becomes available.

The low number of collar points during winter within 15 km is partially due to the fact that Dolphin and Union caribou were historically collared in Huikitak River valley (approximately 50 km south of the Project) and did not interact with the Project location during winter. Recent collars (since 2015) were put on caribou from the Doris camp and these animals stayed further north during winter. The Hope Bay Greenstone Belt, which is approximately 10-km across may also affect the number of collared caribou near the Project. The Greenstone Belt is made up of steep, volcanic dikes and wide sedge meadows that collect snow in winter. Caribou may be avoiding the deeper snow in this area and preferring the areas of rolling rocky hills east and west of the Project site.

Review of Other Projects and Scientific Literature

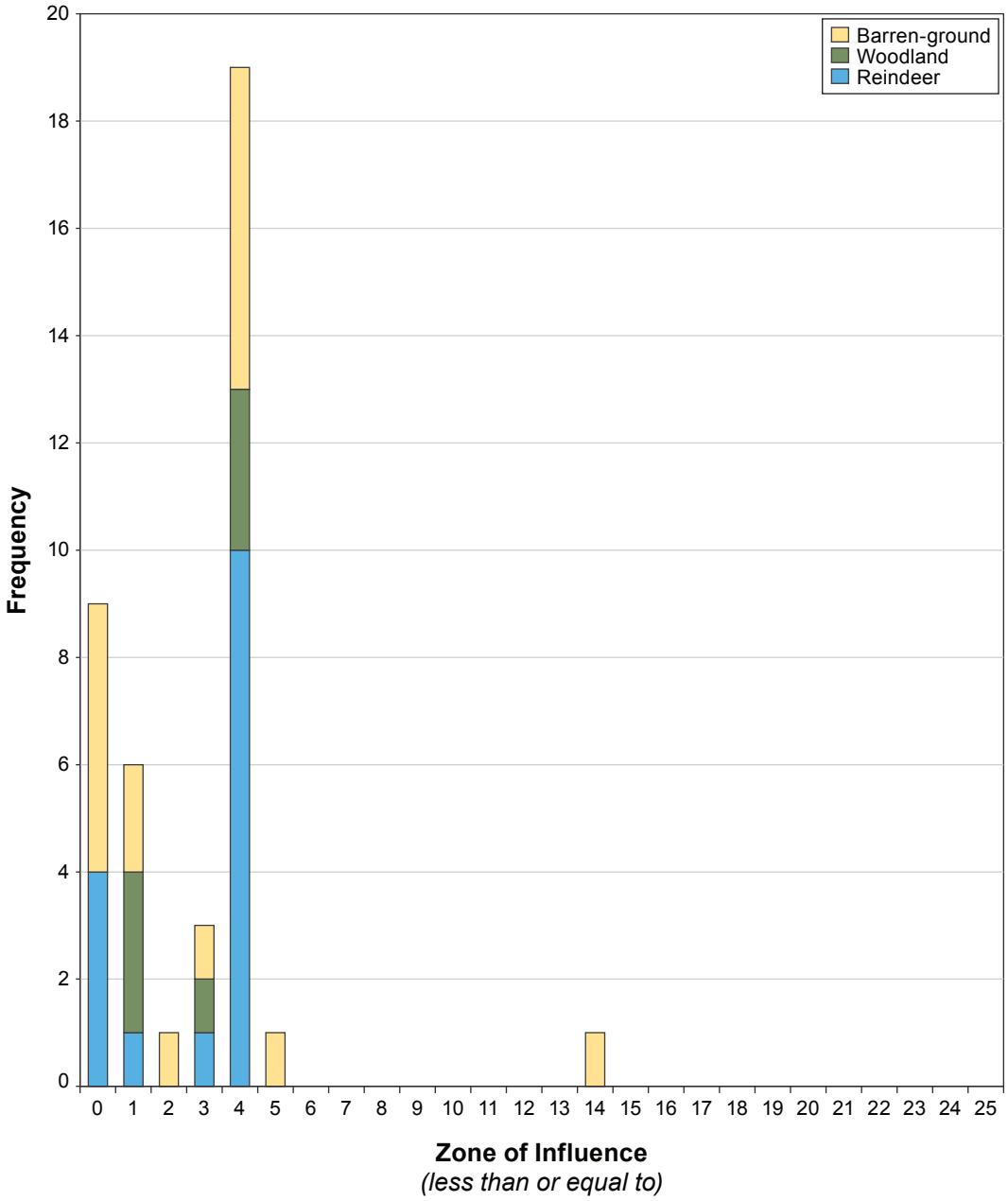
A review of monitoring reports and the scientific literature identified 130 articles, including review articles, which discuss a zone of influence (ZOI) for caribou. Of these, 40 articles provided a direct estimate of ZOI. Studies were performed on three sub-species of caribou; barren-ground (*Rangifer tarandus groenlandicus*), woodland (*Rangifer tarandus*), and reindeer (*Rangifer tarandus tarandus*). Studies were conducted in Alaska, Northwest Territories, Alberta, British Columbia, Newfoundland and Norway. The main disturbance features that were investigated included petroleum and mineral exploration and extraction, roads, electrical transmission corridors, power generation facilities, settlements, tourist cabins, pipelines, seismic lines, helicopter activity, hiking, cutblocks, forest burns, and snowmobiles. Studies that used both direct observations of caribou and proxies such as pellets were included. Researchers collected data using aerial surveys, satellite collars, direct observations from snow machines, and pellet counts to determine caribou abundance.

Studies using a Resource Selection Function (RSF) approach were the minority of studies and were excluded for methodological reasons. RSF studies are conducted to determine habitat preferences. If the preferred habitat is distant from an industrial site, then researchers can erroneously conclude that a ZOI exists.

A range of ZOIs have been reported for various caribou herds and types of human development activities (Wolfe, Griffith, and Gray Wolfe 2000; C.J. Johnson et al. 2005; Weir et al. 2007; Boulanger et al. 2012; C. J. Johnson and Russell 2014). Some studies report no avoidance by caribou beyond a few hundred meters (M. A. Cronin et al. 1998; Noel et al. 1998; Noel, Parker, and Cronin 2004; Noel et al. 2006; Reimers and Colman 2006; Reimers et al. 2007; Boulanger et al. 2012; C. J. Johnson and Russell 2014). Overall, 95% of the ZOI estimates were 4 km or less (Figure 9.8-15). Estimates of ZOI for roads were less than those associated with mines. Barren-ground caribou had larger ZOIs than reindeer and woodland caribou. ZOI estimates for barren-ground caribou in Northwest Territories were higher than ZOI estimates taken from barren-ground caribou around the Prudhoe Oil Fields and associated areas, as discussed below.

Figure 9.8-15

Frequency of Reported Zone of Influence for Caribou and Reindeer



Researchers have hypothesized that caribou may avoid mines due to noise, human presence, or altered habitat in a ZOI (Polfus, Hebblewhite, and Heinemeyer 2011; CCME 2013). As a measure of disturbance, it has been argued that ZOIs are important when used to measure cumulative effects, mitigate impacts, or inform population models (Sorensen et al. 2008). However, differences in how ZOIs are calculated and how the underlying mechanisms are identified can lead to controversies about biologically meaningful ZOIs, significance, and the type of response measures (Gunn, Russell, and Eamer 2011). It is unlikely that caribou respond to development in a strictly linear fashion. Rather, disturbance is likely apparent out to a certain distance or threshold, beyond which sensory effects no longer apply. Recently, there have been calls for a consistent approach to monitor avoidance that can be applied across scales for species that are affected by human development (Ficetola and Denoël 2009; Polfus, Hebblewhite, and Heinemeyer 2011).

Studies on woodland caribou have reported that caribou may avoid industrial infrastructure and roads to a distance ranging between 1 to 10 km (Murphy and Curatolo 1987; Wolfe et al. 2000; Vistnes et al. 2001; Shane P. Mahoney and Schaefer 2002; Cameron et al. 2005; Joly, Nellemann, and Vistnes 2006; Weir et al. 2007; Vistnes and Nellemann 2008a; Polfus, Hebblewhite, and Heinemeyer 2011). The most common value for avoidance of industrial mine sites reported in the literature ranges between 2 and 4 km and tends to vary depending on the footprint and magnitude of mining activities, as reported for woodland caribou around a large open-pit gold mine in Newfoundland (4 km; Weir et al. 2007), around small placer mines in northwestern BC (2 km; Polfus, Hebblewhite, and Heinemeyer 2011), and for the Quintette caribou herd around coal mines (3 km; C. J. Johnson, Ehlers, and Seip 2015).

For barren-ground caribou, the most common ZOI reported in the literature is approximately 4 km (reviewed in Wolfe, Griffith, and Gray Wolfe 2000). Boulanger et al. (2012) reported a ZOI of 14 km and 11 km respectively around two diamond mines in the Northwest Territories. These studies suggest that caribou may avoid operating mines at a distance beyond which they can hear direct disturbance effects such as noise. Boulanger et al. (2012) reported a correlation between the reported ZOI and modeled dust deposition and hypothesized that caribou may be avoiding the mine complex due to dust deposition. This mechanism remains untested. It was also noted that the ZOI was related to the amount of mining activity and industrial development size as a ZOI of 3 to 4 km was evident after construction of the Ekati mine, and increased to a ZOI of 11 to 14 km after construction of the Diavik diamond mine, with a combined total of seven open pits (Boulanger et al. 2012). The scale of the cumulative footprint of both diamond mines was approximately 40 km^2, which is much larger than those mines where a ZOI ranging between 1 and 10 km was reported.

The results of studies on the response of caribou to disturbance are seldom consistent due to various factors, including the sub-species of caribou (woodland vs. barren-ground), season, habitat quality, the type and intensity of disturbance, underlying distribution of habitat quality, and other types of interrelated human activities. For example, woodland caribou were found to move rapidly away from a source of disturbance for 15 minutes following initial exposure, which can have energetic consequences for northern ungulates (Skogland and Grovan 1988; Banner et al. 2003). Behavioral studies on barren-ground caribou report that caribou have shown a brief interruption in ‘calm or neutral’ behaviours (i.e. grazing, walking, standing) in response to stressors such as traffic, aircraft, and human presence (ERM Rescan 2013).

Avoidance of human activity and industrial developments has been documented to be most pronounced for maternal females (Vistnes et al. 2001). This avoidance behaviour could be an adaptation to reduce exposure to predators, often at the expense of foraging opportunities (Bradshaw, Boutin, and Hebert 1997; CCME 2012). Caribou responses to disturbance can also vary by season. For example, it has been reported that noise from aircraft elicits a larger response during the calving, post-calving and winter seasons when caribou are most energetically stressed due to natural factors (G.W. Calef, DeBock, and

Lortie 1976; Maier et al. 1998; Wolfe, Griffith, and Gray Wolfe 2000). This effect is most prevalent for calves and pregnant females and can negatively affect calf survival (Harrington and Veitch 1992).

Variability in the magnitude of the response could also influence ZOI for caribou. For example, caribou respond negatively to traffic likely because they perceive the noise, lights, vehicles, and people associated with traffic as a predation risk (A. Frid and L.M. Dill 2002) or this may be a learned reaction, since most hunting south of treeline is done close to roads. The behavioural response of caribou to traffic varies with vehicle speed and distance – most strong reactions have been observed when vehicles were within 100 m of caribou, as caribou more than 300 m away did not react (Horejsi 1981; Murphy and Curatolo 1984). Responses for barren-ground caribou are typically short in duration. For example, although most (86%) of 34 caribou ran or trotted away from a truck, the duration of response was less than one minute on each occasion (Horejsi 1981). Monitoring of caribou activity budgets at the Ekati Diamond Mine found that although caribou responded to large open pit blasting 60% of the time within 1 km of the blast, the behavioural response was minimal; animals were alert but typically did not move (Golder 1999). During the winter, avoidance of roads by caribou have been noted and found to depend on traffic activity levels (Cumming and Hyer. 1998; Nellemann et al. 2001).

Seasonal differences in avoidance of infrastructure by caribou may be due to a number of factors. For example, it has been argued that sensory disturbance from development has substantially fewer effects on caribou relative to the stress these animals may face during periods of high insect harassment (Bergerud, Luttich, and Lodewijk 2008). Caribou may be more tolerant to human activity during periods of intense insect harassment from late June to August than at other times of the year (Witter et al. 2012). When insect harassment increases during the summer, caribou have been observed using developed areas such as roads (Murphy and Curatolo 1987) and well pads (Pollard et al. 1996; Noel et al. 1998) and in the shade of elevated pipelines (Pollard et al. 1996; Noel et al. 1998) to find relief from insects.

The important question is whether the avoidance of industrial projects by individual caribou translates into herd-level effects on the population. In areas like Sweden, where there are extensive areas of cabins, ski trails, roads and towns that caribou avoid, the amount of available habitat has been effectively reduced for caribou. However, in the Canadian Arctic, the majority of habitat is available for use, with only a few percent of habitat within a ZOI surrounding these projects. It has been assumed that there is an energetic cost for caribou remaining in a ZOI near a source of disturbance (GNWT ENR 2017).

Estimates of ZOIs surrounding roads, typically fall into two groups: small unpaved roads (similar to the proposed Boston road) and major thoroughfares. Unpaved, local and smaller industrial roads with less traffic that are analogous to the proposed Boston road are commonly reported to have no ZOI (Noel, Parker, and Cronin 2004; Haskell et al. 2006; Noel et al. 2006; Dahle, Reimers, and Colman 2008) (or small ZOI values of 500 m (Murphy and Curatolo 1987; Dyer et al. 2001; S. P. Mahoney et al. 2001). Larger roads, including paved highways, paved access roads with high traffic, mainline haul roads and principal winter roads are reported to have larger ZOI values of 1.5 to 4 km (Cameron and Whitten 1982; Dau and Cameron 1986; Cameron et al. 1992; Nellemann and Cameron 1996; Vistnes and Nellemann 2001; Nellemann et al. 2003; Cameron et al. 2005).

During the DEIS review phase, TMAC added six wind-mills (two each at the Doris, Madrid and Boston sites) to the Project description and evaluated their potential effects on caribou. Note that these six turbines do not constitute a “wind farm”. Typical wind farms contain from 30 to 75 turbines in Canada and so comparisons should be drawn accordingly.

There are no Nunavut government regulations or policies constraining wind farm development within caribou habitat (Government of Nunavut Department of Executive and Intergovernmental Affairs 2017). Studies have been conducted to examine whether wind farms will disturb caribou, particularly reindeer in Scandinavia. Colman et al. (2012) examined the effects of wind farms on the behaviour of reindeer in Finnmark, northern Norway and concluded that it is unlikely that the wind farm had negative impacts on movements. Skarin et al. (2015) reported that reindeer avoided a wind farm during construction in a fragmented landscape by up to 2 km. Skarin and Alam (2017) used pellet counts to examine forest reindeer habitat use during preconstruction, construction and operation in relation to two small wind farms in northern Sweden and reported that reindeer preferred one of the wind farm sites, but that there was no effect on distribution at the regional scale. Kjetil Flydal et al. (2004) tested whether five wind turbines impacted habitat, activity, vigilance bouts, and restless behaviour for semi-domestic reindeer. The experimental area was located within a wind turbine park consisting of five wind turbines in Norway and reported ambiguous effects on the reindeer.

The goal of one wind power development monitoring program initiated in the late 1990s was to describe temporal and spatial distribution, use, and habitat selection of big game in around wind development in Wyoming before and after construction of turbines and to use the collected data to determine if turbines had a displacement effect (Strickland et al. 2000). Kjetil Flydal et al. (2004) summarized this work as being a systematic study on the effects of wind turbines on pronghorns (*Antilocapra americana*) that showed no difference in abundance within 800 m of a wind turbine farm when comparing data from before and after construction activities. 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. These results indicate that any potential response of caribou will be captured within the 4 km zone of influence used for this assessment.

In Alaska there has been a tremendous amount of research on the effects of human disturbance on caribou. After decades of studies, no cause-and-effect relationship has been demonstrated between the Prudhoe Bay Oil Field development and population fluctuations within the Central Arctic Herd (CAH) (Ballard, Cronin, and Whitlaw 2000; M. Cronin, Whitlaw, and Ballard 2000). Since 2000 the central arctic herd increased at 10 to 13% annually while the oil field was constructed and operated, peaking in 2010 with approximately 70,000 caribou. In 2013, there was a significant drop to 50,000 animals and by 2016 it had dropped to 22,630 animals due to increased female mortality and animals switching herds. Increased female mortality is thought to be due to a series of late springs and due to demographics where there were many same-aged females from the rapid population increase in the 2000s that were growing old. The impact of oil infrastructure on the Central Arctic Herd is not thought to be contributing to the decline because the herd grew substantially during peak oil development (Alaska Department of Fish and Game 2017).

This question of whether effects on individual caribou within a theoretical ZOI will result in impacts to the herd was discussed during the caribou workshops. As discussed earlier, Elders and land users agreed that the mitigation for the Doris and Madrid-Boston Projects would be protective of individual caribou near the Project site (within a ZOI). Elders and land users agreed that individual caribou would not be affected if they resided near the Hope Bay Project, and that caribou using the area near the Project would not result in impacts to the caribou herd. Workshop participants agreeing by consensus with the statement that:

> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

Modeling Noise and Dust

Noise, vibration and dust modeling were conducted to predict the future conditions within the local and regional study areas (LSA and RSA) of site during construction and operations and investigate if they exceed applicable exposure thresholds. The assessment focuses on the following:

1. noise and vibration during facility Construction and Operation, including wind turbine operations;
2. noise and vibration during blasting;
3. noise during aircraft and helicopter usage for facility Construction and Operation;
4. shadow flicker from the wind turbines, and
5. dust due to facility Construction and Operation.

The results of this modeling indicate that noise and dust will meet applicable guidelines well within the theoretical zone of influence used in this assessment to evaluate caribou avoidance or disturbance near the Project site. This zone of influence value was defined as 4 km from Project sites (Doris, Madrid and Boston) and 1.5 km from roads. Since the theoretical zone of influence used in the assessment is larger than the area with modeled noise or dust, the individual sources of noise or dust are not assessed further. A description of the noise and dust modeling is below.

A) Facility Noise

The construction of Madrid North and South, Boston and the Boston road will require earth moving equipment and vehicle support. Construction at Doris and Robert's Bay is expected to occur while mining and shipping activities continue. The acoustic model for construction activities at Doris and Robert's Bay therefore includes the ongoing operations for mining and processing such as ore stockpiling and handling, processing plant activities, power generation, air handling to the underground mine, waste management, and support vehicle operations for supplies and personnel. Therefore, the assessment is considered cautiously conservative.

Facility noise was modeled for Operations using the scenario where production rates are highest and where all operable equipment units will be operating continually. This assumption therefore represents a cautiously conservative estimate of the potential noise and vibration effects within the LSA and RSA. An inventory of noise sources was developed for Construction and Operations and the continuous noise from these activities was modeled (Appendix V4-3A). Noise modelling during operations included sound emissions from six turbines – two each near Doris, Madrid North, and Boston. The turbines were assumed to be operating at environmental conditions leading to the highest sound power level.

The results of the assessment in the form of equivalent sound level contours are shown in Appendix V4-3A. Noise levels for both construction and operations met Health Canada thresholds for annoyance within approximately 100 to 650 m from the Doris and Boston sites, and met thresholds for annoyance at specific land use receptors that are 156 m from the Doris site and 826 m from the Boston site. The predictable worst case sound pressure level effects during Construction and Operations are in the range of 30 dBA and 35 dBA at a distance of 4 km from the Project PDA. This is comparable to the baseline acoustic conditions in those areas.

As discussed in Appendix V4-3A vibration from Construction is not expected to be a concern and therefore is not discussed further in this section.

These modeling results are comparable to the current site conditions at the Doris site. Elders and land users were able to hear the operation of the diesel generators and the backup beeper of the loader feeding the mill at approximately 650 m from Doris. However, at 1.3 km, noise from the Doris site was not clearly detectible/audible above ambient in the field on a day favourable for noise propagation; clear weather, no wind/down wind, and -15° C. These areas are well within the 4 km ZOI used for the assessment of disturbance on caribou and are not discussed separately further.

B) Fixed-Wing Aircraft Noise

The analysis of potential noise impacts from the aircraft traffic was assessed using Transport Canada's Noise Exposure Forecast (NEF) software. This software includes a database of sound information for many aircraft and requires inputs such as runway coordinates, flight paths and aircraft movements. The runway coordinates were input from existing data and the proposed Boston airstrip design documents.

For the Doris airstrip, the aircraft used were provided as Boeing 737-200 and Bombardier Dash 8. The Doris airstrip is described as accommodating air traffic of each of these aircraft four times per week. As a precautious conservative assessment of the potential noise impact of this activity, each aircraft was assumed to land and take off once per day. For completeness, the analysis also assumes that each day, there will be one landing and take-off for each aircraft in either direction.

For the Boston airstrip, the design included usage by the Boeing 737-200 Jet and Dash 8 Turbo propeller as well as a Lockheed Hercules C130. As with the Doris airstrip, the traffic at this airstrip is described as flights 4 times per week per aircraft. For modeling purposes, the modelled scenario for one day includes one takeoff and landing per aircraft. As with Doris, the modelling includes an additional daily flight for each aircraft in the other direction.

Modelling details and outputs for these scenarios include isopleths displaying the NEF contours for the airstrips and are shown in Appendix V4-3A. The study uses assessment methods and sound data from Transport Canada and the method is used for urban planning near major airports. Therefore the assessment method is considered cautiously conservative. The modeling indicates that noise levels due to aircraft will reach Health Canada standards for annoyance and disruption of sleep at approximately 600 m from the ends of the runways and 300 m from the sides of the runways. These areas are well within the 4 km ZOI used for the assessment of disturbance on caribou.

C) Helicopter Noise

The analysis of helicopter traffic was broken into two scenarios. The first is considered a base case and includes general traffic at the Doris and Boston Helipads, Commuting between the two helipads and transporting equipment for summer drilling at a specified location from the Boston helipad. The modelled base case scenario includes:

- four flights from each helipad and travel representing general activity around each helipad;
- four flights each from Doris and Boston and travel between the sites representing commuting between the sites; and
- the delivery and return of the equipment to the summer drilling site once per day for summer drilling.

The second scenario represented for completeness is a summer drilling support scenario and includes transporting equipment from Doris, Boston and Windy helipads to additional drilling sites. These nine sites were provided by TMAC and have been conservatively modelled 5/9 sites being supported in one day. Each of these was modelled in CADNA/A to provide an Ldn value which can then be compared to the

existing conditions at the site and assessed against the operations criteria. The primary drill targets are generally within 2 km of the existing Doris site and planned Madrid-Boston roads, including at the existing underground workings north east of Doris Mountain, approximately 1.5 km west of the Doris runway, Madrid North and South, at on the rock outcrops south of the Boston camp. This modeling indicated that noise from helicopters will reach Health Canada standards for annoyance and disruption of sleep for the base case of helicopters flying between Doris and Boston, and for summer drilling support within one to two km of the Doris and Boston sites.

D) Blasting Overpressure

Above ground-blasting is planned for a series of quarries near the Doris, Madrid, and Boston sites and along the Boston road during the Construction phase of the Project and intermittently as borrow material is required during the Operations Phase. Quarries will be utilized sequentially during Construction and Operation, so the effects of overpressures (a type of "noise" associated with blasting events) from quarry activity will generally occur at only one location at any one time.

Potential overpressure and ground-borne vibration levels were predicted using noise and vibration propagation modelling given planned blasting scenarios for quarries (Appendix V4-3A). Overpressure from blasting is measured and assessed as the Lpeak parameter (dBZ). Blast overpressure will meet Health Canada standards for children's hearing (120 dBZ) at approximately 320 m from the blast point, and will meet the Health Canada mitigation noise level for causing annoyance to adults and children from 100 blasts per day (105 dBZ) at approximately 1,450 m from the blast point. This comparison of a standard using 100 blasts per day is cautiously conservative because the actual blasting plan will only include one to two blasts per week during construction.

For caribou, mitigation for possible annoyance due to blasting will be conducted; blasting will be stopped if any caribou is observed within line of sight out to 2.8 km of the blasting point. This value is consistent with scientific literature that reports some ungulates will freeze or startle in response to blasting noises at 96 dBZ (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). However, there is no standard threshold for blasting overpressure provided by either Health Canada or Environment Canada, so this value is provided only for discussion purposes.

Vibration from blasting was also modeled and will meet Health Canada standards of blast-induced Vibration Peak Particle Velocity [PPV, mm/s] of 12.5 mm/s at approximately 540 m from the point of blasting.

E) Shadow Flicker from Wind Towers

Modeling was conducted for the three pairs of wind towers that are proposed for the Project, including shadow flicker modeling and noise modeling. Shadow flicker can occur when the sun is behind the operating wind tower, resulting in a slight flicker that may be detectible to some people. It is generally accepted that the possible effects of shadow flicker are not perceived beyond 10 times the rotor diameter (~1.3 km). This area is within the existing zone of influence used for the assessment and not considered further.

F) Dust Modeling

An air quality modeling study was completed using the CALPUFF model (version 7.2.1 level 150618) to predict the ambient air quality resulting from the Madrid-Boston Project construction and operation air emissions (V8-2).

The CALPUFF model used a variety of input data and parameters, including terrain, land use and meteorological (surface and upper air) datasets specific to the Hope Bay Project area. The model used

air emissions inventories specific to existing permitted activities (Doris Project operations and Madrid Permitted activities), and the Madrid-Boston Project construction and operation activities. These emissions inventories were calculated using the available Project Description information (as of July 31, 2017) along with a variety of different published emission factors. Reasonable conservative assumptions were used when Project Description information was not available.

This modeling predicted that maximum TSP and $PM_{2.5}$ concentrations met applicable standards at a "property boundary", 2 km from the Doris, Madrid North, Madrid South and Boston PDAs. PM_{10} was predicted to exceed the applicable 24-hour average guideline by 19% at the property boundary to the southeast of Madrid South. However, exceedances were predicted to be infrequent (no more than one day per year).

This modeling was conservative because:

- emissions estimates for the Project employed a conservative approach based on maximum production rates which is expected to over-estimate emissions;
- conservative assumptions were used following regulatory guidance, professional judgement and experience where Project specific data was unavailable; and
- regulatory models such as CALPUFF, are designed to have a bias toward over-estimation of contaminant concentrations (e.g., to be conservative under most conditions).

Using a Zone of Influence to Predict Effects on Caribou

To predict the effects of disturbance on caribou, three different scenarios were evaluated:

1. caribou avoid the area adjacent to the Project, resulting in a ZOI — measured as the area of reduced usage in the ZOI, as a proportion of the seasonal and herd range;
2. caribou occupy the Project ZOI, measured as encounter rate and residency time; and
3. whether there are any important habitat features within the Project ZOI.

During the DEIS, TMAC evaluated potential disturbance to caribou using a hypothetical Zone of Influence that was 4 km surrounding the mine.

The scientific literature indicates that 95% of studies reported ZOIs smaller than 4 km. The ZOI values provided in the review of the scientific literature were for a variety of different projects, including large infrastructure projects such as open pit mines and extensive oil and gas developments, and some smaller projects such as roads. The Hope Bay Project, being an underground mine with limited surface activity, would be expected to be comparable to some of the smaller projects on this list. Despite this, the larger 4 km ZOI was used as a conservative approach (i.e., likely over-estimating negative effects). For roads, a ZOI of 0 to 500 m is frequently reported for unpaved and smaller access roads, similar to the Boston road, and a 1.5 km ZOI was chosen for this analysis to be conservative.

During the DEIS review, the GN DOE requested that two additional ZOI scenarios be calculated:

1. 5 km surrounding the mine and 1.5 km surrounding roads; and
2. 14 km surrounding the mine and 4 km surrounding roads.

Each of these ZOI scenarios are evaluated in the following sections for 1) indirect habitat loss, 2) disturbance through encounter rate and residency in the ZOI, and 3) avoidance of important habitat features (Figure 9.8-16).

A) Reduced Habitat Use in ZOI (Indirect Habitat Loss)

This section evaluates the potential effect reduced habitat use inside a zone of influence (ZOI) surrounding the Project. Should caribou avoid reduce their habitat us within a ZOI, then this habitat could be considered to be of lower quality to caribou.

Studies that report caribou avoidance of a project within a ZOI generally report a 25% to 50% decrease in caribou density near major projects. In order to be cautiously conservative, this assessment assumes that no caribou use the ZOI area, resulting in "indirect habitat loss" within the ZOI area. This is a large over-estimate of the real, measured effect of the Project. The remote camera program at the Doris Project found similar densities of caribou near the Project site and in control areas further away.

Three separate ZOI scenarios were used to calculate indirect habitat loss:

- Scenario 1: 4 km mine/ 1.5 km roads;

Based on monitoring results at the Hope Bay site and a review of the scientific literature, Scenario 1 is an overestimate of the current and likely future interaction of caribou with the Project. Scenario 1 is therefore also referred to as the "likely scenario" (Table 9.8-15). Scenarios 2 and 3 were requested by the GN DOE and represent extreme cases of zone of influence for caribou (Table 9.8-15).

- Scenario 2: 5 km mine/ 1.5 km roads; and
- Scenario 3: 14 km mine/4 km roads.

Scenario 1: Under this cautiously conservative scenario, the area of good quality summer habitat that would be indirectly affected by Madrid-Boston is 14,194 ha and 34,918 ha for the Hope Bay Project. This represents 0.21 to 0.36% of the Beverly summer range and 0.11-0.28% of the Ahiak summer range (Table 9.8-15).

The area of good quality fall habitat that would be indirectly affected by Madrid-Boston is 3,926 ha and 14,907 ha for the Hope Bay Project. This represents 0.10 to 0.14% of the Beverly fall range and 0.03 to 0.10% of the Ahiak fall range (Table 9.8-15).

The area of good quality winter habitat that would be indirectly lost due to Madrid-Boston is 4,733 ha, with a total of 15,276 ha for the Hope Bay Project, which represents a total of 6.7% of the Regional Study Area. This area represents 0.07 to 0.24% of the winter range for the Dolphin and Union caribou, 0.06 to 0.08% of the Beverly, and 0.03 to 0.09% of the Ahiak winter ranges (Table 9.8-15).

Overall for the likely scenario, the total area of habitat indirectly lost due to Madrid-Boston irrespective of habitat quality is 14,858 ha, and 41,822 ha for the Hope Bay Project. This represents 0.08 to 0.22% of the Dolphin and Union annual range, 0.05 to 0.15% of the Beverly annual range, and 0.05 to 0.14% of the Ahiak annual range (Table 9.8-15).

Figure 9.8-16
The Predicted Zone of Influence (ZOI) (4 mine/1.5 road km) surrounding the Project, along with Hypothetical Zones of Influence (5/1.5 km) and (14/4 km)

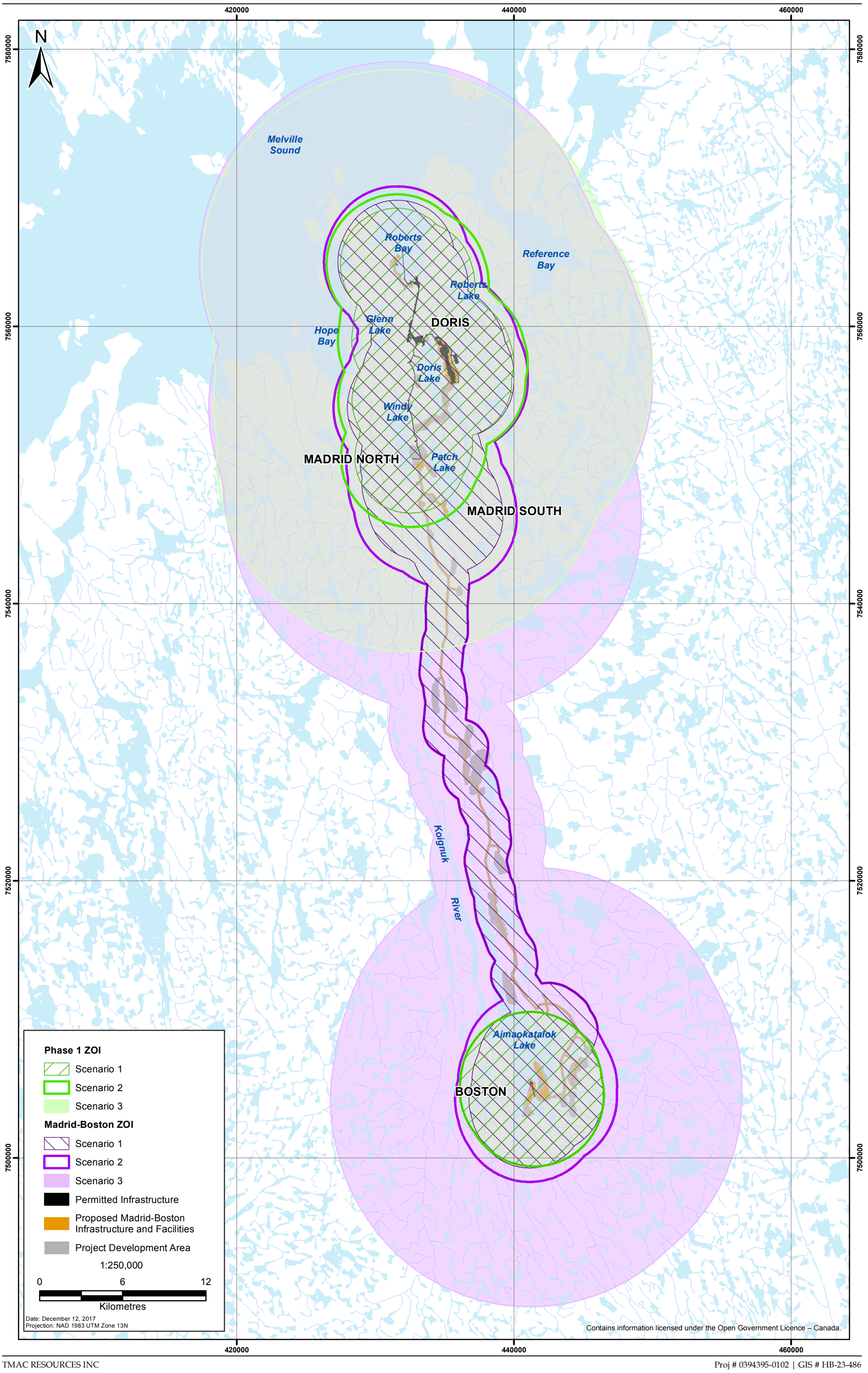


Table 9.8-15. Habitat Area in ZOI Compared to Seasonal and Total Herd Ranges

Season	Area Affected (ha)			Madrid-Boston % of Herd Range[1]			Hope Bay % of Herd Range[1]		
	Phase 1[2]	Madrid-Boston	Total	Beverly	Ahiak	Dolphin and Union	Beverly	Ahiak	Dolphin and Union
Scenario 1: 4 km surrounding mine, 1.5 km for road									
Summer	20,724	14,194	34,918	0.21	0.11	n/a	0.36	0.28	n/a
Fall	10,981	3,926	14,907	0.10	0.03	n/a	0.14	0.10	n/a
Winter	10,543	4,733	15,276	0.06	0.03	0.07	0.08	0.09	0.24
Total Area[3]	26,964	14,858	41,822	0.05	0.05	0.08	0.15	0.14	0.22
Scenario 2: 5 km surrounding mine, 1.5 km for road									
Summer	24,275	17,064	41,339	0.25	0.14	n/a	0.42	0.33	n/a
Fall	13,631	5,638	19,269	0.12	0.04	n/a	0.18	0.13	n/a
Winter	12,303	5,907	18,210	0.07	0.03	0.09	0.10	0.11	0.29
Total Area[3]	31,804	18,527	50,331	0.07	0.06	0.10	0.18	0.17	0.26
Scenario 3: 14 km surrounding mine, 4 km for road									
Summer	69,360	81,104	150,465	0.71	0.65	n/a	1.53	1.21	n/a
Fall	45,522	54,086	99,608	0.42	0.37	n/a	0.91	0.67	n/a
Winter	33,408	41,255	74,664	0.19	0.24	0.65	0.41	0.44	1.17
Total Area[3]	85,189	88,172	173,361	0.32	0.29	0.46	0.63	0.57	0.90

1 Ranges are represented by the 95% kernel UD using available collar data (see Table 9.8-7). Proportions of ranges are developed for the seasonal range that corresponds to the seasonal habitat mapped within the ZOI, i.e., the proportion of summer habitat within ZOIs is compared to the summer ranges of Beverly and Ahiak sub-populations. The total area within ZOIs irrespective of habitat quality is compared to the annual ranges of the three caribou sub-populations/herds.
[2] Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration.
[3] The total area of the disturbance ZOIs do not include any area where buffers overlap the ocean.

Scenario 2 (GN-DoE request): Under this scenario, the area of good quality summer habitat that would be indirectly affected by Madrid-Boston is 17,064 ha and 41,339 ha for the Hope Bay Project. This represents 0.25-0.42% of the Beverly summer range and 0.14-0.33% of the Ahiak summer range (Table 9.8-15). The area of good quality fall habitat that would be indirectly affected by Madrid-Boston is 5,638 ha and 19,269 ha for the Hope Bay Project. This represents 0.12 to 0.18% of the Beverly fall range and 0.04 to 0.13% of the Ahiak fall range (Table 9.8-15). The area of good quality winter habitat that would be indirectly lost due to Madrid-Boston is 5,907 ha, with a total of 18,210 ha for the Hope Bay Project, which represents a total of 8% of the Regional Study Area. This area represents 0.09 to 0.29% of the winter range for the Dolphin and Union caribou, 0.07 to 0.10% of the Beverly, and 0.03 to 0.11% of the Ahiak winters range (Table 9.8-15).

Overall for scenario 2, the total area of the habitat that would be indirectly lost due to Madrid-Boston irrespective of habitat quality is 18,527 ha and 50,331 ha for the Hope Bay Project. This represents 0.10 to 0.26% of the Dolphin and Union annual range, 0.07 to 0.18% of the Beverly annual range, and 0.06 to 0.17% of the Ahiak annual range (Table 9.8-15).

Scenario 3 (GN-DoE Request): Under this scenario, the area of good quality summer habitat that would be indirectly affected by Madrid-Boston is 81,104 ha and 150,465 ha for the Hope Bay Project. This represents 0.07 to 1.5% of the Beverly summer range and 0.65 to 1.21% of the Ahiak summer range (Table 9.8-15).

The area of good quality fall habitat indirectly affected by Madrid-Boston is 54,086 ha and 99,608 ha for the Hope Bay Project. This represents 0.42-0.91% of the Beverly fall range and 0.37 to 0.67% of the Ahiak fall range (Table 9.8-15).

The area of good quality winter habitat indirectly lost due to Madrid-Boston is 41,255 ha, with a total of 74,664 ha for the Hope Bay Project, which represents a total of 32.7% of the Regional Study Area. This area represents 0.65 to 1.17% of the winter range for the Dolphin and Union caribou, 0.19 to 0.41% of the Beverly and 0.24 to 0.44% of the Ahiak winter range (Table 9.8-15).

Overall for scenario three, the total area of the habitat that would be indirectly lost due to Madrid-Boston irrespective of habitat quality is 88,172 ha and 173,361 ha for the Hope Bay Project. This represents 0.46 to 0.90% of the Dolphin and Union annual range, 0.32 to 0.63% of the Beverly annual range, and 0.29 to 0.57% of the Ahiak annual range (Table 9.8-15).

B) Evaluating Potential Effects using Encounter Rate and Residency Time

Caribou interactions with the existing Doris Project and proposed Madrid-Boston Project were examined using an encounter rate and residency time analysis. The GN DOE requested this analysis, due to concerns that increases in encounter rate or residency time near the Project may alter caribou behaviour, possibly resulting in reduced energy uptake.

The PDA surrounding the Doris Project (Phase 1), the proposed Madrid-Boston Project (Phase 2) and the additive Hope Bay Project were used to represent the Project location. The three ZOI scenarios used to calculate indirect habitat loss were used to assess encounter rates and residency time:

- Scenario 1: 4 km mine / 1.5 km roads (likely);
- Scenario 2 (GN-DoE request): 5 km mine/ 1.5 km roads; and
- Scenario 3 (GN-DoE request): 14 km mine/4 km roads.

A GIS exercise was used to calculate encounter rate using standard encounter rate techniques. Successive satellite collar locations were connected with a line. A caribou was recorded as "encountering" the Project when that line crossed into the PDA or ZOI. The residency time was calculated as the line length inside the PDA or ZOI, calculated as a proportion of the time between two successive collar locations.

The results of encounter rate and residency time analysis agreed with TK knowledge, information from the caribou workshops, and kernel density mapping conducted for the FEIS. None of the collared female caribou from the three caribou groups interact with the Hope Bay PDA or ZOI during calving, post-calving, or summer. Camera data recorded caribou in the Project RSA during summer, but these animals are typically small groups of males that would not be represented in the collar data because typically only female caribou are collared.

The Beverly caribou encounter the Madrid-Boston PDA during fall, with 80% of encounters in November and the remainder during winter. Approximately 5.5% of Beverly collars encountered the likely ZOI scenario 1, and these animals were resident in the ZOI for approximately 5.5 hours per year (Table 9.8-16). The relatively small proportion of Beverly caribou that encounter the Project during winter is consistent with land user knowledge and kernel mapping of the winter range that shows that the Beverly caribou largely winters south of the Project area.

Table 9.8-16. Beverly Encounter Rate and Residency Time

Study Area	% of collars[1]	Average # of encounters per collar[2]	Average Residency (days)[3]	Residency (SE days)[4]	Average Residency (hours)	Average Residency (% of year)	Residence of Average Caribou (% of year)[5]
Doris PDA	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Madrid-Boston PDA	3.670	3.000	0.186	0.150	4.453	0.051	0.002
Hope Bay PDA	3.670	3.000	0.186	0.150	4.453	0.051	0.002
ZOI Scenario 1	5.505	1.333	0.226	0.120	5.429	0.062	0.003
ZOI Scenario 2	6.422	2.429	0.377	0.125	9.056	0.103	0.007
ZOI Scenario 3	10.092	2.818	3.382	1.065	81.161	0.927	0.094

[1]: Encounters within a year were added.
[2]: The average number of encounters (entering the PDA or ZOI) per year.
[3]: Of those collars that interacted with a PDA or ZOI, this is the period of time spent in that location. Residency measured as the proportion of line length between two successive collar locations that is inside the PDA or ZOI.
[4]: Standard Error of residency time.
[5]: The total residency time as a fraction of the total time collars active - represents an "average caribou".

Like the Beverly caribou, Ahiak caribou typically encounter the Project PDA and ZOI during November (75% of encounters) and to a lesser degree during winter (25%). The Ahiak caribou winter on the tundra, typically further north than the Beverly herd, leading to a higher encounter rate with the Hope Bay PDA (13%) and ZOI Scenario 1 (14%) (Table 9.8-17). These data are consistent with kernel density estimates of herd range, which show the Boston PDA in the Ahiak herd range, but the Doris PDA outside the herd range. Residency is similar to the Beverly caribou, with an average of two days per year inside ZOI scenario 1.

Table 9.8-17. Ahiak Encounter Rate and Residency Time

Study Area	% of collars[1]	Average # of encounters per collar	Residency (days)	Residency (SE days)	Residency (hours)	Residency (% of year)	Residence of Average Caribou (% of year)
Doris PDA	1.099	1.000	0.028	0.000	0.682	0.008	0.000
Madrid-Boston PDA	12.088	2.667	0.261	0.138	6.270	0.072	0.009
Hope Bay PDA	13.187	2.750	0.264	0.138	6.327	0.072	0.010
ZOI Scenario 1	14.286	1.846	2.164	0.632	51.926	0.593	0.085
ZOI Scenario 2	16.484	2.400	0.985	0.420	23.649	0.270	0.045
ZOI Scenario 3	23.077	3.143	5.263	1.342	126.300	1.442	0.044

[1]: See footnotes on Table 9.8-14.

Inuit TK and information from caribou workshop participants indicates that the majority of Dolphin and Union caribou spend the winter outside of the Project RSA on the east side of Bathurst inlet, with concentrations of caribou wintering in the Huikitak River valley ~50 km south of the Project and south of Etibliakyok (Kent Peninsula isthmus) ~30 to 60 km east of the Project.

Approximately 55% of the encounters are during fall migration (November), with another 20% during spring migration (May) (Figure 9.8-17). The remaining 25% of encounters occur in winter. During spring and fall migration larger numbers of Dolphin and Union caribou interact with the Project PDAs, typically for a very short period of time as they migrate through the Project area (~4 to 5 hours). Caribou interact with the Project ZOIs for longer periods, as they travel parallel to the road north and south during migration (Table 9.8-18).

Table 9.8-18. Dolphin and Union Encounter Rate and Residency Time during Winter

Study Area	% of collars[1]	Average # of encounters per collar	Residency (days)	Residency (SE days)	Residency (hours)	Residency (% of year)	Residence of Average Caribou (% of year)
Doris PDA	2.083	2.333	0.079	0.072	1.895	0.022	0.000
Madrid-Boston PDA	9.028	1.857	0.007	0.067	0.174	0.002	0.004
Hope Bay PDA	11.111	2.063	0.141	0.059	3.389	0.039	0.004
ZOI Scenario 1	14.583	2.857	1.155	0.387	27.711	0.316	0.046
ZOI Scenario 2	17.361	2.960	1.182	0.349	28.359	0.324	0.056
ZOI Scenario 3	27.083	4.359	4.103	0.864	98.482	1.124	0.304

[1] *See footnotes on Table 9.8-14.*

During the workshops, Elders and land users concluded that caribou would not be adversely affected if they reside in the Hope Bay area near the Project (within the PDAs) or withinin the ZOI. Elders and land users agreed by consensus that:

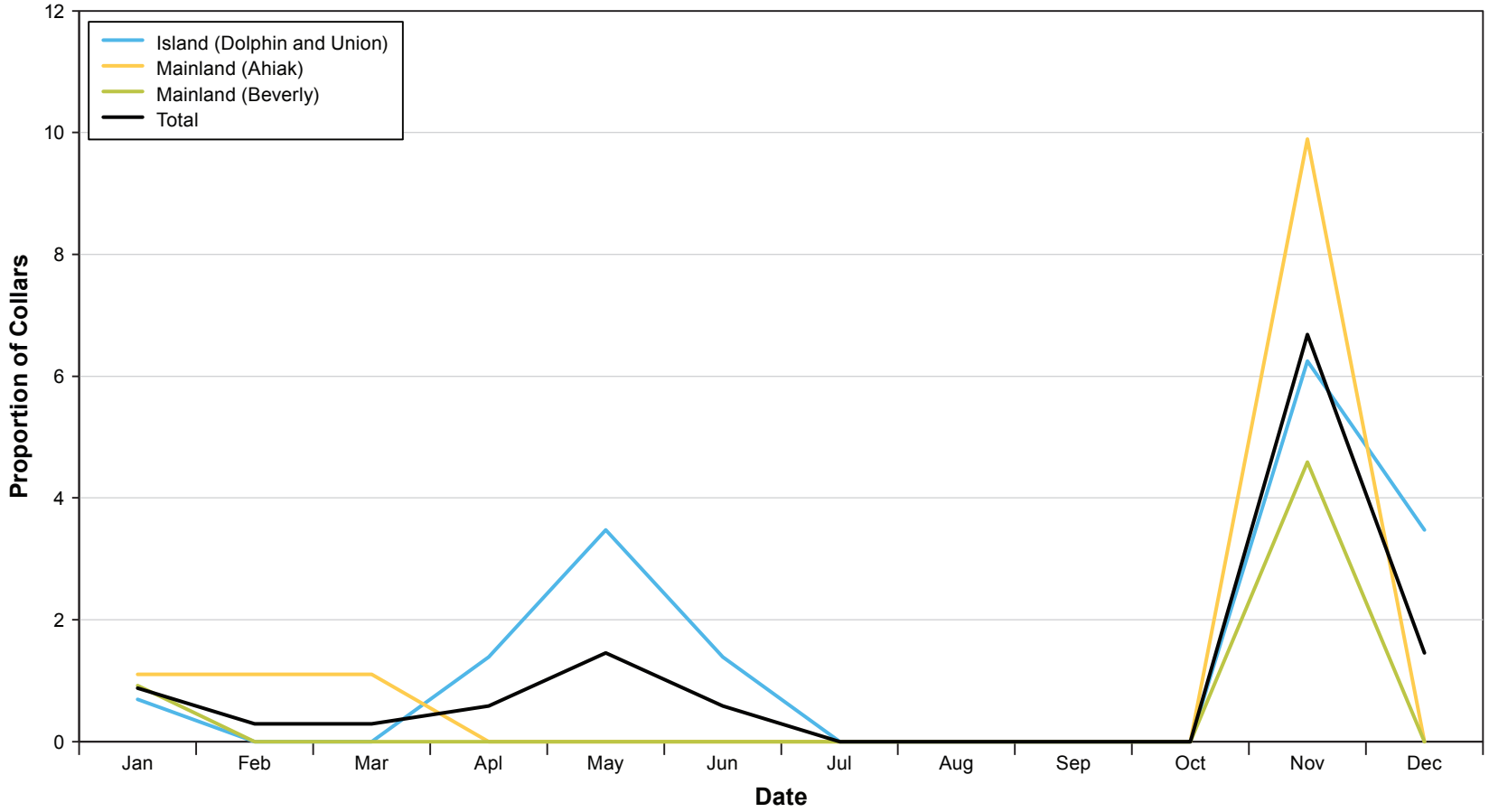
> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

As a consequence, TMAC concludes that while some caribou are currently using the proposed Project PDA areas and the surrounding ZOI areas, that these caribou will remain safe and without any effects on their survival or energetics.

C) Disturbance of Important Habitat Features

This section examines the potential effects of disturbance on important habitat features for caribou such as calving and post-calving areas, eskers, upland areas, freshwater crossings, and sea ice crossing areas.

The Madrid-Boston /Hope Bay Project does not overlap or occur within 4 km of the calving or post-calving areas for either Island or Mainland caribou. Once aircraft leave the Project, aircraft will be managed to minimize potential effects on caribou. These mitigation measures include fixed wing aircraft maintaining a minimum of 610 m elevation, except when landing and taking off. Helicopter flights will avoid animals by a minimum of 300 m vertically and 600 m horizontally (Table 9.8-4). There is no plan for helicopters to travel east towards the calving or post-calving area of the Beverly and Ahiak caribou, but if caribou are observed during calving helicopters will maintain a minimum of 610 m vertical or 600 m horizontal from caribou.


Island (Dolphin and Union)
Mainland (Ahiak)
Mainland (Beverly)
Total
Proportion of Collars
0
2
4
6
8
10
12
Jan
Feb
Mar
Apl
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

Eskers are used by caribou as movement corridors. As described in Section 9.8.3.1 - Habitat Loss, eskers are uncommon in the RSA and the Project will not directly interact with any eskers. Likewise, a review of the Ecological Land Classification (ELC) data for the Slave Geological Province (Matthews, Epp, and Smith 2001) indicates that there are only two (300 m long) fragments of esker within 4 km of the Project site, which is the ZOI considered in this assessment. Likewise, TK did not identify any specific eskers used by caribou in the RSA.

Hills and rock outcrops, where the wind is stronger, are used by caribou for insect relief. The coastline and area to the west of the Project site has high relief compared to many areas of Nunavut, with many rocky outcrops, hills and linear dikes. Generally, the Hope Bay Greenstone Belt is in an area of lower relief than the surrounding area in the RSA (Section 9.8.3.1) and areas of higher relief are generally located at greater than 4 km from the site (Figure 9.8-8). As a consequence, it is not expected that noise or other disturbances from the Project will significantly affect any areas of uplands potentially used by caribou.

The location of the Project relative to freshwater and sea ice crossings is evaluated in Section 9.8.3.3 - Disruption of Movement. This analysis indicates that there are no freshwater or sea ice crossings that will directly interact with the Project or within 4 km of the Project.

Effects of Disturbance on Caribou

A review of monitoring programs for the Windy camp and the Doris Project indicated that there was either no effect on caribou, or a small effect on caribou distribution surrounding the Project site. A scientific literature review indicated that the most likely zone of influence for industrial projects in the Arctic is 4 km for projects often much larger than the Hope Bay Project. Noise and dust modeling indicated that predicted noise and dust would reach acceptable indicator levels within that 2 km buffer.

Calculating the actual habitat lost within the Project PDAs was addressed in Section 9.8.3.1 — Habitat Loss. This section evaluated if caribou would avoid the Project resulting in indirect habitat loss. Using a 4 km ZOI (likely scenario) and predicting that all caribou would avoid the Project ZOI – a conservative over-estimate of a negative impact because the monitoring results showed only a small reduction in caribou near the site – these calculations indicated that the Project ZOI could affect between 0.03% and 0.36% of the ranges of the Dolphin and Union, Beverly, and Ahiak caribou herds.

The current Doris Project and the proposed Madrid-Boston Project have extensive mitigation and management measures to manage potential impacts to caribou. After discussing risk to caribou and reviewing the mitigation measures in the field, Elders and land users agreed with the following statement:

> *"Mitigation for the existing Doris Project protects caribou."*

Calculations were conducted to examine the encounter rate and residency time of caribou in the proposed Project area. Caribou from each group encountered the Project site; however, their residency time within ZOIs was low, typically a few hours. After Elders and land users visited the Doris site, reviewed the mitigation measures and discussed at length the potential impacts of the Project on caribou, they concluded that caribou would not be adversely affected if they reside in the Hope Bay area. Elders and land users agreed with the following statements:

> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

and

> *"[With the planned mitigation and monitoring] the risk to caribou associated with Phase 2 are acceptable."*

Workshop participants determined that the management for aircraft, mine site noise, quarry blasting, roads and dust are appropriate and will protect caribou. Therefore, whether caribou avoid the Project site or continue to use the Project site they will be safe from any impacts from the Project.

Despite this, and using a very conservative and precautionary list of assumptions (that caribou would avoid the Project site and lose habitat), there would be a small but measurable impact on caribou habitat availability. As a consequence, **this potential effect of disturbance was rated as a residual effect** for all three caribou groups: Island caribou (Dolphin and Union) and Mainland caribou (Beverly and Ahiak sub-populations).

9.8.3.3 Disruption of Movement

The Doris Project currently has two primary all weather roads, extending from Roberts Bay to Doris camp (4.8 km) and from Doris Camp south to the closed Windy Camp/Madrid North site (approximately 9.5 km), plus some ancillary roads to the TIA and quarry (Section 9.4.1.1). In most years the Doris Project operates a winter ice road from the Madrid North site to the Boston exploration camp, largely following the same route as the proposed Boston all weather road. As part of the Madrid-Boston Project, that winter road will be replaced with an all season road.

During the first caribou workshop (September, 2016), Elders and land users identified the potential for the existing and proposed all-weather road and mine infrastructure to alter caribou migration as a potential effect with a high impact without mitigation because it has the potential to affect many caribou without mitigation and management. Participants conducted a mapping exercise to identify caribou movement routes during migration to and from Victoria Island, in Melville sound and on the mainland. Participants also suggested mitigation to reduce potential risks to caribou by monitoring caribou during migration near the road and to install caribou crossing structures at locations where evidence indicates caribou cross the road.

During the second caribou workshop (April, 2017), Elders and land users reviewed the potential risks of the Project to caribou, including the risk of roads disrupting caribou movements during migration. Workshop participants conducted a site visit on April 19, 2017 to review and discuss the mitigation measures used to reduce disruption of movement for caribou. They suggested that an additional site visit would be beneficial during summer to see the road structures without snow and specifically to view the Boston site.

In the third caribou workshop, Elders and land users visited the Doris and Boston sites without snow cover on August 24, 2017. Participants observed the proposed Boston road via helicopter, stopped at various sites to examine the road route from the ground, and suggested sites for crossing structures to help caribou cross the road. Following the site visit, Elders and land users discussed the mitigation measures for the existing Doris Project and the proposed Madrid-Boston development, supported existing mitigation, and discussed their conclusions on the risk to caribou populations with those mitigation measures in place.

The results of discussions on mitigation measures during the caribou workshops and site visits are presented in the following section along with a description of existing mitigation at the Doris site and proposed mitigations for the Madrid-Boston development. The conclusions made by Elders and land users of the risks to caribou as a result of the Madrid-Boston Proposal are also presented.

Sea Ice Crossings

Traditional Knowledge indicates that Island caribou summer on Victoria Island and spend the winter on the mainland, crossing the sea ice in spring and fall. COSEWIC (2004) identified the threats to Dolphin and Union caribou as climate change, ice breaking for marine navigation, and harvest. The Proposed Dolphin and Union caribou management plan (Environment and Climate Change Canada 2017a) identified loss of sea ice and ice breaking as part of shipping as a high impact risk to this herd. Potential effects on movement of Dolphin and Union caribou on the sea ice and on the mainland are discussed in this section.

Traditional Knowledge and land users indicate that Island caribou travel between the mainland and Victoria Island across the Dolphin and Union Strait (formerly), Coronation Gulf, Melville Sound and Dease Strait. Caribou migrate north in the spring (late April to early June) and south in the fall (late November and early December). On the west side of Bathurst Inlet, caribou cross Coronation Gulf directly to the mainland. On the east side of Bathurst Inlet, caribou cross Dease Strait to the Kent Peninsula and then to the mainland (Figure 9.8-18).

Caribou workshop participants indicated that during fall migration, Island caribou for many years gathered on the shoreline near Cambridge Bay to wait for the sea ice to freeze. From there, they crossed the sea ice south-west to the eastern tip of the Kent Peninsula. However, in recent years, Island caribou have gathered further away, near Wellington Bay, 100 km west by snow machine, although the reasons for this were unclear.

Caribou workshop participants, TK and satellite collar data indicate that after Island caribou cross from Victoria Island to the Kent Peninsula they travel south along Etibliakyok (the isthmus connecting the Kent Peninsula to the mainland) to the mainland, which is approximately 60 km east of the Hope Bay Project (Figure 9.8-18). Some caribou also cross Melville Sound directly in spring and fall, primarily at the string of islands that separate Melville Sound from Elu Inlet and within Elu Inlet itself, approximately 15 km to the north-east of Roberts Bay. Smaller numbers of caribou also cross Melville Sound anywhere that points of land or island chains reduce the travel distance over sea ice (Figure 9.8-18), including at the mouth of Melville Sound (50 km west of the Project), at the point known as Hinikyoak (20 km west of the Project), and at the mouth of the Akinngak and Angimayak Rivers (K. G. Poole et al. 2010).

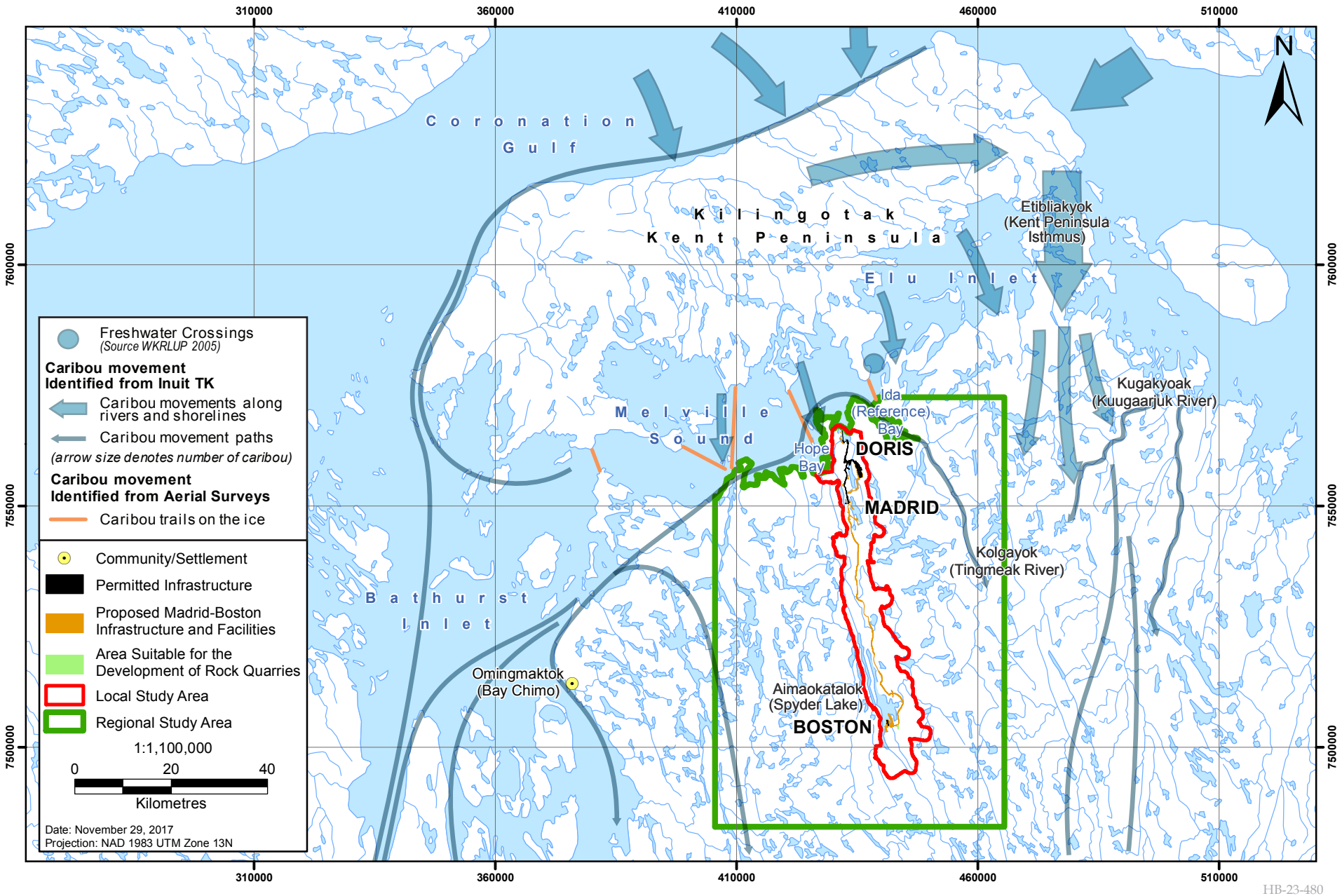
Community members, the GN DOE, COSEWIC and ECCC have identified climate change and winter ice breaking in the Northwest Passage as a potential threat to Dolphin and Union caribou. The concern is that caribou may fall through recently broken ice or that repeated ice breaking may cause areas of impassable broken ice.

Arctic shipping typically falls into three categories: 1) open water shipping, 2) ice-capable shipping where ice up to 10 cm thick can be broken, and 3) ice breaking, where ice over 10 cm is broken. Caribou can use sea ice that is less than 10 cm thick, particularly in the fall. The proposed Dolphin and Union caribou management plan (Environment and Climate Change Canada 2017a) identified both ice-capable shipping and ice breaking as concerns for these caribou and proposed as part of its Management Objective #4 to manage disturbance and ice breaking at sea-ice crossings and suggested that guidelines for shipping should be developed.

TMAC's plan is to use sealifts only during the open water season, typically between early August and late October, except in an emergency for the safety of the ship or crew. This plan addresses concerns raised in the proposed Dolphin and Union caribou management plan (Environment and Climate Change Canada 2017a) and will effectively manage any potential effects on caribou sea ice crossings.

Figure 9.8-18

Water Crossings and Movement Corridors for Caribou from Inuit TK and Aerial Surveys and Collar Data



HB-23-480

Movements on the Mainland

During the first caribou workshop in September 2016, participants identified that without mitigation, an all season road presents a medium risk to altering caribou migration pathways. One workshop participant, who had worked at the Echo Bay Mine [Lupin Mine] in the 1970s, stated that they believed that caribou did not cross the mine access road due to high snowbanks of several meters on the winter ice road across Contwoyto Lake.

To mitigate this potential effect, workshop participants suggested monitoring of roads during migration, monitoring of caribou movements near roads, and installing crossing structures on roads at locations where caribou are known to cross. Workshop participants visited the site on April 19 and August 24, 2017, to view the existing Doris roads and road crossing structures and evaluate their effectiveness, described below.

Workshop participants described the migratory movement of Island caribou near the Project as typically east-west along the sea ice of Melville sound and north-south on the mainland, particularly following larger rivers such as the Kolgayok (Tingmeak River), Kugakyoak (Kuugaarjuk River) and Koignuk River. Satellite collar information indicate that as part of spring and fall migration, Island caribou travel in a north-south direction on the mainland to reach their winter range. Island caribou are observed on-site primarily during the fall and spring as they migrate towards or from wintering areas further south. These movements are generally parallel to the 53 km north-south all season road connecting Boston to Doris during spring migration (Figures 9.8-19 and 9.8-20) and fall migration (Figures 9.8-21 and 9.8-22).

As discussed in the previous section, during the fall migration caribou traditionally massed on the shore of Victoria Island near Cambridge Bay waiting for the sea to freeze, and then crossed to the Kent Peninsula. Once on the mainland, caribou followed the Kent Peninsula isthmus south and then spread out on the mainland. During that period, some caribou would cross the Boston road route during November, typically between km 8 and 20. This area has several linear dikes that face north-south that tend to concentrate caribou movement. Elders and land users identified several potential sites for crossing structures on the proposed road at these locations.

Workshop participants indicated that during the last decade, Island caribou have stopped massing near Cambridge Bay during fall, and instead gather at west of Wellington Bay and cross to the Kent Peninsula from there (Figures 9.8-21 and 9.8-22). Once on the mainland, these caribou tend to travel directly south, parallel to the proposed Boston road route.

During winter, TK indicates that Island caribou use the mainland on both the east and west side of Bathurst Inlet. There are several areas with a higher density of caribou in winter, including Kilingotak (the Kent Peninsula), Etibliakyok (the Kent Peninsula isthmus), and the Queen Maud Gulf area. Inuit TK identifies the entire mainland area as being used for movement by caribou in some form, including Aimaokatalok (Spyder Lake), and most river systems.

Inuit TK, land user and satellite collar information indicates that the Mainland (Beverly and Ahiak) caribou do not use the Project RSA during spring migration, calving, and post-calving movements. Land user information, wildlife cameras and survey data from the GN DOE indicate that caribou typically occur in small groups in the RSA. Hence, there are no times when large aggregations of Mainland caribou will be crossing the Boston all-weather road.

Figure 9.8-19
Spring Migration Travel Paths of Dolphin and Union (Island) Caribou in the Region Surrounding the Project, 1999 to 2004 and 2015 to 2017

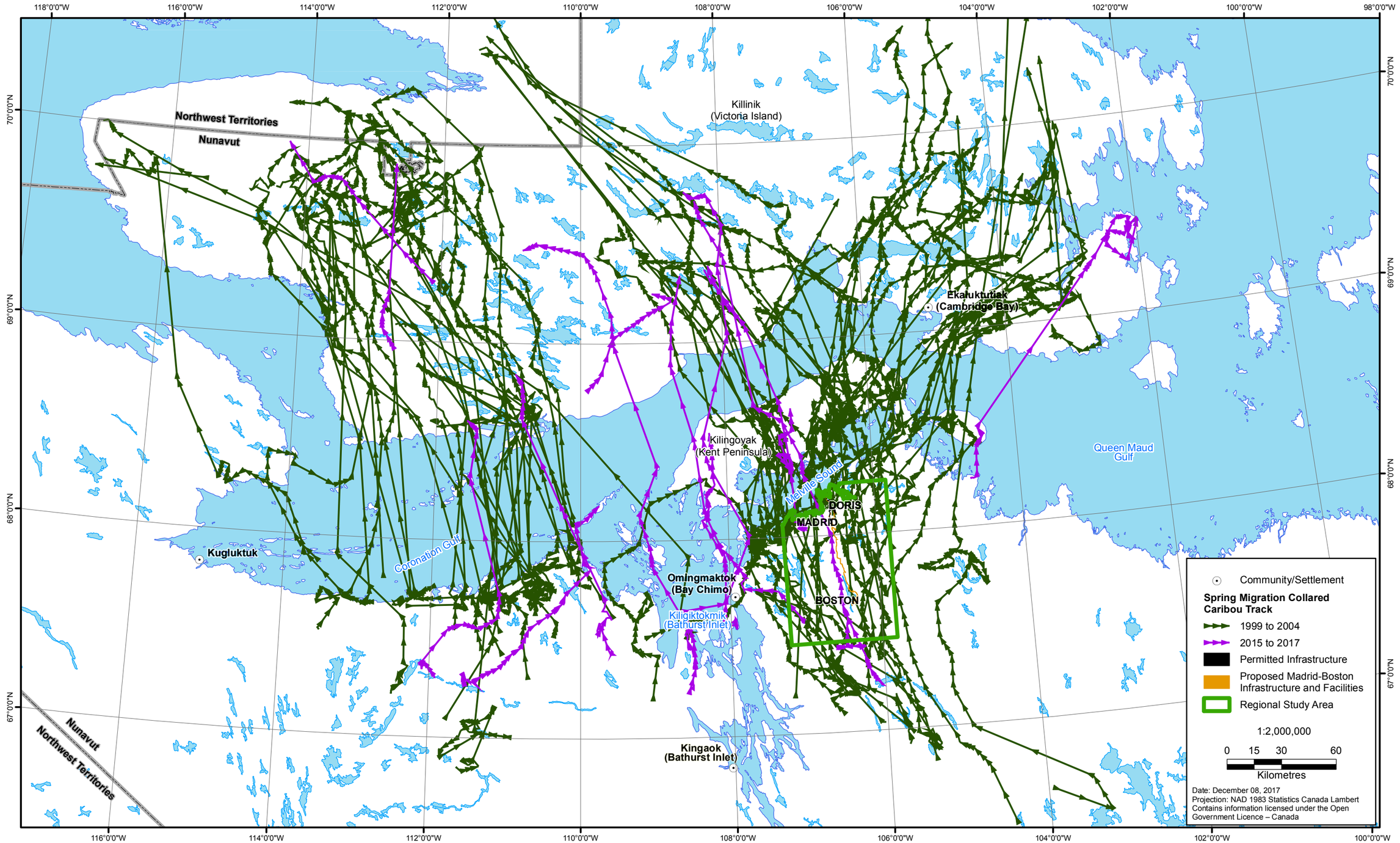


Figure 9.8-20
Spring Migration Travel Paths of Dolphin and Union (Island) Caribou in relation to the Project, 1999 to 2004 and 2015 to 2017

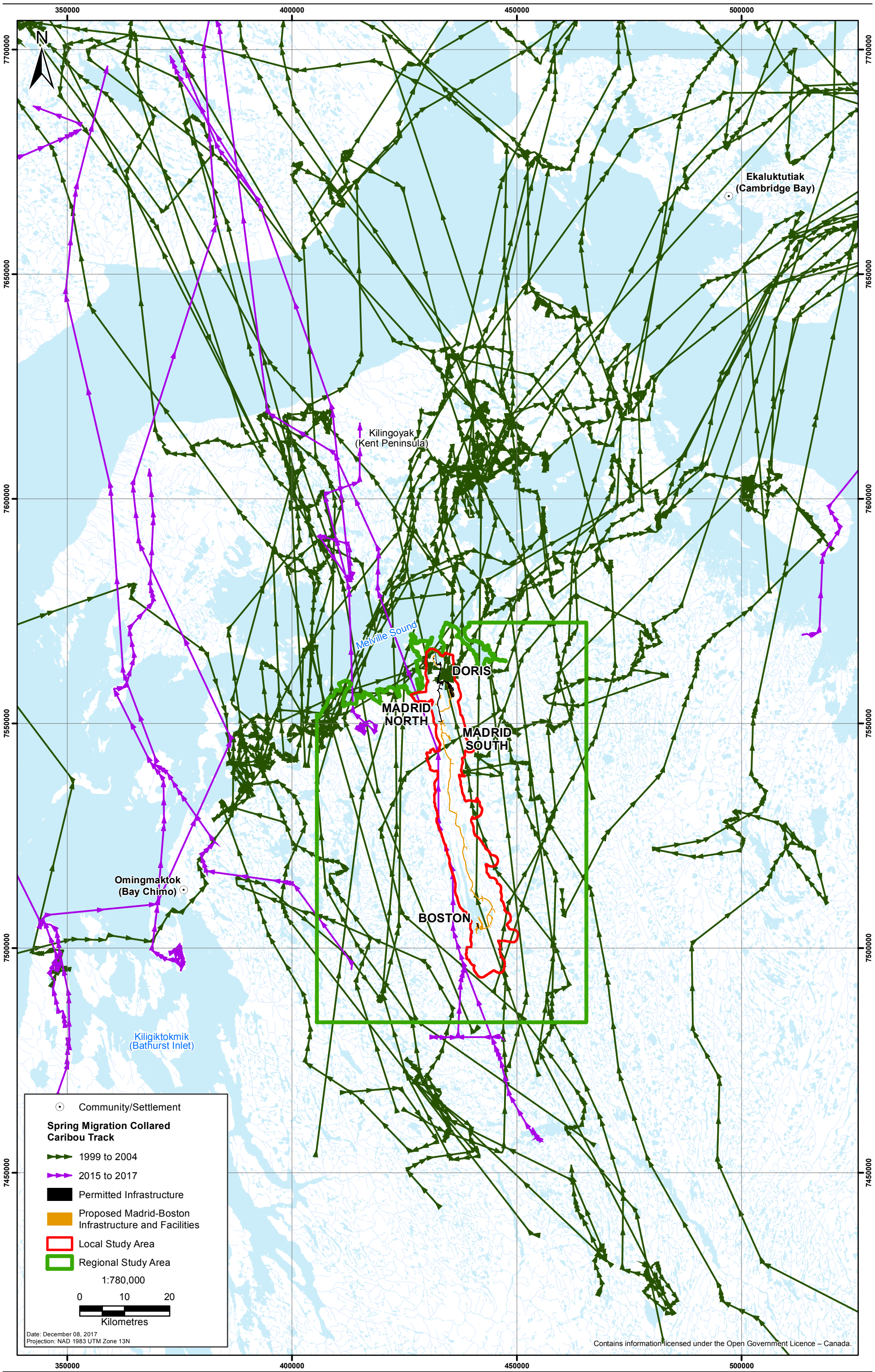


Figure 9.8-21
Fall Migration Travel Paths of Dolphin and Union (Island) Caribou in the Region Surrounding the Project, 1999 to 2004 and 2015 to 2017

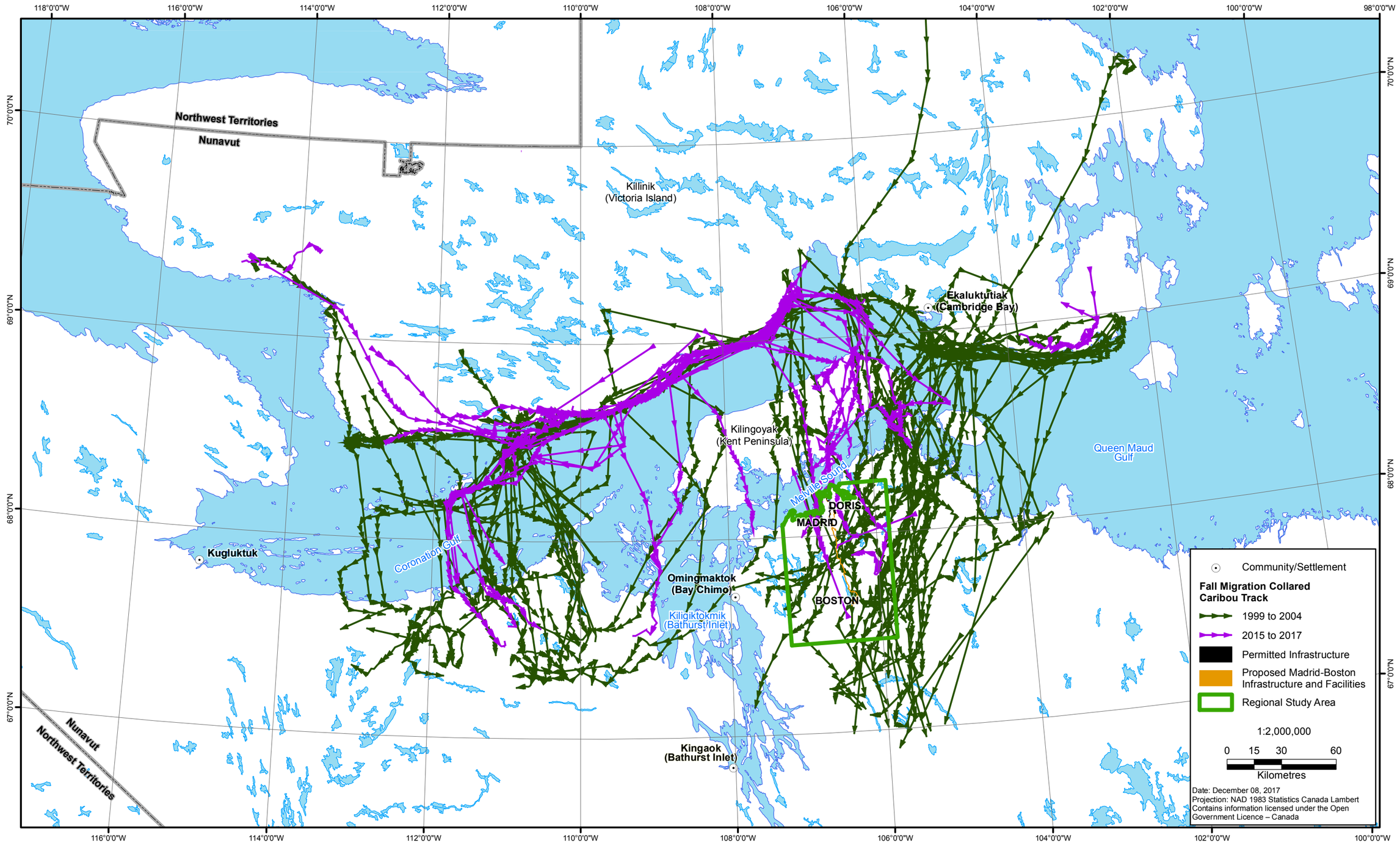
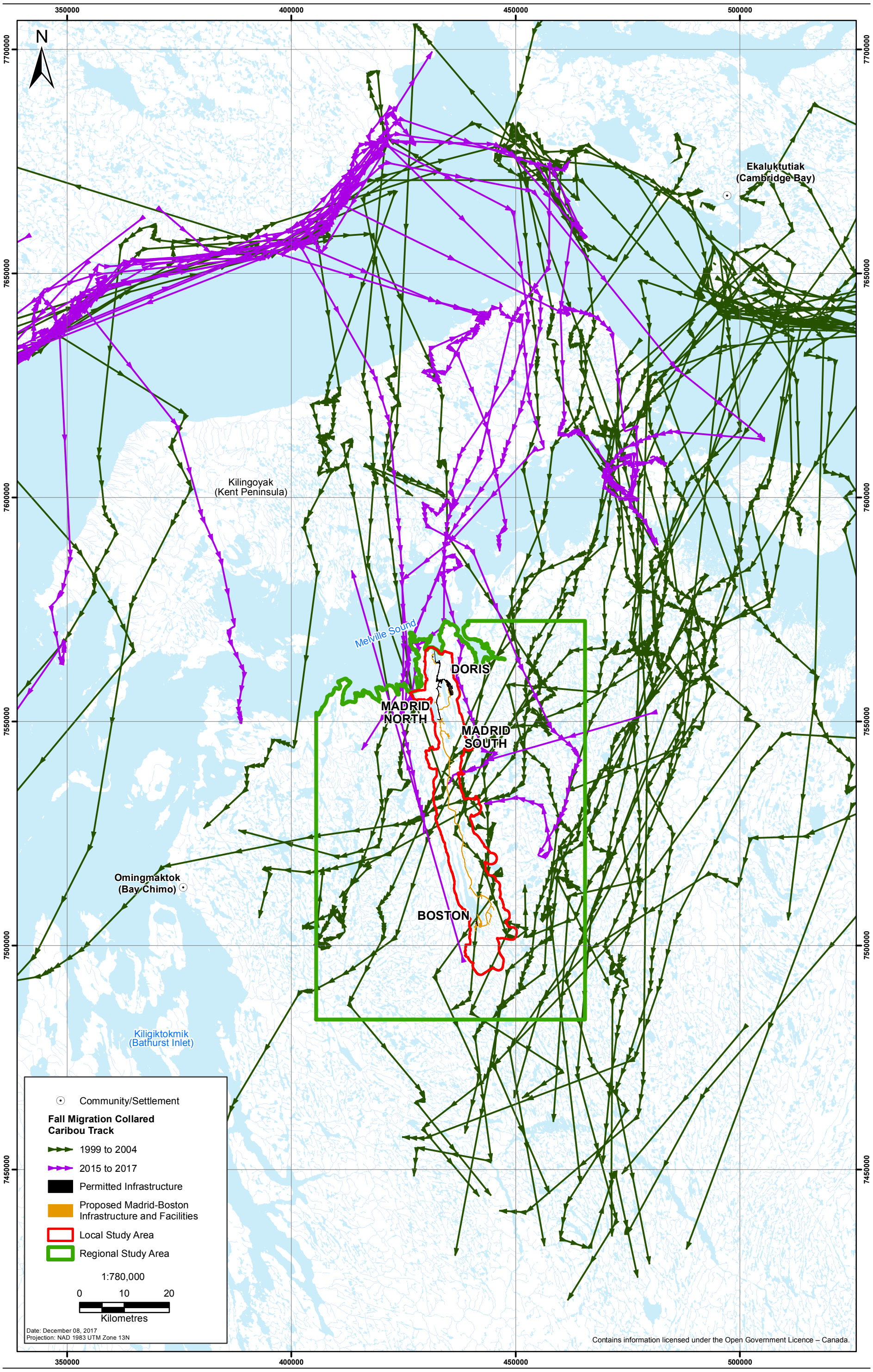


Figure 9.8-22
Fall Migration Travel Paths of Dolphin and Union (Island) Caribou in relation to the Project, 1999 to 2004 and 2015 to 2016



In most years the Doris Project operated a winter ice road to the Boston exploration camp, largely following the same route as the proposed Boston all weather road. Therefore, caribou in winter are already crossing the winter ice road. Construction of the all-weather road is not expected to change the number of caribou that wish to cross. For all three herds, the majority of caribou interact with the Project during fall migration (up to 75% of the interactions are in November). Crossings as a proportion of collars are displayed in Table 9.8-19.

Table 9.8-19. Crossing Rates of Caribou across the Existing Winter Road and Proposed Boston all-weather Road

Herd	Road	% collars	Average time in PDA (h)
Dolphin and Union	Boston AWR	9.72	2.217
Ahiak	Boston AWR	9.89	2.944
Beverly	Boston AWR	1.83	4.411

Mitigation currently in use for the Doris Project is proposed for Madrid-Boston to ensure that caribou can easily cross the all season road, including: 1) maintaining a low road height wherever possible, 2) blading snowbanks down to prevent snow drifts as part of normal road maintenance, and 3) installing road crossing structures where caribou are known to regularly cross. Workshop participants visited the site in April and August, 2017 to evaluate these mitigation measures.

Roads with low heights above the ground have the advantages that wildlife can see over the road and it does not become a visual barrier. A low road height also means that the size of material used in road construction is generally quite small, which improves the ability of animals to walk up the side of the road to cross it. Finally, having low roads means that safety berms are not required for vehicles on the road. The Nunavut Mine Safety Regulations (Reg (Nu) 125-95) require safety berms on all mine roads higher than 3 m above the surrounding land. For the current Roberts Bay to Doris to Windy all season road, all of the road is less than 3 m tall. Less than 1% of the proposed Windy to Boston road will be above 3 m in height and require berms. An example of typical road construction of the Doris road that is approximately 1 m high, and featuring a caribou crossing ramp is provided in Plate 9.8-7.



Plate 9.8-7. A section of the Doris all-season road, with a road height of approximately 1 m and a caribou crossing ramp installed.

To reduce snow drifting on the existing Doris Project road and increase the safety of drivers, snow is plowed off the road and then bladed down to produce a smooth transition between the road surface and the surrounding snow-covered landscape. This snow management practice has the added benefit of facilitating caribou movement across the road without having to climb and descend snow banks. The same snow management practices will be used for the proposed Boston road. As part of the caribou workshop, participants viewed the road during normal winter operations during the April 19, 2017 site visit and observed snow banks that were several cm high (Plate 9.8-8.). Group consensus for these protection measures was that the snow management practices would not inhibit caribou movement across the existing or proposed road.



Plate 9.8-8. Caribou workshop participants conduct site inspection of the existing Doris road snow management. Note the lack of snow banks on the road.

In addition to a low road height and snow management, the existing Doris road has three types of road crossing structures installed to assist caribou with crossing the road. These structures were installed in 2009 and 2010 during road construction at locations identified as caribou movement corridors by Inuit Elders during a site tour. The primary road crossing structures are road ramps. Bridges and tunnels are also used to assist caribou to cross the road. During the August 24 site visit, caribou workshop participants visited each of these structures to evaluate their effectiveness.

The road ramps were constructed in locations identified by Inuit Elders, with a general slope of 4:1 and a length of approximately 6 to 8 m (Plate 9.8-9). The ramps have a core of rock material and a surface of approximately 2 to 4 cm gravel. Caribou workshop participants visited these sites in August 2017 and noted that there was a caribou trail leading directly to the crossing ramp with evidence of recent use (Plate 9.8-10) and there were caribou tracks leading up the ramp and across the road. In addition to that observation, the motion-triggered cameras placed at road ramps recorded caribou crossing the road at these locations.

Bridges are installed on the Doris road at some areas with seasonal and permanent water flow and are designed with a clearance of approximately 2.5 m to permit water flow and enable caribou to cross under the bridge. Caribou workshop participants visited a bridge site and noted several caribou trails with signs of extensive and recent use under the bridge (Plate 9.8-11).

The third type of crossing structure is tunnels constructed of corrugated metal with an open bottom (e.g., soil on the bottom of the tunnel; Plate 9.8-12). Environmental monitors for the Doris Project indicate that caribou are observed sheltering in the shade of the tunnel on warm days during the summer. Caribou workshop participants noted that the tunnels were used by caribou, evidenced by the soil on the tunnel floor being churned to mud by caribou hooves and there were abundant droppings in the tunnel (Plate 9.8-12).



Plate 9.8-9. Typical road crossing ramp for caribou installed on the Doris to Windy road.



Plate 9.8-10. Caribou trail leading to road crossing structure for the Doris road.



Plate 9.8-11. Caribou trail leading under the bridge over a wetland area on the Doris road.



Plate 9.8-12. Caribou tracks in tunnel under the Doris road.

During the third caribou workshop in August 2017, workshop participants conducted an aerial tour of the proposed Boston road route to identify areas for crossing structures on the road. A variety of

locations with concentrations of trails were identified for installation of crossing ramps. Workshop participants noted that Boulder Creek, a tributary of the Koignuk River, had considerable numbers of caribou trails on the river bank. Workshop participants suggested that a bridge structure be used at this location to allow caribou to cross under the road (third caribou workshop report; Appendix V2-3C). The proposed crossing type on Boulder Creek is an end-bearing pile bridge with a minimum 15 m span length (Project Description; Volume 3, Table 3.7-1) similar to the Bridge in Plate 9.8-13, which will address this request by the caribou workshop participants and allow caribou to move under the bridge.



Plate 9.8-13. Caribou trails at Boulder Creek – proposed location for a bridge allowing caribou to cross under the road.

Scientific studies report caribou may be impeded from crossing roads when traffic volume exceeds certain levels (Kite et al. 2017). A study of caribou movement in Alberta indicated that roads were not a barrier to caribou movement unless traffic was present (Dyer et al. 2002a) . Studies in Alaska reported that caribou crossing of a pipeline road was impeded by traffic rates higher than 20 vehicles per hour (Murphy and Curatolo 1984; W. A. Smith and Cameron 1985). Likewise, Murphy (1988) reported that caribou in the Kuparuk Oilfield in northern Alaska reported that road crossings by barren-ground caribou were only impeded once traffic rates were greater than 1 per minute (1440 per day).

Wildlife behaviour relative to roads varies between species and within species such that certain populations, age/sex groups, or individuals react either positively, negatively, or have a neutral reaction to roads (James and Stuart-Smith 2000). There is a growing body of evidence of the impacts of roads on wildlife (Trombulak and Frissell 2000; Underhill and Angold 2000; Carr, Pope, and Fahrig 2002; Roedenbeck et al. 2007; R. R. Wilson et al. 2016). Roads may disrupt movement of wildlife through a combination of disturbance and avoidance effects and physical obstacles. R. R. Wilson et al. (2016) indicated that roads may also influence rates of crossing, with some individuals taking a much longer time to cross a road (slow crossers) than others (normal crossers). In this same study, slow and normal crossers approached roads at the same pace, but slow crossers moved more than one and half times faster than normal crossers after crossing occurred.

The barrier effect is a non-linear function of traffic density, road width, roadside characteristics, the animals' behaviour and its sensitivity to disturbances. Traffic intensity and vehicle speed appear to have the strongest influence on the barrier effect of roads on those mammals that do not experience any physical barrier or repellent habitat effect in road corridors. With increasing traffic and higher vehicle speed, mortality rates usually increase until the deterrent effect of the traffic prevents more animals from getting killed. (Müller and Berthoud 1994, reviewed in Seiler 2004) suggested five categories of infrastructure/traffic intensity with respect to their barrier impact on wildlife:

1. Local access and service roads with very light traffic can serve as partial filters on wildlife movements.
2. Minor roads with traffic below 1,000 vehicles per day may cause incidental traffic mortality and exert a stronger barrier/avoidance effect on small species, but crossing movements will still frequently occur.
3. Intermediate link roads with up to 5,000 vehicles per day may comprise a serious barrier to certain species. Traffic noise and vehicle movement are likely to have a major deterrent effect on small mammals and some larger mammals. Due to this repellence, the increase in overall barrier impact is not proportional to the increase in traffic volume.
4. Arterial roads with heavy traffic between 5,000 and 10,000 vehicles per day cause a significant barrier to many terrestrial species, but due to strong repellence by the traffic, the number of road kills may level out. Road kills and safety issues are the most important issues in this category.
5. Motorways and highways with traffic above 10,000 vehicles per day impose an impermeable barrier to almost any wildlife species, as the dense traffic repels most species approaching the road and kills those that attempt to cross.

Preliminary results from an analysis of the potential effects of the all-season road connecting the town of Baker Lake to the Meadowbank mine in the Kivalliq Region indicate an increase in road avoidance during the fall migration (after the road was constructed; Kite et al. 2017). This effect was demonstrated by an increase in the frequency of avoidance movements between the pre-and post-road construction time periods. Slowed movement and avoidance of the road by caribou appeared to indicate that the road may be acting as a semi-permeable barrier to movement. A corresponding study using the same caribou telemetry dataset did not indicate avoidance during spring and fall, but did during winter (Golder and Associates 2017). The different conclusions from both these regression based approaches highlight the importance of appropriately considering habitat variables, the location of infrastructure relative to seasonal range extents, and the timing of collar deployment and frequency of location data in how the analyses are constructed.

The Project will include an aerial or ground-based transmission line. Research on effects of transmission lines on caribou are complicated by the fact that transmission lines often parallel other developments such as highways (Nellemann et al. 2001; Vistnes and Nellemann 2001; Nellemann et al. 2003; Vistnes and Nellemann 2008b). Studies indicate that caribou do not avoid areas surrounding power lines, but the abundance around some transmission lines may be reduced in forested environments (Nellemann et al. 2001; Vistnes and Nellemann 2008a). The behaviour of reindeer in enclosures did not change relative to the distance from power lines (K. Flydal et al. 2009). Since the Project is not located in a forested environment where the cleared right of way may alter behaviour, no effect is expected on caribou movement.

At the Ekati Diamond Mine, which includes a 29 km all-weather road, caribou timing and road crossing events have been recorded since 2011 through a wildlife camera program. Results indicate that the road is not an impermeable barrier to caribou movement through the Ekati Diamond Mine area, either due to the physical construction of the road or due to current traffic volumes (ERM Rescan 2014b; DDEC 2016). Maximum daily traffic volume was approximately 300 vehicles (ERM Rescan 2014b). Overall, less than 1% of road encounters resulted in a deflection event, and some of these animals may have crossed the road elsewhere.

For the Project, approximately half of the vehicle trips on the all-weather road will be hauling concentrate from Madrid and Boston to Doris. The remainder will be for fuel, a bus to transport employees and various service vehicles. Traffic rates will be variable across the life of the Project but is anticipated to be the highest across all sections of the proposed and existing roads for two years (Year 5 and 6). The proposed 53 km Boston will make up 85% of the road from Boston to Doris and will carry approximately 25 to 33 return trips per day (2.1 to 2.8 vehicle passes per hour; Table 9.8-20). The existing 9.5 km road from Madrid to Doris makes up approximately 15% of the Boston to Doris road and will carry traffic both for Boston and Madrid, with approximately 51 to 98 return trips per day (4.3 to 8.2 vehicle passes per hour). The existing 4.8 km road from Doris to Roberts Bay, over which fuel and other supplies for Madrid-Boston are transported, will carry approximately 10 to 12 return trips per day (0.8 to 1 vehicle passes per hour). These traffic rates are below the traffic volumes reported to cause caribou to avoid crossing roads.

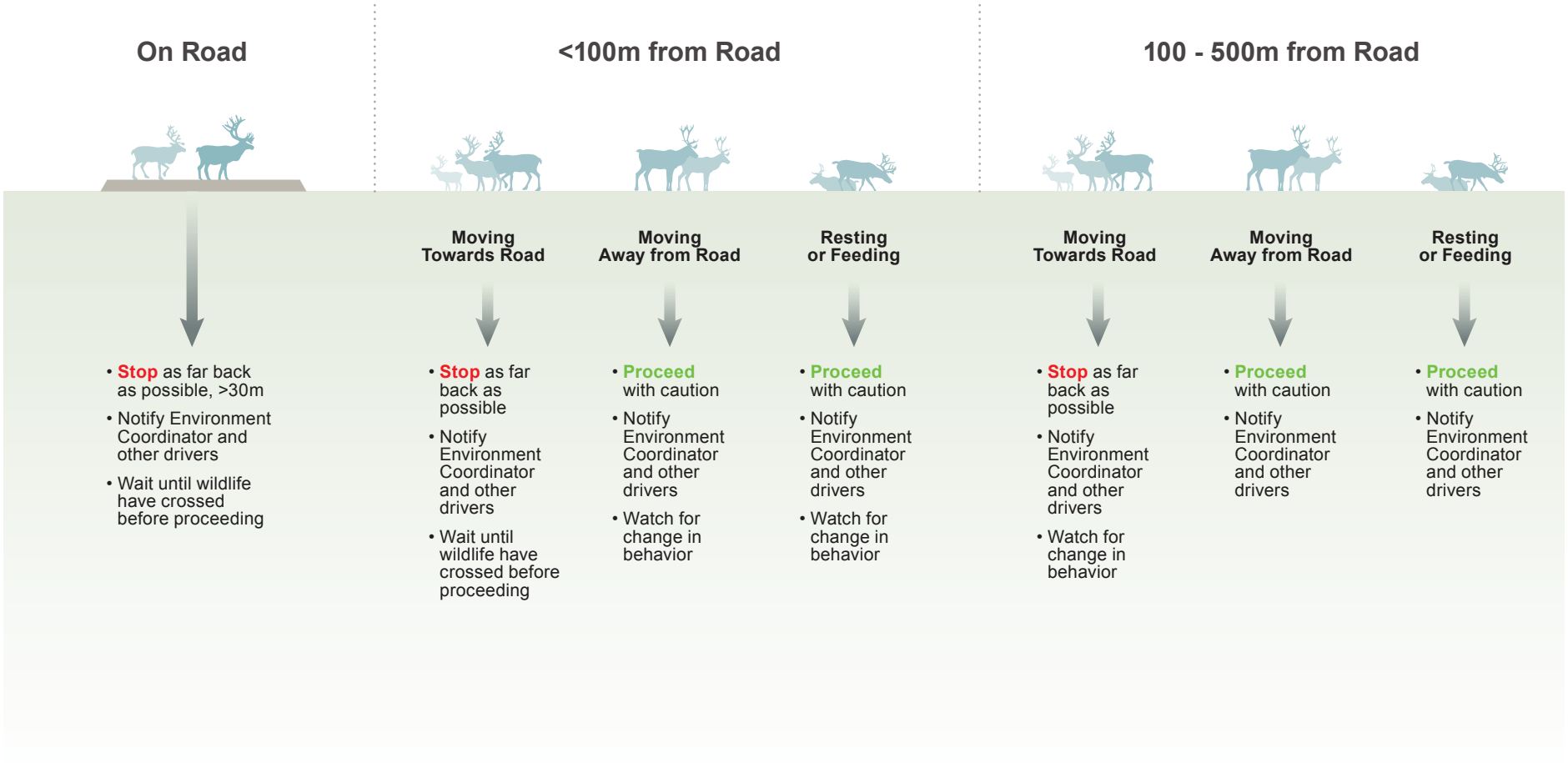
Table 9.8-20. Vehicle Traffic Rates for the Life of the Project

		Traffic Volumes (Daily Return Trips)[1], by Year (Y)												
Road Segments	**Length (km)**	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**	**Y11**	**Y12**	**Y13**
Roberts Bay-Doris	4.8	10	10	10	12	12	12	12	12	12	12	12	12	10
Doris-Madrid	9.5	51	51	51	54	98	98	98	98	98	98	98	98	92
Madrid-Boston	53	0	0	0	32	33	33	25	25	25	25	25	25	0

[1]: Vehicle traffic is based on peak traffic rates provided in Table 4.5-1 of the Project Description (Volume 3). For the assessment, traffic numbers assume that all vehicle trips will be daily, although some vehicle trips will be once every two or three days. Number represent return trips, outbound and inbound; multiply number by two to obtain one-way trips.

To ensure that caribou (and other wildlife) are not dissuaded from crossing the road, management of vehicles will include 1) speed limits, 2) regular call-ins for observations of wildlife, 3) giving wildlife the right of way, 4) drivers staying in their vehicles near caribou, and 5) alerting the Environmental Department when caribou are observed near the road so that more vigilant monitoring may be triggered. A speed limit of 50 km/h will be used on all Project roads, which limits the noise and dust produced by trucks so animals are less likely to avoid the road area. Existing and proposed Project roads are typical of controlled-access industrial roads, with all drivers required to call in by radio at specified waypoints every two km. When calling in, drivers are responsible to report any information important for other drivers, such as road and environmental conditions and wildlife sightings. Drivers are responsible to evaluate how far away the caribou are from the road, and whether they are moving towards the road or are on the road. Based on the distance and activity of caribou, drivers will slow or stop their vehicles and wait until the animals move off the road. A decision tree that will be given to drivers is presented in Figure 9.8-23.

Figure 9.8-23
Driver Mitigation for Caribou



During spring and fall migration, when data indicates that the majority of road crossing events occur, TMAC will conduct additional monitoring to evaluate if caribou are near the road and guide mitigation. TMAC will continue to engage with the IEAC to identify locations where caribou are more likely to cross the Boston road. During migration, TMAC will conduct height of land surveys during spring and fall migration to examine if caribou are present up to 4 km from the road (the expected maximum sighting distance from hill tops). Survey methods will be refined with the IEAC prior to construction. Surveys will examine 1) if caribou are present, 2) caribou reactions to vehicles, 3) compliance with road rules to stop when caribou are near the road. Observations of caribou approaching the road will be communicated to the Environmental Manager, who will alert drivers to approaching caribou and remind them of the management steps should caribou be observed closer to the road.

Should height-of-land surveys determine that caribou are turning around and moving away from the road, then TMAC will work with the IEAC to evaluate if the design and execution of snow track surveys is required and or acceptable to monitor caribou tracks as they approach the road. The survey transects and complete study design would be developed in consultation with the GN and IEAC. Results of the survey would be used to evaluate if and what kind of mitigation may be required for traffic on the AWR.

Training is provided for all drivers during their initial site orientation, and supplemented with frequent reminders and signage along the road. If groups of caribou are observed on or near the road, then the Environment Department will be notified and all drivers will then be alerted to the presence of caribou and their responsibilities as operators to allow wildlife the right-of-way.

Workshop participants suggested that when vehicles stop to give caribou the right of way to cross the road that drivers and passengers should stay in the vehicle because caribou can be frightened by the sight of people, but are less concerned by the stopped vehicle itself.

Overall effect of disruption of movement on caribou

TMAC's plan for shipping is to ship during the open water season. With this plan, there will be no effect on Dolphin and Union caribou migration to and from Victoria Island.

The location of the proposed Boston all-weather road has several key advantages that will reduce its potential effects on caribou, including:

- During resource mapping in the caribou workshops, Elders and land users indicated that movement corridors were parallel to the proposed Boston road (north-south) along rivers on the mainland, and east-west on the sea-ice of Melville sound and will not interact with the Project roads.
- Collar data indicate that island caribou migrate north-south, generally parallel to the road, and do not cross the road en-masse at any time of year.
- The Hope Bay Greenstone Belt where the Project is located is a relatively poor travel corridor for caribou. The large, open sedge meadows collect snow in winter. In contrast, the areas east and west of the Project are characterized by low rocky hills which are wind-blown of snow during winter and make better winter habitat and travel corridors.
- Mainland caribou likewise do not migrate across the road route in spring, nor do post-calving aggregations, large summer aggregations cross the road route.

- There is already a winter road at this location when caribou are in the area during winter. The construction of an all-season road will represent a small increase in the encounter rate of caribou that may cross the road in spring and fall.

To minimize the potential for disruption of movement, Elders and land users proposed constructing and monitoring crossing structures on the Boston road and monitoring for caribou during migration. TMAC is monitoring existing crossing structures for the Doris Project at locations identified by Elders as caribou movement paths. TMAC has worked with Elders to identify good locations for crossing ramps on the Boston road and will monitor the use of these ramps as part of the WMMP. TMAC personnel will report all observations of caribou during all seasons and TMAC will manage vehicles on the Boston road to limit disturbance and disruption of caribou movement, particularly during migration. In addition, TMAC will have increased vigilance for caribou during migration periods, with height-of-land surveys in appropriate locations along the roads.

In addition, TMAC will be conducting a variety of management actions to reduce disturbance to caribou (Section 9.8.3.2) that will also reduce the risk to potential disruption of movement, such as pausing blasting when caribou are near quarries, avoidance of groups of caribou by helicopters vertically or horizontally, noise will be minimized at the mine site, and noise and dust will be minimized on roads by setting and enforcing a speed limit and conducting dust suppression.

Participants evaluated the effectiveness of mitigation measures in the field during two site visits in April and August, 2017. Elders and current land users made suggestions for additional mitigation, which have been incorporated into TMAC's mitigation plans for caribou. With the proposed and additional mitigation measures, there was consensus among caribou workshop participants that:

> *"Open water shipping does not interact with caribou."*

and

> *"Mitigations for roads and road use will keep caribou safe."*

As a consequence of the plan to ship only during the open water season, the lack of overlap between movement corridors and the Project, the installation of caribou crossing structures on all site roads, and the low traffic level on the Boston road, the potential effect of disruption of movement due to the Project is considered small. However, due to concern over this potential effect it is rated as a residual effect for the Madrid-Boston Project and the Hope Bay Project.

9.8.3.4 Attraction to the Project

In the first caribou workshop (September, 2016), Elders and land users identified that one of the expected effects of the Project will be for caribou to move towards the mine to avoid predators. However, workshop participants identified this as a low risk to caribou populations. Elders and land users also expected that caribou may be attracted to the TIA as a source of salt, but that this would also be a low risk to caribou populations. In the second and third caribou workshops (April and August, 2017), Elders and land users reviewed the potential risks of caribou being attracted to the Project and conducted site visits to evaluate mitigation measures. Following the site visit, Elders and land users discussed the mitigation measures for the existing Doris Project and the proposed Madrid-Boston development.

The KIA also identified potential attraction of caribou to the TIA as a concern during the review of the Doris Type A water licence in 2016. These concerns were raised by referencing an inland Project in

NWT. In contrast, the Project TIA is 4.5 km from the ocean, where salt is readily available in any season. During the Doris Type A water licence review in 2016, TMAC added specific mitigation to address the potential for caribou to be attracted to the TIA as a source of salt. TMAC will 1) monitor whether caribou are using the TIA, and 2) monitor the water quality of the TIA to determine if it is safe for caribou to consume, and report the results of this monitoring regularly to the NIRB. If caribou are using the TIA as a salt lick and a toxicological risk assessment determines that the water in the TIA is not safe to consume, then caribou will be excluded from the TIA. TMAC will work with the KIA to determine effective methods for excluding caribou, including the use of Inuksuk to guide caribou away from the TIA. At Closure, the TIA will be capped by quarried rock to a depth where the tailings and water are inaccessible to caribou.

Workshop participants reviewed the planned mitigation to address potential attraction of caribou to site and had the following suggestions and comments:

- Workshop participants commented that there should be no feeding of wildlife. For example, if ground squirrels are attracted to the site (e.g., being fed) this will, in turn, attract predators (e.g., bear) which could affect caribou. TMAC has a policy for all Project employees of no feeding of any wildlife.
- Workshop participants commented that Elders should be involved in the installation of Inuksuk to direct caribou away from the TIA. Determining the appropriate location of Inuksuk to direct the movement and migration of caribou is specialized knowledge and needs to be done with care. TMAC agreed that it was already part of its management plans for the approved and operating Doris Project that Elders would direct the placement and installation of Inuksuk should it be required to direct caribou away from the TIA.
- Workshop participants asked what camp staff would do if caribou were observed on site. TMAC clarified that if caribou are observed, the environmental coordinator is notified and he or she will determine if workers would avoid certain work activities and locations depending on where the caribou is/are located.

At the conclusion of the caribou workshops, participants came to consensus and agreed that:

"Mitigation for the existing Doris Project protects caribou"

and

"The mitigation for Phase 2, as agreed to by consensus by the group, will protect caribou."

The discussed mitigation and management measures are common to both the Doris and Madrid-Boston Projects. With these mitigation measures in place, **no residual effects** of attraction of the Doris and Madrid-Boston Projects combined are predicted for either the Island or Mainland caribou and this potential effect is not considered further.

9.8.3.5 Direct Mortality

The potential for caribou to suffer mortality due to Madrid-Boston and the Hope Bay Project is evaluated in this section. In the first caribou workshop, Elders and land users identified three concerns where caribou could suffer direct mortality: 1) due to vehicle collisions, 2) if caribou run on to the Madrid-Boston footprint and are hit by vehicles or aircraft, and 3) due to accidents resulting from explosions. During the site visits as part of the second and third caribou workshops (April and August, 2017) Elders and land users evaluated the mitigation measures to keep caribou safe.

The Doris Project has used a winter ice road in most years from Madrid to Boston. The Madrid-Boston Project includes replacing that winter road with a proposed 53 km all-season road connecting Madrid with Boston. Island and Mainland caribou may interact with this road. The potential for vehicle-wildlife collisions will be managed through:

- construction standards for the road to maintain good sight lines;
- low speed limits (a maximum of 50 km/h);
- reporting and disseminating observations of caribou near the road to the environment department and other drivers; and
- vehicles operators will give caribou the right of way (e.g., stop and wait for caribou) if they are attempting to cross the road or are using the road as a movement corridor.

The Doris Project has used these same mitigation and management measures since the beginning of Construction in 2009. During that period, WMMP monitoring has indicated there has been no mortality of caribou due to vehicle-caribou collisions. The Ekati diamond mine, which has been operating in the Bathurst caribou range since 1997, has likewise reported that there have been no mortality or injury of caribou from vehicle strikes (ERM 2015c). The Tibbitt to Contwoyto Lake Winter Road, which has been supplying multiple diamond and gold mines from Yellowknife since 1997 and is approximately 400 km long, has reported five caribou mortalities during 20 years of operation (Golder 2014). A review of wildlife reporting documents, there have been 28 mine-related moralities of caribou at mine sites in NWT and Nunavut and supporting infrastructure (i.e., the Tibbitt to Contwoyto Lake Winter Road) in the last 20 years, for an average of roughly one caribou (1.35) per year for all mining-related activities combined in Nunavut and NWT; 18 of these mortalities were from vehicle collisions and 10 were from entanglements.

Elders and land users identified a concern that caribou may run on to the Project site to escape wolves and be injured by vehicles or aircraft. Between 2006 and 2017, there have been no reports of caribou running on to the Doris Project site to avoid wolves. Should this occur, then standard mitigation measures would ensure that caribou are protected, including the use of speed limits, reporting caribou observations, and giving caribou the right of way on all Project roads. Following the site visits and a review of mitigation measures, workshop participants agreed with the following statement:

"Mitigation for roads and road use will keep caribou safe."

The potential for collisions with aircraft must be mitigated by observations for caribou prior to takeoffs and landings and the pausing of aircraft operations when caribou are in a position where they could run onto the airstrip; i.e., within 250 m. These measures are in place to protect the safety of personnel and prevent potential human casualties from such an event. During the past 20 years there have been no reported mortalities due to aircraft striking a caribou at mine sites in either the NWT or Nunavut. Following the site visits and a review of mitigation measures, workshop participants agreed with the following statement:

"Mitigation for aircraft will keep caribou safe."

Elders and land users discussed that should an accident cause a large explosion, that caribou could be injured. During the third caribou workshop, participants visited the explosives storage facility and interviewed the blasting manager (Plates 9.8-5 and 9.8-6). Explosives on mine sites represent a risk to personnel and are strictly controlled as a consequence. The Northwest Territories / Nunavut Mine Health and Safety Act and Regulations and the Quarry Management and Monitoring Plan (P4-17) govern

the safe use of explosives on site, including appointing a person(s) who is/are qualified, certified and authorized to conduct/supervise all blasting operations on the mine site, ensure worker safety, and store, transport, and use explosives in a safe manner (Package P4-23). This includes setting a blast safety zone surrounding the quarry prior to blasting, which is calculated based on the size of the blast, type of rock, etc. to ensure worker safety. The explosives storage facility is located well away from the Doris camp to protect personnel and is surrounded by a wall of rock-filled sea cans for protection. With these measures in place, caribou will likewise be protected from any potential explosions on site. Following this site visit, participants agreed with the statement:

"Mitigation for blasting will keep caribou safe."

The WMMP has reported two caribou mortalities at the Doris Project. In mid-summer 2009, a caribou became entangled in geophysical survey wiring as it was being deployed. The animal died shortly after being found, and before attempts to free it could be made. This was communicated to the KIA and GN DOE. In mid-summer 2012, a male caribou was found with its antlers entangled in a rope that was tied between several traffic pylons marking off the core storage area on the camp pads. The rope was cut in an attempt to release the animal, but the pylon and rope did not come free. After repeated attempts to free the animal, a Wildlife Officer from GN DOE instructed wildlife responders to harvest the animal and salvage the meat, which was provided to the community. The caribou was located on the tundra approximately 5 km from camp and was harvested by Inuit workers, who also dressed the carcass. The meat was distributed in Cambridge Bay. The KIA was compensated according to Article 6 of the Nunavut Agreement.

Following these incidents, management actions have been taken to reduce the chance that caribou can become entangled at the Doris Project. This includes stricter handling of geophysical wire. The Project also stopped using ropes or other materials that could entangle caribou as part of traffic management structures. As a consequence, no further incidents have occurred at the Doris Project site and no further incidents are expected as part of Madrid-Boston or Hope Bay Project. Following site visits and a review of mitigation measures, workshop participants agreed with the following statements:

"Mitigation for the existing Doris Project protects caribou" and

"The mitigation for Phase 2, as agreed to by consensus by the group, will protect caribou."

With the continued use of these mitigation and management measures, caribou mortality is considered unlikely due to vehicles, aircraft, accidental explosions or entanglements. As a consequence, this potential effect is not rated as a residual effect for either the Madrid-Boston Project or the combined Hope Bay Project.

9.8.3.6 Increased Access and Harvest

This section evaluates whether the Project will cause increased access and harvest of caribou. In the first caribou workshop, Elders and land users indicated that employees at the mine site may alert land users in Cambridge Bay about the location of caribou. During the review of the DEIS, the GN DOE asked for additional monitoring and mitigation to limit the number of hunters using the proposed Project all-season road from Madrid to Boston for access to hunting areas. In the second and third caribou workshops, Elders and land users discussed this potential effect in depth and evaluated potential risks to the caribou population.

The Doris Project currently has an all-weather road that extends from Roberts Bay to Doris camp and then to Windy Lake (14.5 km; Section 9.4.1.1). In most years the Doris Project operates a winter ice

road from Windy Lake to the Boston exploration camp. As part of the Madrid-Boston Project, that winter road will be replaced with an all season road.

Experience on site indicates that most visits to the Doris site were made by persons traveling between Cambridge Bay and Omingmaktok. The main snow-machine route from Cambridge Bay leads south across Dease Straight to Etibliakyok (the Kent Peninsula isthmus), where they cross the isthmus and proceed west across Elu Inlet and Melville Sound to Omingmaktok, passing Roberts Bay and the Doris Project on the way.

The number of these visits was less than 10 per year until approximately 2011 when Omingmaktok was no longer permanently occupied. Since that time, the number of groups visiting the Doris site has fallen to approximately one to two hunting groups per year. Discussions with these hunters who visit the Doris site indicate that most groups are hunting for predators for their furs, and are not typically hunting for caribou. To date, there has been no evidence that personnel from site have influenced hunters from Cambridge Bay to hunt near the Project site.

Elders and land users discussed the practicalities of accessing the site with TMAC during the caribou workshops. The Project road is different from other all season or mining roads, such as the Tibbitt to Contwoyto Winter Road or the Meadowbank access road, because it does not connect to a community. During summer, the site can only be accessed by boat. To use the Project road would require bringing a quad in a boat to site and then driving the quad on the all-season road. However, the all-season roads at Hope Bay are not open for public vehicles for safety reasons. Therefore, additional roads for the Madrid-Boston Project are not anticipated to facilitate access to southern reaches of the Hope Bay Belt. Further, the KIA supports TMAC in polices that maintain public and individual safety and assists TMAC in communicating such information to Kitikmeot residents.

Currently, when the winter ice road from Madrid to Boston is active, land users could access the Boston area by snow machine from Cambridge Bay. However, they could also access this area without the winter road. To date, there have been no reports of any land users using the existing winter road to Boston.

During the winter, the site can be accessed by snow machine from Cambridge Bay, which is approximately 130 km away. Once reaching the site on a snow machine, a harvester could travel south to Boston whether the road is present or not. Harvesters are unlikely to use the all-season road on their snow machines because TMAC does not permit use of the roads by members of the public and residents are unlikely to want to use the road given that the gravel top to the road damages snow machine skis and tracks.

Wildlife management in Nunavut is the responsibility of the Government of Nunavut and the Nunavut Wildlife Management Board, under Section 151 of the Consolidated *Nunavut Wildlife Act*:

> *151. (1) The NWMB was established by the Agreement as an institution of public government with responsibilities for wildlife and habitat under the Agreement.*
>
> *(2) Pursuant to the Agreement, which recognizes that the Government of Nunavut retains ultimate responsibility for wildlife management, the NWMB is the main instrument of wildlife management in the Nunavut Settlement Area, the main regulator of access to wildlife and has the primary responsibility in relation thereto in the manner described in the Agreement.*

For the safety of Project personnel, TMAC has a no firearms rule for all Project personnel while at the Project site and has a no hunting policy while employed at the Project site. In addition, the *Nunavut Wildlife Act* prohibits discharging firearms within 1.6 km of the Project:

> *(2)(f) any place within a radius of 1.6 km of any building, structure or other facility on lands under a surface lease, an agreement for sale or owned in fee simple.*

However, for those Inuit not employed by the Project, and for those employees on their off-work rotation, TMAC does not have the right to limit where they harvest during their off hours (Section 11):

> *(1) Subject to this Act, all Inuit have the free and unrestricted right of access for the purpose of harvesting wildlife to all lands within Nunavut, including, for greater certainty, critical habitats, wildlife sanctuaries, special management areas, parks and all lands vested in a municipal corporation.*
>
> *(4) Pursuant to the Agreement, any term of an employment contract that attempts to limit an Inuk's rights of access to wildlife or harvesting of wildlife during the Inuk's leisure hours shall be null and void.*

Currently, as part of the Doris Project, TMAC allows harvesters access to the Doris camp to visit relatives and as a safety refuge. TMAC provides locked, cold storage for firearms when harvesters visit camp to protect the firearms and to ensure that TMACs no firearms policy is followed. As part of Madrid-Boston, TMAC will record the names, dates and size of party for those harvesters that visit the Doris camp.

It is reasonable to assume that the primary reason for traveling to the site will continue to be as a stopover en-route to Omingmaktok and to hunt predators. The construction of the Boston road will not provide new access to any new hunting areas because this area is already readily accessible by snow-machine down the Akinngak River to Aimaokatalok (Spyder Lake).

Incidental observations of caribou by helicopter pilots, drivers or other personnel are reported to the Environment Manager. As part of the DEIS WMMP, the observation of caribou during certain seasons or locations would trigger a “site alert” where Project personnel would be alerted via radio or through their morning safety meetings that caribou are present. As part of the discussions with caribou workshop participants, TMAC has changed the WMMP so that only selected personnel who need to know about caribou will be advised – i.e., drivers on particular roads where caribou have been observed. This will help reduce the number of Project personnel who are aware of the presence of caribou and who can communicate this to community residents.

Caribou workshop participants also discussed the practicalities of Project personnel alerting harvesters in Cambridge Bay about the presence of caribou. By the time that a Project personnel’s 12-hour duty rotation has ended and they have communicated the information to friends in the communities, harvesters prepare to go hunting, and then make the 4 to 6 hour snow machine trip to Hope Bay, at least a day has passed and the caribou would have moved on, far out of the Project site.

Caribou workshop participants conducted two site visits and reviewed the mitigation measures at the Doris site and those proposed for Madrid-Boston. Workshop participants agreed by consensus with the following statement:

> *“TMAC policies and procedures will prevent harvesting on and near project infrastructure.”*

The construction and operations of Madrid-Boston are unlikely to change these movements and hunting patterns. Therefore the potential effect of increased access and harvest of caribou is not considered a residual effect for Madrid-Boston or for the Hope Bay Project.

9.8.3.7 Environmental Media Quality

In the first caribou workshop, Elders and land users identified pollution of the land and water as a potential, high impact effect for caribou without proper mitigation and management. Elders and land users also identified a concern around oil and fuel spills resulting in contamination as an expected but low impact effect. The NIRB required TMAC to evaluate the potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation. Finally, Elders and land users identified a potential tailings pond failure or breach as an unlikely, low impact effect on caribou. The potential for chemicals from the Project to reduce the quality of environmental media (i.e., soil, water and vegetation) is evaluated in this section.

Caribou workshop participants visited site twice to evaluate the mitigation measures proposed by TMAC for the Project. These mitigation measures and expected water quality due to the Project are reviewed and regulated by the Nunavut Water Board.

The human health and ecological risk assessment (Volume 6, Chapter 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to normal Project activities resulting in dust deposition and discharging water during the Pre-Construction phase for the combined Doris and Madrid-Boston Project. This assessment also evaluated the potential for increased risk of adverse health effects in ecological receptors; e.g., caribou and the people who consume caribou. The assessment determined that planned Project effects on environmental media quality were negligible, thus there is no potential increase in the risk of adverse health effects to caribou due to Project activities.

Mitigation and management to reduce the risk of fuels, chemicals or dust altering the quality of environmental media include:

- managing the use of fuels;
- managing hazardous chemicals following the Hope Bay Project Hazardous Waste Management Plan (P4-15);
- managing water quality through the Doris-Madrid Water Management Plan (P4-7) and Boston Water Management Plan (P4-8);
- monitoring water quality through the Aquatic Effects Management Plan (P4-18);
- managing and monitoring dust and air quality through the Air Quality Monitoring and Management Plan (V8-2);
- storing fuels and chemicals in wildlife-proof buildings;
- locating cyanide destruction inside the mill; and
- taking appropriate measures to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

Elders and land users recommended appropriate pollution management and rapid responses to spills as appropriate mitigation. Spills of fuel or other chemicals will be managed through the:

- Oil Pollution Prevention/Oil Pollution Emergency Plan (V8-1); and

- Spill Contingency Plan (P4-3).

These plans include education of Project personnel, roles and responsibilities in the event of a spill, response measures, equipment and training to use that equipment, monitoring and reporting requirements. With adherence to these spill response plans, potential effects due to spills will be effectively managed.

The dams at the Tailings Impoundment Area (TIA) will be constructed, maintained and monitored as per the guidelines set by the Canadian Dam Association.

TMAC currently monitors a variety of environmental media as part of the Doris Project, and will continue to monitor these environmental media as part of the Madrid-Boston Project, including:

- the quality of discharged water and the water and benthos in the streams, lakes and ocean surrounding the Project as part of the Aquatic Effects Monitoring Program (Volume 8, Section 2.17);
- health of fish by taking fish samples in lakes and Roberts Bay for analysis as part of the Aquatic Effects Monitoring Program (Volume 8, Section 2.17); and
- the amount and type of dust as part of the Air Quality Monitoring Plan (Volume 8, Section 2.15).

The results of these monitoring programs will be provided to regulators, including the NIRB, the KIA, the Nunavut Water Board, the Government of Nunavut, Environment Canada and Aboriginal Affairs and Northern Development Canada to ensure that TMAC is meeting the conditions of its water licence. These results are also distributed to Inuit through the HTOs and the IEAC, which is part of the Inuit IIBA with the KIA to ensure that Inuit are aware of what the Project is doing and that wildlife are safe to eat near the Project site.

Caribou workshop participants reviewed the mitigation and management conducted for the Doris Project and proposed for the Madrid-Boston Project through two site visits. Workshop participants discussed concerns about how the Doris fueling facility is managed and how any spills are cleaned up. TMAC described the training, management and mitigation measures (lined facility) for the fueling station, and the cleanup protocols and the use of a lined land farm for remediating contaminated soils. Following discussions with TMAC, workshop participants agreed with the following statements:

"Mitigation for the existing Doris Project protects caribou" and

"The mitigation for Phase 2, as agreed to by consensus by the group, will protect caribou."

With these measures in place to control chemicals (including fuels, paints, and processing chemicals, etc.) and ensuring that they do not enter the environment, clean up spills, monitor water quality and dust deposition, and modeling to determine potential effects on the environment, the effects of environmental contaminants and bioaccumulation are not considered residual effects on caribou.

9.8.3.8 Evaluating Impacts on Herds

The potential effects of the Hope Bay Project on caribou energetics, female reproductive output, and population were modeled to evaluate the potential effects of the Project on the size of the caribou herds. Two modeling approaches were used by two caribou biologists, both regarded as experts in energetics modeling; the Caribou Cumulative Effects Model and the Energetics Assessment Model.

Satellite collar data for the Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak sub-populations) was used to evaluated the encounter rate and residency time of caribou inside the zone of influence of the Project. Three zones of influence were used to calculate encounter rate when discussing disturbance to caribou (Section 9.8.3.2) and are used here as well for the modeling exercise.

Cumulative effects were also evaluated using both models. The effects on caribou energetics, reproductive output and herd size were modeled for the current conditions in each herd's range. Caribou populations were also modeled for future conditions with all reasonably foreseeable projects operating concurrently. Zones of influence for communities, roads and industrial projects are described in Section 9.9. Both current conditions and future conditions were modeled with and without the Hope Bay Project to evaluate the impact of the Project on caribou populations.

Despite taking different modeling approaches, the two models produced the same results:

- The Hope Bay Project alone will not affect the population size of the Beverly, Ahiak or Dolphin and Union herds.
- The addition of the Hope Bay Project to the current conditions, with disturbance effects from communities and industrial projects does not affect the population size for any of the three herds.
- The addition of the Hope Bay Project to future conditions, with disturbance from communities and all reasonably foreseeable future projects does not affect the population size for any of the three herds.

The two Protein-Energetics models were made with extremely conservative assumptions, including that both models assumed the starting populations are declining in order to model the most sensitive scenario for caribou. Details of the modeling assumptions and methods are discussed below.

The Caribou Cumulative Effects Model

The Caribou Cumulative Effects model (the model) was used to evaluate the effects of the Project and the cumulative effects of current and future development within the ranges of the Dolphin and Union herd and Beverly and Ahiak herds. In this modeling scenario, the Beverly and Ahiak caribou were considered as a single herd because their distribution on the landscape, calving areas, and movement paths are sufficiently similar to allow them to be modeled together.

This model that has been used on a number of herds and for a number of herd management programs in the Canadian Arctic (Russell 2011; D.E. Russell 2014; D. E. Russell 2014). The model framework consists of three linked sub-models that, together, allow caribou managers to undertake "what-if" analyses of the cumulative effects of development, climate change and other stressors on various aspects of caribou biology. The sub-models in the CCE model include:

1. a model tracking movement patterns of a caribou herd with respect to past present and future development;
2. an Energy:Protein model of the change in an individual caribou's body condition over time; and
3. a model of the caribou herd's population dynamics.

The movement model tracks historic caribou migration patterns across the herd's range, and the subsequent consequences of this daily movement pattern on caribou behaviour and available forage,

especially with respect to encountering development. The body condition model takes output from the movement model, to predict changes in body condition of an individual caribou over time. The output of the body condition model is then used to predict changes in caribou fecundity and survival which are fed into a population model to project the future size and composition of the caribou herd.

Modeling approach:

Collar location data was obtained from Government of Northwest Territories (Beverly and Ahiak herds) and Government of Nunavut (Dolphin and Union Herd). A vegetation map, the Circa 2000 Landsat ETM+ Land Cover Mosaic of Northern Canada was acquired from Natural Resources Canada (Olthof, Latifovic, and Pouliot 2009). The 19 vegetation types in this map were collapsed into four types – lichen, shrub, herb and barren which accounted for the vast majority of vegetation types encountered by both herds. For the Dolphin and Union herd and the Beverly and Ahiak herds, the use of barren veg type was 66% and 58% respectively; for lichen types 19 and 10% respectively and for herb types – 14% and 30% respectively. Shrub types were used less than 5% of the time for both herds. Climate data was summarized from the CircumArctic Rangifer Monitoring and Assessment (CARMA) climate database (Russell et al. 2013).

Three types of development scenarios were evaluated with the model:

1. with and without the Hope Bay Project;
2. current industrial conditions and future conditions with all reasonably foreseeable projects in operation at the same time; and
3. with three modeled zones of influence used in the calculation of indirect habitat alteration and encounter rate (Section 9.8.3.2):
    - scenario 1: 4 km surrounding mines and 1.5 km surrounding roads;
    - Scenario 2: 5 km surrounding mines and 1.5 km surrounding roads; and
    - Scenario 3: 14 km surrounding mines and 4 km surrounding roads.

The calculated encounter rates varied between individuals, so the sample size used for analysis was increased to 75 caribou run through each scenario. Based on experience with modeling the Bathurst herd, the initial approach was to run the caribou through the Energy-Protein model from January 1 to the rut (mid-October) and determine the resultant fall body weights of the cows and calves. However, for these herds a large proportion of the interactions with existing and potential developments occur in October to December. Thus, for this application the model was run from January 1, year 1 to mid-October year 2, thus capturing the potential effects of late fall early winter encounters with development.

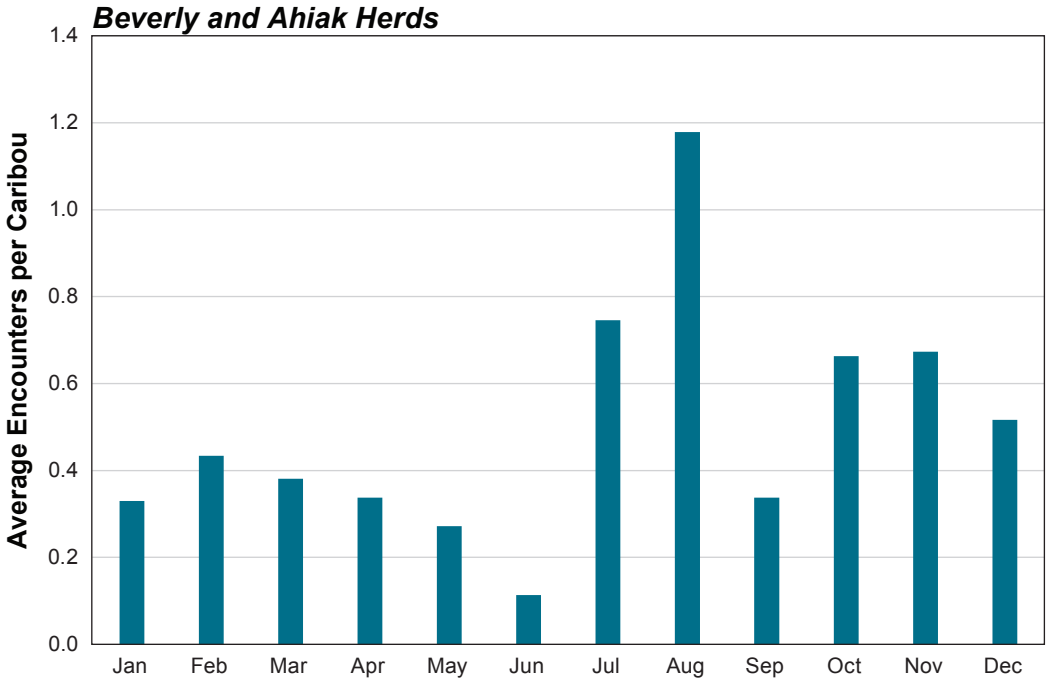
Results – Movement Model:

Caribou in both herds experienced relatively little exposure to development throughout their annual cycle (Figure 9.8-24). For all caribou movement patterns modeled for each herd (75 individuals x 12 scenarios) the average annual encounter rate was 6.8 for the Beverly and Ahiak herds and 5.9 for the Dolphin and Union Herd. As well 48% of the Beverly and Ahiak animals and 30% of the Dolphin and Union animals did not encounter any development based on the scenarios considered.

There was a relationship between increasing ZOI size, from scenario 1 to 3 with encounter rates (Figure 9.8-25). Not surprising the larger the ZOI, the higher the potential for encountering development. The highest encounter rate was determined for future development in the widest ZOI (Figure 9.8-25).

Figure 9.8-24

Average Number of Encounters with Development Zone of Influence by Month for the Beverly and Ahiak herds and the Dolphin and Union herd



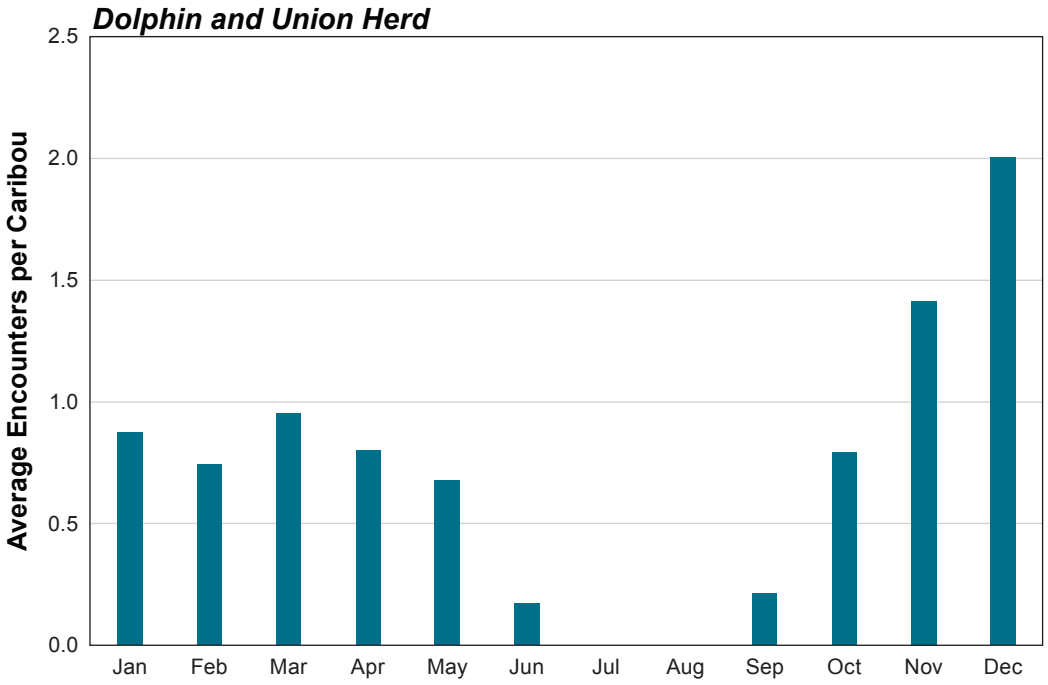
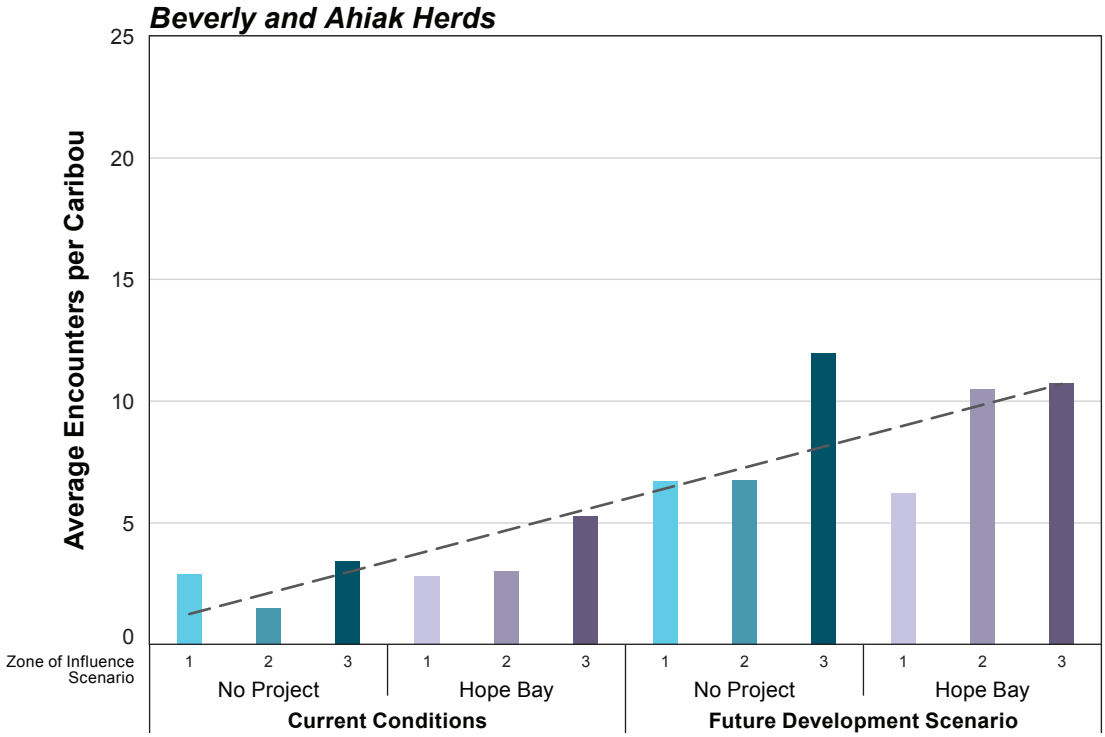
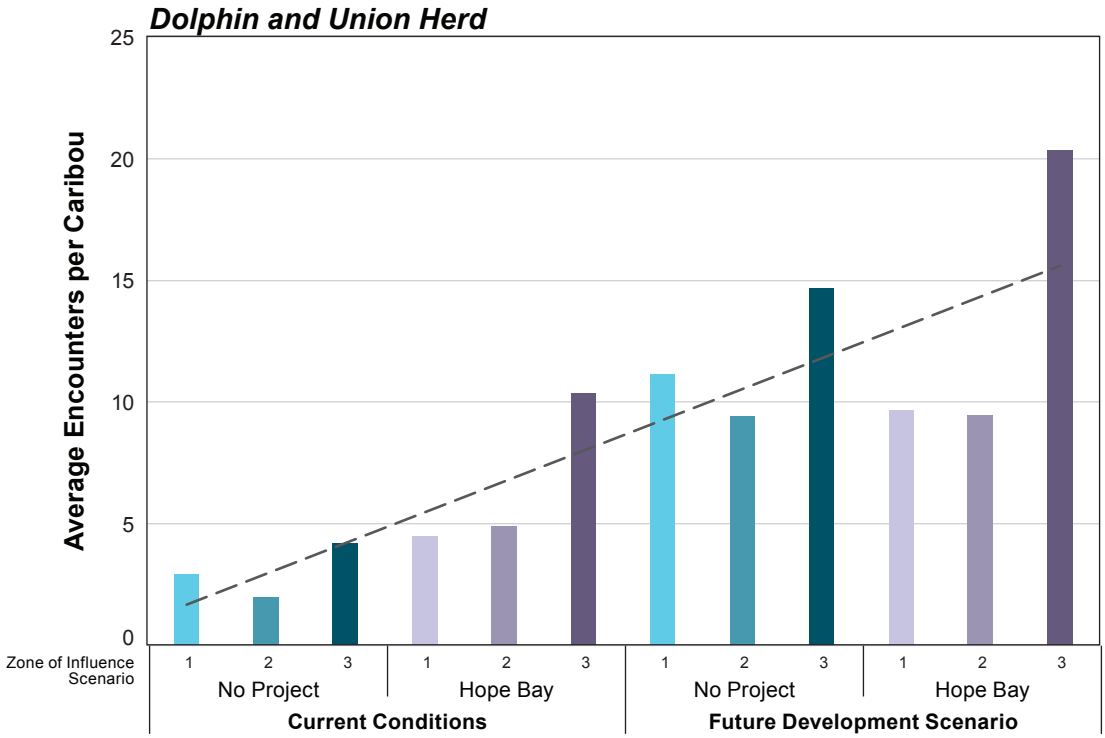


Figure 9.8-25

Average Number of Encounters with and without the Hope Bay Project, under Current and Future Development Conditions, and with Three Zone of Influence Values





Results – Energy:Protein Model:

The encounter rate increased with increasing size of the modeled ZOI from scenario 1 to 3. However, the increased encounter rate did not translate into altered cow and calf weight during the rut. The relationship is weak for cows (Figure 9.8-26) and non-existent for calves (Figure 9.8-27).

Results – Population Model:

The demographic models for both herds were parameterized with the best available data; but vital rate data for these herds is limited. The models were set to decline in population size based on reports that these herds may be declining. All of the scenarios were run through the model: 1) with and without Hope Bay, 2) current and future development, and 3) with the three ZOI scenarios. The populations were modeled for 15 years and rerun 50 times to reflect stochastic variability. Differences between model runs were small, inconsistent, and largely reflect the stochastic variability surrounding vital rate data.

Results – Role of Hope Bay:

When the scenarios that exclude the Hope Bay Project are subtracted from the equivalent scenario with Hope Bay and the differences are averaged, the "cost" of the Hope Bay Project was an additional 2.5 encounters per year and a loss on average of 10 grams to the adult cow and a gain of 4 grams to the calf.

Discussion:

Based on this modeling analysis, there was a "general" increase in encounter rates with increasing size of modeled ZOI (from scenario 1 to 3). However this increase did not result in a subsequent cost to cow and calf weights at rut. The relationship may be mirrored if all variables were held constant (for example forced every caribou to occupy the same vegetation types). From analysis of the Kiggavik project, the time of year that encounters took placed had an important effect on fall body weights of cows and calves (D. E. Russell 2014). The most sensitive times were calving and summer. For the Dolphin and Union herd there were no encounters between May and August and, although July and August were the months with the highest encounter rates for the Beverly and Ahiak herds the average total encounters between May and August was three. In fact 70% of the Dolphin and Union herd and 50% of the Beverly and Ahiak herds encounters were between October and March. Provided caribou stay healthy losing weight over winter is normal and may actually be an advantage in the spring when small body mass requires less energy for maintenance and thus more available for gestation and lactation once green-up occurs.

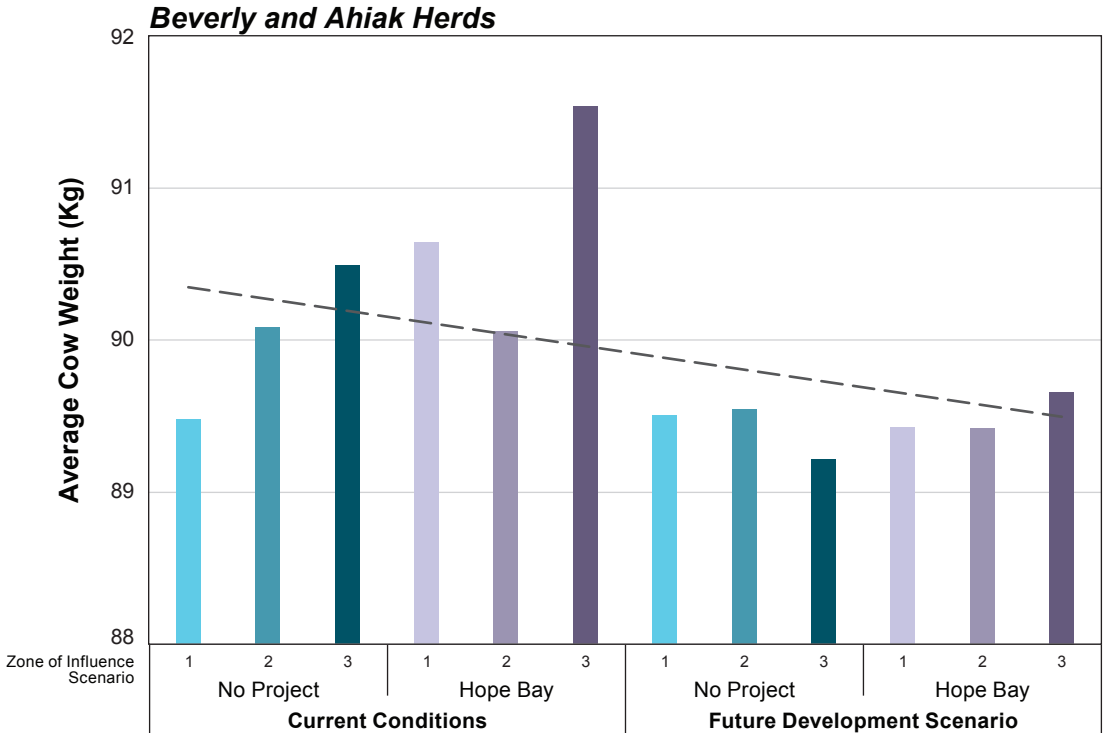
Based on this analysis, there is no evidence that the addition of the Hope Bay Project has a measureable energy/protein cost to caribou.

Energetic Assessment Model

The effects of potential energetic costs of development to caribou were applied to calf survival and calf productivity for each of the three herds in the RSA. The method followed that used by (Dominion Diamond 2014, 2015) where caribou encounters with project footprints and zones of influence (ZOIs) were converted to potential energy loss and then to potential decreases in fecundity and survival based on a simplified mathematical relationship. Stochastic population models were created for each of the Beverly, Ahiak, and Dolphin and Union herds. Potential population growth was modelled independently for each herd without the Project and then with the Project after caribou vital rates were adjusted to account for energetic costs of encounters with the Project and ZOI. Modelling was restricted to the female component of the population and models were run for a period of ten years.

Figure 9.8-26

Average Cow Weight with and without the Hope Bay Project, under Current and Future Development Conditions, and with Three Zone of Influence Values



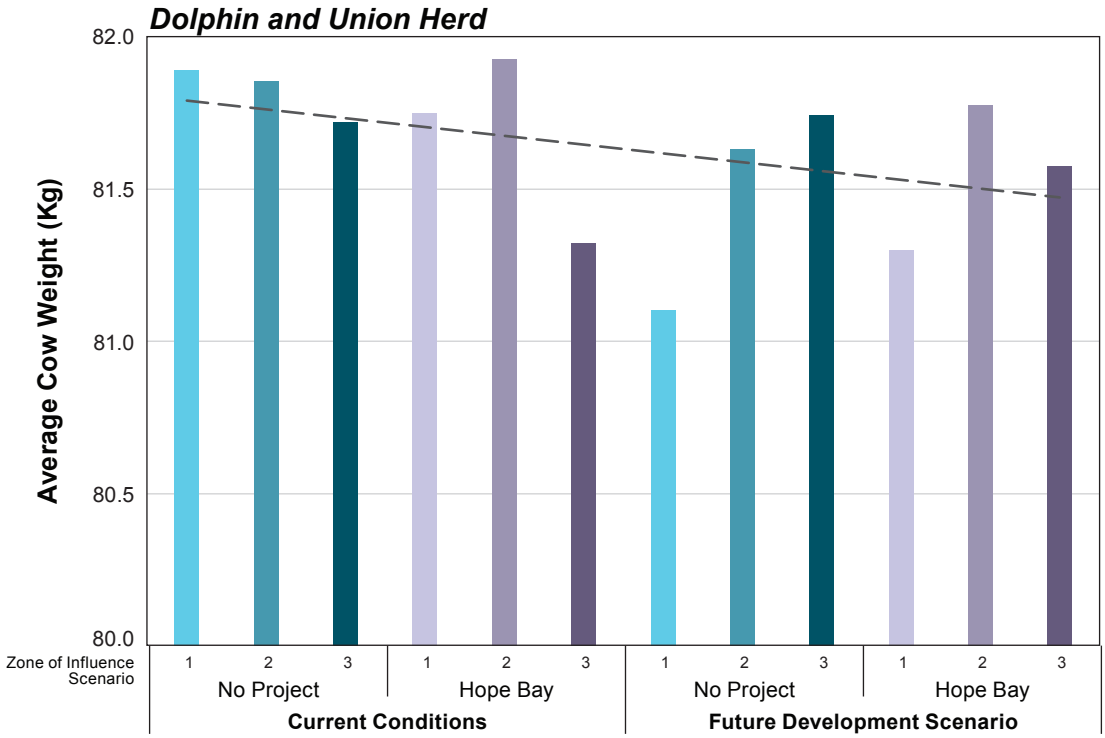
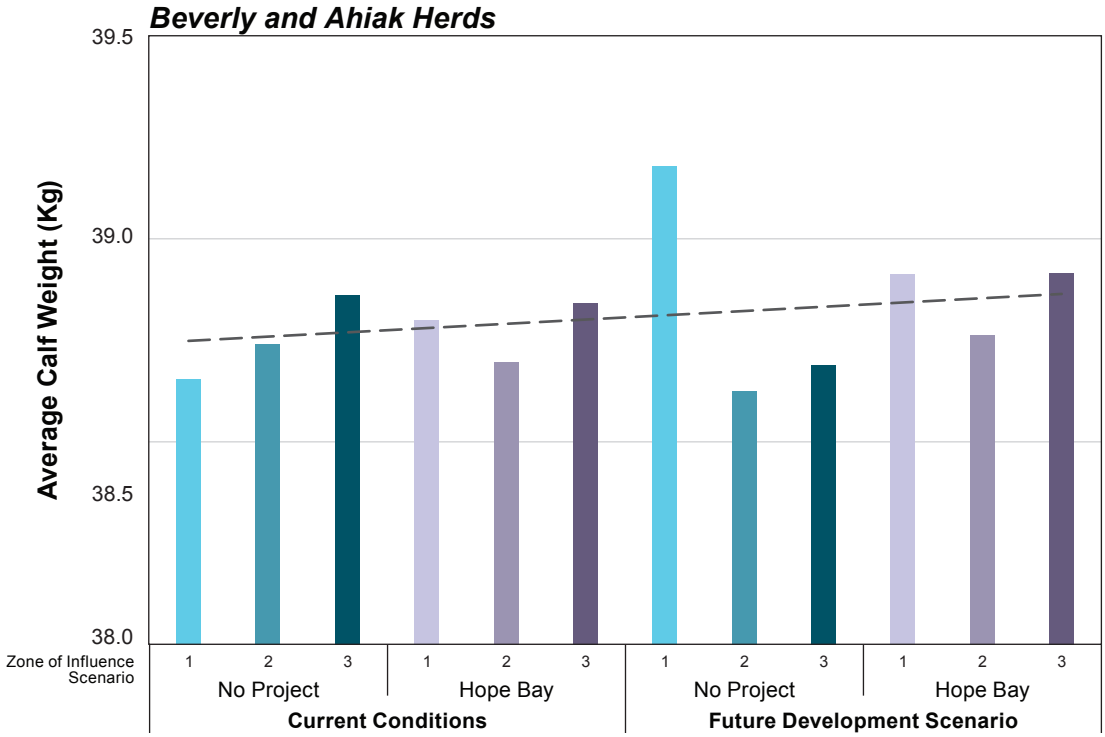
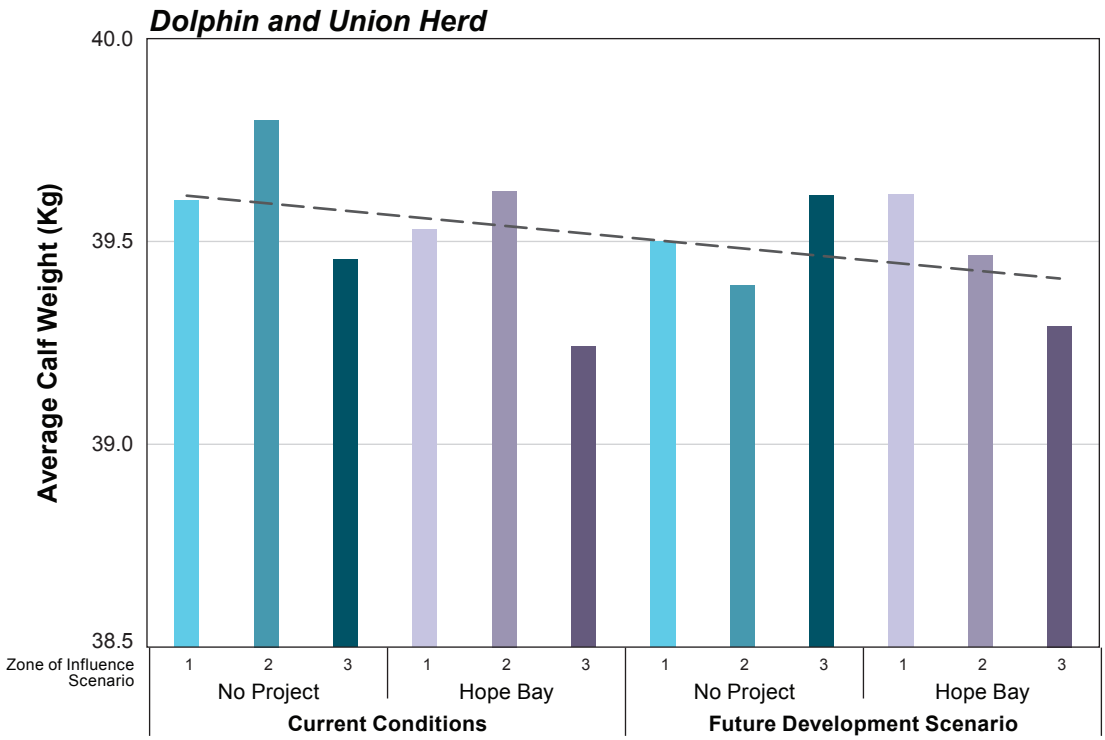


Figure 9.8-27

Average Calf Weight with and without the Hope Bay Project, under Current and Future Development Conditions, and with Three Zone of Influence Values





The accurate prediction of future population size through population modelling is dependent on accurate population estimates and accurate estimates of population vital rates. There are insufficient historical mortality and recruitment data for the Dolphin and Union herd to build herd-specific models (Dumond and Lee 2013). There is a similar absence of recent vital rate information for the Beverly herd (Adamczewski et al. 2015) and the Ahiak herd (M. Campbell et al. 2014). As current and accurate vital rate estimates are absent for the three herds in the RSA, realistic and locally relevant vital rate estimates were substituted from Thomas and Barry (1990b, 1990a) who produced age-specific fecundity and survival estimates for the Beverly herd. The intent of the models is not to accurately predict future population sizes or trends but to examine the relative potential population growth patterns with and without the Project and other developments. All three models were designed to show a declining population to match recent population counts, to make the assessment more conservative and to make the modeling output more sensitive to disturbance and other effects.

Modelling process

Population modelling was conducted in the software package RAMAS 5.0 (Akçakaya 2005). Each model was run stochastically (to reflect the ranges of uncertainty in input parameters) for 1000 iterations. Stochastic modelling yields a range of potential outcomes that reflects uncertainty in the survival and recruitment information used to create the model. Estimates of carrying capacity and density dependent population growth responses were not included in the models. Further, there were no catastrophic events included that might limit population growth.

Initial Population Size

M. Campbell et al. (2014) provided the most current population estimates for both the Beverly and Ahiak herds. They considered the number of breeding females to be the best demographic data available for the herds; and these are the relevant data for population modelling. The Dolphin and Union herd estimate was based on Environment and Climate Change Canada (2017a). Though Dumond and Lee (2013) and Environment and Climate Change Canada (2017a) do not provide estimates by sex and age classes, it was assumed 60% of the 2015 population (18,413 from Environment and Climate Change Canada (2017a)) was adult females and that the standard error was 60% of one half of the 95% bound. Initial population sizes used in the models were: Ahiak: 27,729 (SE = 1,579), Beverly: 52,825 (SE = 2,638), and Dolphin and Union: 11,048 (SE = 2,039).

Survival and Fecundity

Vital rates for each life stage in the models were based on the work of Thomas and Barry (1990a, 1990b); their survival and fecundity rates correspond to a population declining by 1% per year and were adopted directly for the Ahiak herd (Table 9.8-21) whose annual rate of growth is uncertain (M. Campbell et al. 2014). To account for the 4% to 5% annual decline recently observed for both the Beverly (M. Campbell et al. 2014) and Dolphin and Union herds (Environment and Climate Change Canada 2017a) the Thomas and Barry (1990a, 1990b) age class survival rates were uniformly reduced by 4%, yielding a base model projecting 5% annual decline (Table 9.8-22).

Table 9.8-21. Life-stage-specific vital rates used for modelling the Ahiak caribou herds

Age/Stage	Annual Female Survival	Annual Fecundity (Females Calves Only)
Calf	0.500 (0.100)	0.000 (0.000)
Yearling	0.800 (0.013)	0.000 (0.000)
2-year old	0.894 (0.013)	0.060 (0.040)
3-6 years old	0.874 (0.013)	0.405 (0.020)
7-10 years old	0.813 (0.013)	0.458 (0.020)

Age/Stage	Annual Female Survival	Annual Fecundity (Females Calves Only)
11-14 years old	0.508 (0.013)	0.451 (0.020)
15 years old	0.000 (0.000)	0.000 (0.000)

Notes: Fecundity values represent only female calves. Standard deviations appear in parentheses Thomas and Barry (1990b, 1990a).

Table 9.8-22. Life-stage-specific vital rates used for modelling the Beverly and Dolphin and Union caribou herds

Age/Stage	Annual Female Survival	Annual Fecundity (Females Calves Only)
Calf	0.460 (0.100)	0.000 (0.000)
Yearling	0.760 (0.013)	0.000 (0.000)
2-year old	0.854 (0.013)	0.060 (0.040)
3-6 years old	0.834 (0.013)	0.405 (0.020)
7-10 years old	0.773 (0.013)	0.458 (0.020)
11-14 years old	0.464 (0.013)	0.451 (0.020)
15 years old	0.000 (0.000)	0.000 (0.000)

Notes: Fecundity values represent only female calves. Standard deviations appear in parentheses. After Thomas and Barry (1990a, 1990b) corrected for recent observed Beverly (Campbell et al. 2014) and Dolphin and Union population growth (Environment and Climate Change Canada 2017a).

Model Scenarios

The population model criteria are presented in Table 9.8-23. The 21 simulations are for each of the three herds in each of seven scenarios:

1. reference (no encounter scenario);
2. Doris Project (Phase 1) conditions with maximum ZOI (ZOI Scenario 3; Section 9.8.3.2);
3. with the Hope Bay Project and maximum ZOI;
4. current cumulative effects of all development not including Hope Bay;
5. Current cumulative effects of all developments including the Hope Bay Project and maximum ZOI;
6. future cumulative effects of all development not including Hope Bay; and
7. future cumulative effects of all developments including the Hope Bay Project and maximum ZOI

The differences between the vital rates in Tables 9.8-21 and 9.8-22 are noted in Table 9.8-23.

Table 9.8-23. Population simulation details for modelling of the Beverly, Ahiak, and Dolphin and Union caribou herds

Herd	Simulation	Input parameters	Modification to reference vital rates
Beverly	Reference (no projects)	Calf survival	None
		Fecundity	None
		No encounters or residency	

Herd	Simulation	Input parameters	Modification to reference vital rates
	Doris Project (Phase 1), ZOI 3	Calf survival	-0.004
		Fecundity	-0.002
		6% animal encounter; 2.8 days mean annual residency	
	Hope Bay Project, ZOI 3	Calf survival	-0.008
		Fecundity	-0.004
		10 % animal encounter; 4.9 days mean annual residency	
	Current Cumulative Effects without Hope Bay Project	Calf survival	-0.012
		Fecundity	-0.006
		43% animal encounter; 8.1 days mean residency	
	Current Cumulative Effects with Hope Bay Project	Calf survival	-0.012
		Fecundity	-0.006
		46% animal encounter; 8.4 days mean residency	
	Future Cumulative Effects without Hope Bay	Calf survival	-0.022
		Fecundity	-0.011
		48% animal encounter; 13.6 days mean residency	
	Future Cumulative Effects with Hope Bay	Calf survival	-0.022
		Fecundity	-0.011
		50% animal encounter; 13.5 days mean residency	
Ahiak	Reference (no projects)	Calf survival	None
		Fecundity	None
		No encounters or residency	
	Doris Project (Phase 1), ZOI 3	Calf survival	-0.006
		Fecundity	-0.003
		11% animal encounter; 4.1 days mean annual residency	
	Hope Bay Project, ZOI 3	Calf survival	-0.012
		Fecundity	-0.006
		24% animal encounter; 6.9 days mean annual residency	
	Current Cumulative Effects without Hope Bay Project	Calf survival	-0.012
		Fecundity	-0.006
		33% animal encounter; 6.9 days mean residency	
	Current Cumulative Effects with Hope Bay Project	Calf survival	-0.012
		Fecundity	-0.006
		42% animal encounter; 8.3 days mean residency	
	Future Cumulative Effects without Hope Bay	Calf survival	-0.014
		Fecundity	-0.007
		38% animal encounter; 8.6 days mean residency	
	Future Cumulative Effects with Hope Bay	Calf survival	-0.016
		Fecundity	-0.008
		47% animal encounter; 9.6 days mean residency	

Herd	Simulation	Input parameters	Modification to reference vital rates
Dolphin and Union	Reference (no projects)	Calf survival	None
		Fecundity	None
		No encounters or residency	
	Doris Project (Phase 1), ZOI 3	Calf survival	-0.008
		Fecundity	-0.004
		22% animal encounter; 4.7 days mean annual residency	
	Hope Bay Project, ZOI 3	Calf survival	-0.012
		Fecundity	-0.006
		27% animal encounter; 8.0 days mean annual residency	
	Current Cumulative Effects without Hope Bay Project	Calf survival	-0.006
		Fecundity	-0.003
		51% animal encounter; 4.3 days mean residency	
	Current Cumulative Effects with Hope Bay Project	Calf survival	-0.012
		Fecundity	-0.006
		52% animal encounter; 6.7 days mean residency	
	Future Cumulative Effects without Hope Bay	Calf survival	-0.022
		Fecundity	-0.011
		58% animal encounter; 13.7 days mean residency	
	Future Cumulative Effects with Hope Bay	Calf survival	-0.024
		Fecundity	-0.012
		59% animal encounter; 15.3 days mean residency	

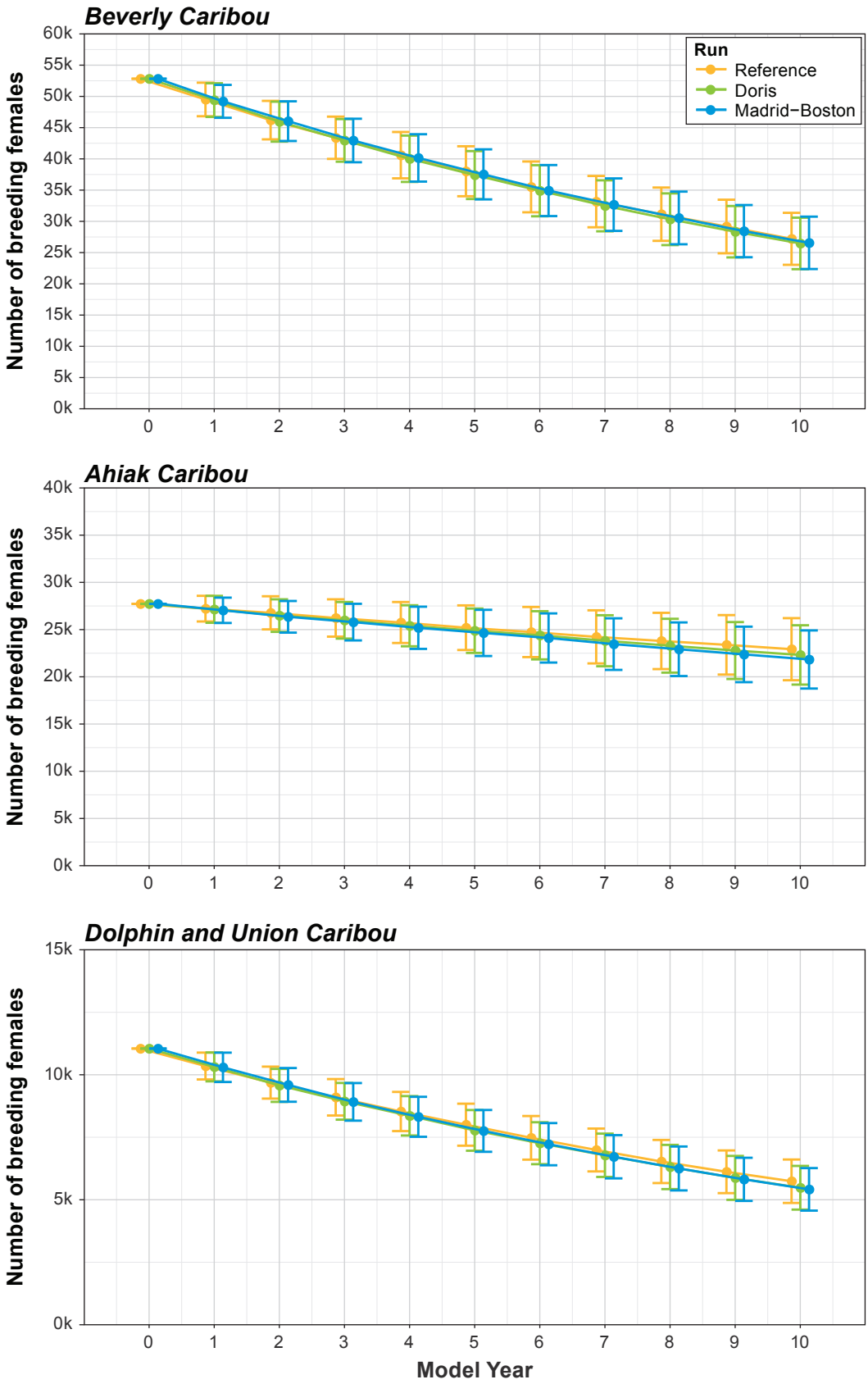
Results

The objective of the modelling process was to determine the likely difference between the natural population trajectory and the population trajectories associated with changes in caribou behaviour that may arise from interactions with development.

Results include:

- In all cases, the addition of the Doris Project and the Madrid-Boston Project did not produce a significant change in population size, for the Beverly, Ahiak or Dolphin and Union herds.
- Under a current cumulative effects scenario, with the effects of all communities and industrial projects included in the model, there is no change expected in the size of caribou populations with and without the Hope Bay Project (i.e., overlapping confidence intervals.
- Under a future cumulative effects scenario, with all communities and reasonably foreseeable projects active at the same time, there is no change expected in the size of the caribou populations with and without the Hope Bay Project (i.e., overlapping confidence intervals).

The starting conditions of the model used vital rates that were chosen to cause all three caribou populations to decline (Figures 9.8-28, 29 and 30). In each figure, the reference scenario reflects the population trajectory specified by the declining base model. As discussed above, there is no current assessment of the population trend of the Ahiak herd and the base model parameters plot a decline; if the Ahiak herd is stable or increasing the vital rates in the model would need to be adjusted to account for that.


Beverly Caribou
Ahiak Caribou
Dolphin and Union Caribou
Number of breeding females
Model Year
Run
Reference
Doris
Madrid−Boston
0k
5k
10k
15k
20k
25k
30k
35k
40k
45k
50k
55k
60k
0
1
2
3
4
5
6
7
8
9
10

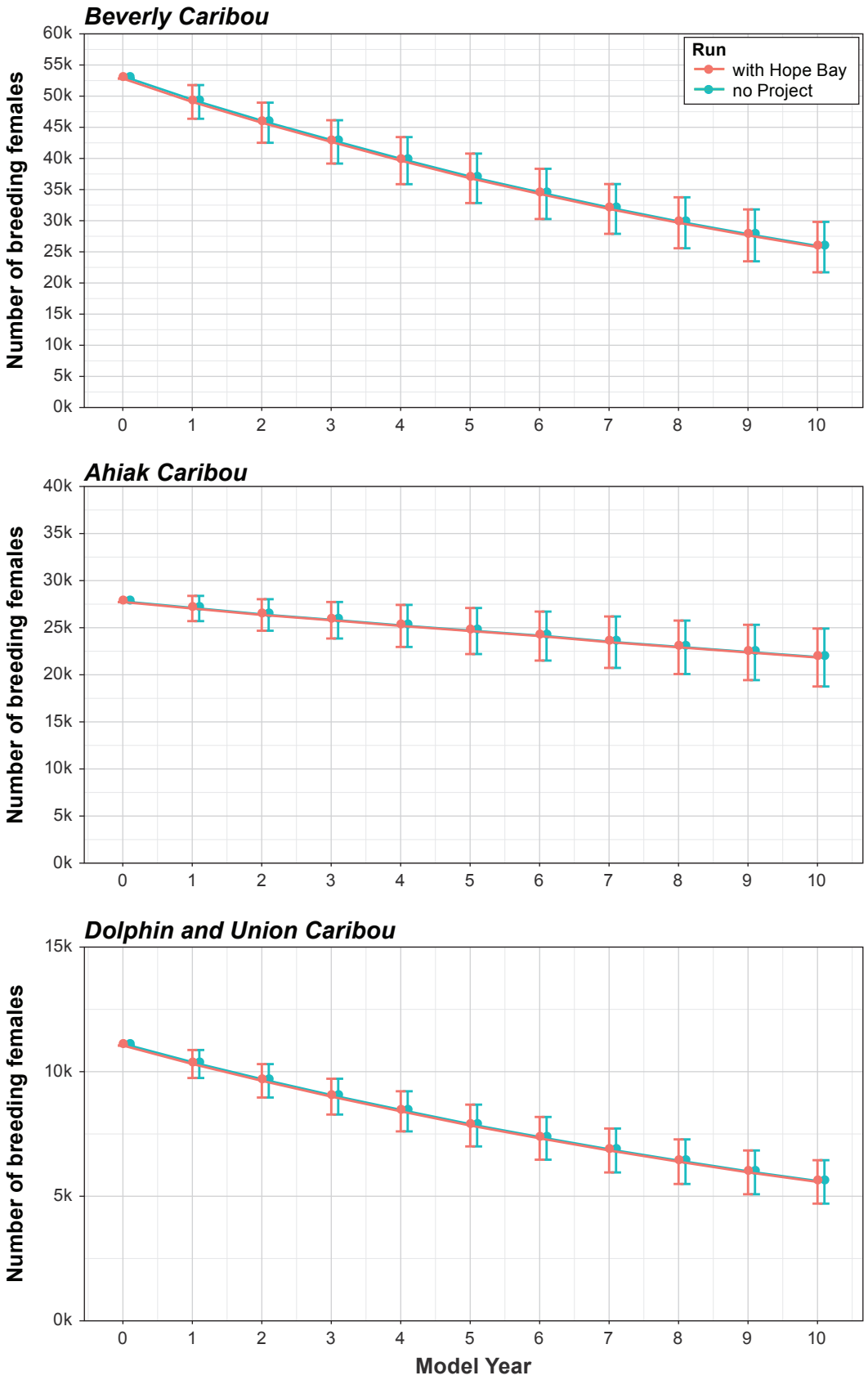
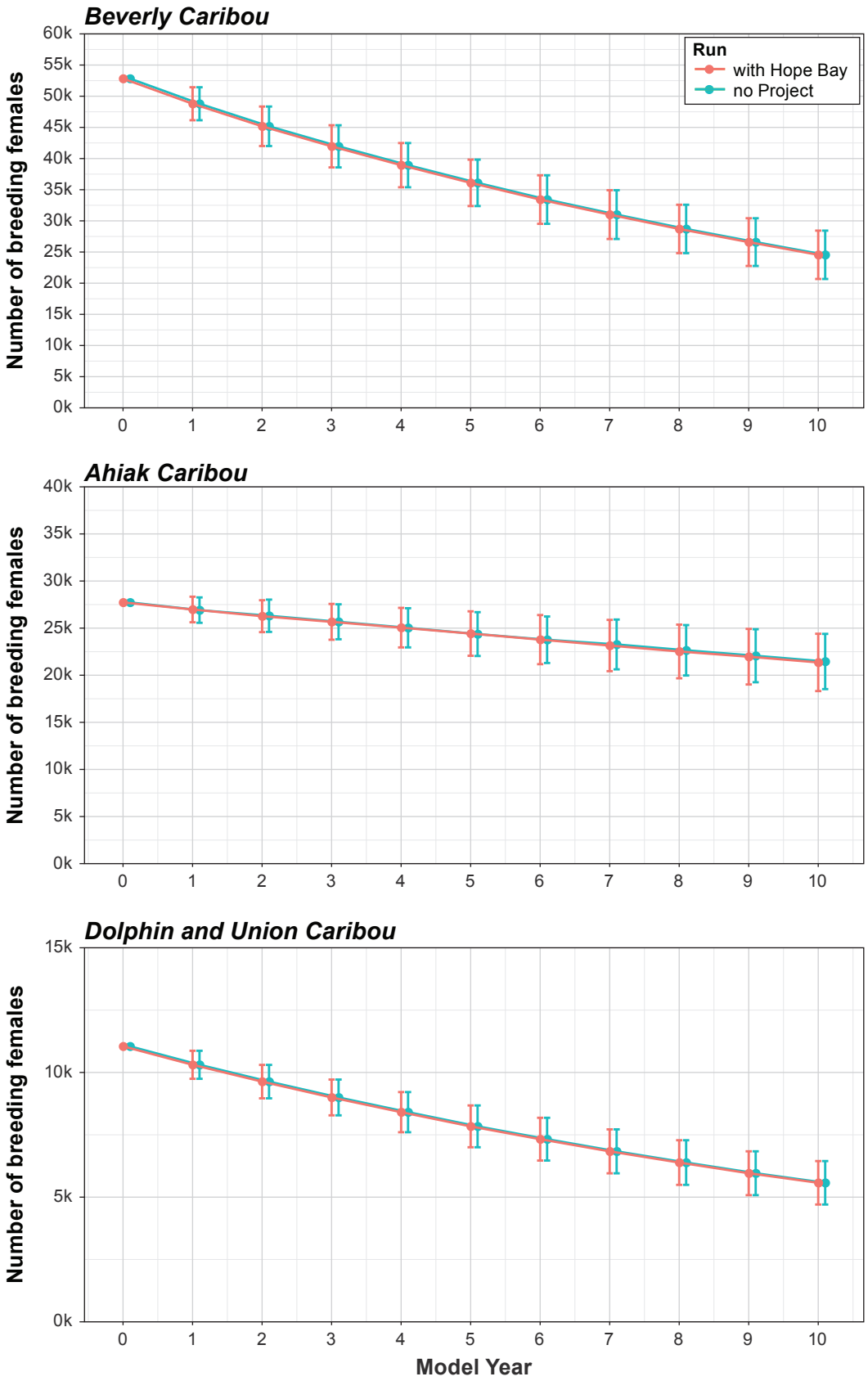

Beverly Caribou
Ahiak Caribou
Dolphin and Union Caribou
Number of breeding females
Model Year
Run
with Hope Bay
no Project
0k
5k
10k
15k
20k
25k
30k
35k
40k
45k
50k
55k
60k
0
1
2
3
4
5
6
7
8
9
10

Figure 9.8-30

Population Size of Beverly, Ahiak and Dolphin and Union herds with all other Reasonably Foreseeable Future Projects; with and without Hope Bay



The scenarios included in the modelling contained several conservative assumptions that inflate the potential effect of the Project:

- The populations were modeled to be declining in order to model the most conservative case of effects on a population.
- Modeling used the zone of influence scenario 3 (Section 9.8.3.2), which is a very large hypothetical zone of influence of 4 km surrounding the mine and 4 km surrounding roads.
- There was a maximum energetic loss calculated from each interaction through animals ceasing feeding for a period of time and responding with increased movement.
- Caribou were assumed not to compensate for energy loss through increased feeding.
- All energetic losses were assumed to directly affect the ability of females to calve and for their offspring to survive.
- The models assumed that all female caribou would interact with the Project and its ZOI, despite results from radio-collared animals that show the actual number of animals interacting with the Project and its ZOI between 10% and 27% of the population.

Consequently, the actual effect of the Hope Bay Project should be a small fraction of the effects shown in the model results.

9.8.4 Conclusion and Significance of Residual Effects

This section provides the concluding statements about significance of the Madrid-Boston (Phase 2) Project's potential impacts to caribou populations. The assessment of the Madrid-Boston Project potential impacts on caribou was based on a precautionary approach and considered any sound and credible case that a risk of serious or irreversible harm to caribou may exist. The risk was based on conditions observed from impact monitoring from the existing Doris operation, Inuit TK provided by the KIA and a Project-specific commissioned report, and especially through engagement with expert Elders and land users in three risk assessment and management workshops looking specifically at the potential impacts of the Madrid-Boston Project on caribou and other wildlife. The assessment of the identified risks included incorporation of observations from other northern mines and information in the published literature, direction from herd management plans, and analysis of habitat and disturbance effects that included energetics and population structure to evaluate the risk to caribou individuals and herds that interact with the Madrid-Boston Project.

During the course of the Project, individual caribou may encounter Project infrastructure or activities such as helicopter flights, traffic and general site noise. To determine whether these individual encounters could have effects on caribou populations, TMAC used both Inuit TK, western science, and experience from the operating site to assess the risk to caribou. TMAC discussed whether these encounters could have impacts on caribou herds with Elders and land users as part of the caribou workshops. TMAC also conducted energetics-protein and population modeling to project long-term impact risk to caribou from Project and cumulative effects.

Inuit TK and western science indicate that caribou encountering the Project would not result in herd-level impacts to the populations of the Dolphin and Union, Beverly or Ahiak herds. The potential risk of the Project on caribou is negligible

An overview of the key lines of evidence and caribou management directives used to support the conclusions about potential impacts on caribou are provided in the following subsections.

9.8.4.1 Traditional Knowledge

As described throughout this document, Inuit TK was gathered and considered throughout the FEIS. Inuit TK was gathered by KIA's *Naonaiyaotit Traditional Knowledge Project* (NTKP) and a Project-specific report commissioned by TMAC (Banci and Spicker 2016). From those information sources and engagement opportunities, key points from Inuit TK and land users that are important for conclusions about potential impacts include:

- Inuit TK identified important areas for caribou wintering, summer and calving areas and traditional areas for harvesting.
- Calving for Island caribou occurs on Victoria Island, and for Mainland caribou in the Queen Maud Gulf. The Project is outside the calving and post-calving areas of both types of caribou.
- The main wintering areas for caribou are outside the RSA, largely in the Huikitak River valley south west of Aimaokatalok (Spyder Lake), Etibliakyok (Kent Peninsula isthmus), the Kugyoak and Kunayok areas (Perry and Ellice Rivers) in the Queen Maud Gulf Migratory Bird Sanctuary (QMGMBS), and a large rocky area inland from Omingmaktok.
- Spring migration of Island caribou is largely along major rivers, lakes and along the coast, traveling north, parallel to the proposed Boston road.
- Fall migration of Island caribou has historically been from the area surrounding Cambridge Bay to the Kent Peninsula, then through Etibliakyok and fanning out east and west on the mainland. However, this has changed, with many animals migrating from the area west of Cambridge Bay to the western end of the Kent Peninsula and then south. In both historic and current caes, these movements are also parallel to the proposed Boston road.
- There are sea-ice crossing locations at the entrance to Melville sound and Elu Inlet, both of which are outside the RSA and will not be affected because the Project is conducting sea lifts in the open-water period.

The long history of Inuit TK made available for this assessment show that caribou use the Project site, but that the Project does not interact with key habitat areas and movement areas for caribou.

9.8.4.2 Inuit Environmental Advisory Committee

The Inuit Environmental Advisory Committee (IEAC), made up of Inuit Elders and land users chosen by the KIA, is formed from the Project's IIBA. TMAC meets with the IEAC regularly to discuss the results of monitoring for the Doris Project, and solicit feedback from the IEAC. The IEAC is involved in monitoring and reviewing results on a regular basis for the operating Doris North Project, including:

- reviewed and commented on management plans and suggested changes that TMAC has incorporated into the WMMP; and
- reviewed monitoring reports and commented on how the monitoring reports fit with their experience of wildlife and the environment.

Specifically for the Phase 2 assessment, TMAC held three risk assessment workshop that engaged expert Elders and land users to assess potential impacts and significance of those impacts on caribou and wildlife.

9.8.4.3 Caribou Risk Assessment Workshops

The caribou workshops were developed to engage with and understand the interests and knowledge of Elders and harvesters, and to consider this information in developing caribou protection measures for the Hope Bay Project. The three caribou workshops were held in September 2016, and in April and August 2017.

Elders and land users visited the Doris site and reviewed mitigation measures first-hand. Information and perspectives shared by Elders and land users and the group consensus on potential impacts and risks to caribou and proposed mitigation measures are included throughout the impact assessment for caribou where potential impacts and mitigation are discussed. Participants discussed risk to individual caribou and to caribou herds and developed by consensus statements about Phase 2 Project potential impacts and risk, including:

> *"Mitigation for the existing Doris Project protects caribou."*

and for the Phase 2 Project:

> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

and

> "[With the planned mitigation and monitoring] *the risk to caribou associated with Phase 2 are acceptable."*

9.8.4.4 Herd Management Plans

There are four management plans for caribou that could apply to the Project area. Based on areas of importance identified in those plans, it is apparent that the Project is located outside of key areas for caribou, and that mitigation and management conducted at the Doris Project and included in the Madrid-Boston FEIS will address management concerns identified in the plans. The four plans, and how TMAC is considering those plans, are discussed below for:

1. the KIA Mobile Caribou Protection Measures;
2. the Draft Dolphin and Union Caribou Management Plan;
3. the Beverly Qamanirjuaq Caribou Management Plan; and,
4. the 2016 Draft Nunavut Land Use Plan.

<u>Kitikmeot Inuit Association Mobile Caribou Protection Measures</u>

On May 5, 2016, the KIA Board adopted a resolution to support its initiative for mobile caribou protection measures. These measures would direct monitoring for caribou and management of industrial activities to protect concentrations of caribou, including calving caribou. The Hope Bay Project will meet these mobile caribou protection measures, through a series of initiatives, including mitigation and management plans:

- The caribou management and mitigation for the Hope Bay Project focuses on where caribou are within the Project area, is applied year round, and includes stopping certain activities such as quarry blasting, vehicles on the all-weather road, helicopters and fixed wing aircraft when caribou are nearby.

- TMAC includes monitoring for caribou in the WMMP to identify when concentrations of caribou are in the Project area.
- TMAC has worked with the KIA and the GN through the NIRB Environmental Assessment process to improve mitigation and management for caribou.
- TMAC supports research initiatives for caribou, including herd level research led by the GN DOE through funding agreed to in an MOU, and research through Polar Knowledge Canada.

The Dolphin and Union Management Plan

The management plan for Island caribou (Dolphin and Union caribou) lists the threats evaluated by local communities, organizations and government agencies to this herd: *Management Plan for the Barren-ground Caribou (Rangifer tarandus groenlandicus), Dolphin and Union population, in Canada* (Environment and Climate Change Canada 2017a). This management plan identified mining and roads as low impact activities for the herd, sixth and seventh in importance after changes to sea ice and predation (both rated as high impact), harvest, parasites and disease, climate change, and icing events (rated medium to low impact). The management plan identifies five management objectives, which TMAC is contributing to and meeting (Section 9.8.2.4).

The Dolphin and Union management plan identifies several key issues where industrial activities may affect caribou (Section 9.8.2.4). TMAC has mitigation and management for each of these key issues, which have been reviewed, discussed and supported by Elders and land users as part of the caribou workshops (Table 9.8-21). This mitigation will manage potential impacts to 1) caribou movement, 2) research into impacts, 3) disruption of sea ice crossings, 4) displacement from winter foraging areas, 5) entanglement risk, 6) aircraft management and 7) road management. With this management in place, the Project will be compliant with the Dolphin and Union Management Plan.

Beverly Qamanirjuaq Management Plan

The Beverly caribou sub-population is managed through the *Beverly and Qamanirjuaq Caribou Management Plan 2013-2022* (BQCMB 2014). The key management guidance for industrial development is listed below. The Project mitigation and monitoring addresses all of these management objectives.

1) Calving and Post-Calving Areas - The plan calls for prohibiting development in calving and post-calving area. Inuit TK, Elders and land users in the caribou workshops and western science agree that the Hope Bay Project is outside of both the calving and post-calving areas for Island and Mainland caribou.

2) Roads - The Project is not connected to a settlement by an all-season road and there is no plan to build a winter road from Cambridge Bay to the Hope Bay site. The all season road is therefore not accessible by people from Cambridge bay with wheeled vehicles and no increase in harvest is anticipated.

3) Other Management - TMAC has used TK and information from Elders and land users collected during the caribou workshops to assess if the Project will alter seasonal movements of caribou. The Project does not interact with any identified water crossings or key movement corridors for the Beverly herd. The design of the all season road will manage possible disruption of movement by maintaining a low profile and TMAC will work with Elders to locate and install crossing structures for caribou and conduct enhanced monitoring for caribou during migration.

Draft Nunavut Land Use Plan

The Draft Nunavut Land Use Plan (Nunavut Planning Commission 2016) identifies some areas in Nunavut suspected as being important to caribou. TMAC believes that the Project will be compliant with NPC important caribou areas, including:

1. Calving and Post-calving areas - The Project does not overlap with the calving or post-calving areas for Island or Mainland caribou, as mapped by the NPC.
2. Rutting, Spring Migration, Summer Areas, and Fall Areas – The Project does not overlap any of these seasonal use areas.
3. The Project does not overlap with any of three Special Management Areas identified in draft plan; sea ice crossings, freshwater crossing or Huikitak River valley, over 50 km south of the Project, and will not interact with the Hope Bay Project.

TMAC believes that due to the location of the Project, and due to the mitigation and management conducted for the Doris Project and included in the FEIS, that the Project is compliant with the NPC direction.

9.8.4.5 Precautionary Principle

TMAC has considered the precautionary principle in the assessment and management programs (Volume 2, Section 1.7.2). The precautionary principle states that should there be the potential for a "… t*hreat of serious or irreversible damage…*" (UNCED 1992) actions to avert risks of serious or irreversible harm to the environment will be enacted, given if there is a sound or credible case that a risk of serious or irreversible harm exists (Privy Council Office, Government of Canada 2003).

As per the NIRB guidelines, TMAC has applied the precautionary principle in the assessment of potential effects on caribou:

1. Examining the potential impacts of the Project and ensuring that it will not cause serious or irreversible harm to caribou;
2. The assessment outlines the assumptions made about the effects of the proposed Project and the approaches to reasonably minimize these effects, including assumptions that are developed where scientific uncertainty exists;
3. Identify follow-up and monitoring activities, particularly in areas where scientific uncertainty exists in the prediction of effects; and
4. Present public views on the acceptability of these effects.

TMAC's approach to addressing these features of the precautionary approach are detailed below.

1) Examine Potential Impacts

TMAC examined potential impacts to caribou and proposed mitigation to ensure no serious or irreversible harm to caribou. Information was drawn from:

- Traditional Knowledge – TMAC commissioned a Traditional Knowledge report from the KIA through the *Naonaiyaotit Traditional Knowledge Project (NTKP)* (Banci and Spicker 2016).
- Traditional Knowledge and Land user Information – TMAC's conducted three caribou workshops with Elders and land users in 2016 and 2017 to: 1) identify potential impacts to caribou, 2) rate the risks to caribou herds, 3) review mitigation, and 4) propose additional mitigation.

- Monitoring Reports – TMAC used the over ten years of monitoring that has been conducted for the Windy exploration camp and Doris Project to examine the real, measured impacts of a camp and mine on caribou.
- Western Science – TMAC reviewed monitoring reports from similar Arctic projects and the scientific literature to examine the likely impacts of industrial developments in the Canadian Arctic.
- Modeling – TMAC used standard noise and dust modeling to examine the likely scale and types of impacts of the Project on caribou.

Potential impacts were evaluated following a cautious approach. Potential impacts proposed by Elders and land users were evaluated using TK, land user knowledge, monitoring results, scientific data and energetics modeling to determine effects on caribou populations. These results indicated that no serious or irreversible harm will come to caribou populations.

2) The Assessment Outlines the Assumptions and Approach to Reasonably Minimize Effects

The assessment outlines the assumptions made about the effects of the proposed Project and the approaches to reasonably minimize these effects. TMAC also increased the certainty of predictions by over-estimating the potential impacts of the Project on caribou, including:

- The area of habitat loss was overestimated by using a Project Development Area, which is three times larger than the actual, anticipated Project footprint.
- The predicted zone of influence used in the calculation of disturbance effects was taken from the scientific literature for a variety of industrial projects, many of which are much larger than the relatively small, underground Phase 2 project. In addition, disturbance effects were calculated using two larger zones of influence in order to be cautious.
- The calculation of indirect habitat loss in the Zone of Influence used an assumption that no caribou would occupy the ZOI, when in reality monitoring for the Doris Project indicates that there is approximately the same density of caribou near the Doris Project as at control sites further away.
- The noise and dust modeling used values that would represent peak noise and dust production instead of typical operating values which are much lower.
- The human health and ecological risk assessment (Volume 6, Section 5) used conservative values for the duration of caribou residency in the Project area, and for calculating the update of dust and water from the Project site and its incorporation in to caribou.
- Energetics modeling made extremely cautious assumptions, including that all caribou would encounter the Project and that the largest possible zone of influence would occur, whereas in reality these interactions will be much smaller. The energetics modeling also assumed that all populations are declining in order to be conservative and model the worst case scenario.

Based on the cautious estimation of impacts, TMAC proposed mitigation and monitoring programs that will reasonably minimize these effects, as discussed below.

3) Follow-up and Monitoring Activities

TMAC has proposed appropriate follow-up and monitoring activities in the WMMP that are based on the monitoring program conducted for the existing Doris Project. This program includes additional

mitigation and management measures to address uncertainty in impact predictions. The objectives of this monitoring program are to:

1. test impact predictions from the FEIS, particularly in area where scientific uncertainty exists;
2. monitor for caribou to evaluate the effectiveness of mitigation;
3. monitor for caribou and trigger appropriate management actions; and
4. monitor for unexpected impacts due to the Project.

The Project WMMP has been reviewed, commented on, and improved over the years as part of the Doris monitoring program, and in the preparation of the FEIS, including:

- Meeting with Elders and land users through the caribou workshops to review the existing Doris and proposed Phase 2 mitigation and monitoring plans and to identify new and improved mitigation measures and monitoring programs.
- Long-term collaboration with the IEAC, who review monitoring reports and propose and review mitigation measures annually.
- Long-term collaboration with the KIA to review and update mitigation and monitoring measures. The KIA and GN review the Doris project monitoring report each year and provide mitigation and monitoring suggestions.
- TMAC has also held a series of technical meetings to examine long-term monitoring data and mitigation measures, including:
  - Camera program design meeting with the KIA and GN, February 2016.
  - Mitigation planning and review meeting with the KIA, November 2017.
  - Mitigation planning and review meeting with the KIA and GN, December 2017.

Key modifications to the Doris WMMP to make it applicable to the Phase 2 Project include:

- expansion of the wildlife camera monitoring program to Madrid and Boston;
- continued discussions with the KIA, GN and CWS on the 10 year analysis of bird data and plans for the program during Phase 2;
- addition of a collar monitoring program to examine if caribou are hesitating to cross the Boston road; and
- addition of a height-of-land monitoring program to identify when caribou are approaching the Boston road during migration and guide adaptive management of vehicle traffic.

4) Present public views on the acceptability of these effects.

TMAC worked to identify public issues and concerns about caribou and public views on the acceptability of these effects, including:

- TMAC conducted community meetings during 2016 and 2017 in the communities of Cambridge Bay, Kugluktuk, and Gjoa Haven to meet community members and hear their concerns about caribou.
- Under the IIBA for the Doris Project, TMAC has jointly formed the IEAC. This committee reviews the monitoring reports from the Doris Project and provides input on potential impacts to caribou and mitigation and management activities on site.

- TMAC conducted engagement interviews with HTOs during the summers of 2016 and 2017 to identify and outstanding concerns related to caribou.
- TMAC worked with the KIA to conduct a series of three caribou workshops. Elders and land users who historically or currently use the Project area were identified and attended the three workshops in September 2016, and April and August 2017. Workshop participants identified potential risks to caribou and caribou populations, the current state of the Doris project and mitigation and management measures for the Doris and Phase 2 projects.

As part of the first caribou workshop, Elders and land users evaluated the potential risks of various Project impacts to the caribou herds. Workshop participants developed a risk matrix which examined the likelihood of an impact and the risk to caribou populations (Table 9.8-1).

Elders and land users identified noise from aircraft and the mine site as expected impacts of the Project with the potential for a high impact on caribou without mitigation. During the second and third caribou workshops, Elders and land users visited the Doris site to review first-hand the degree of noise disturbance produced by the Doris Project. During the site visit, Elders and land users also reviewed the mitigation measures at the Doris site.

During the third caribou workshop, Elders and land users discussed whether caribou encountering the Project would affect that caribou given their life-long experience with caribou and their experience at the Doris Project site. The workshop participants indicated that effects on caribou that encounter the Project are unlikely formulated the following statement by consensus:

> *"Mitigation for the existing Doris Project protects caribou."*

During the third caribou workshop, participants also discussed whether caribou encountering the Project or living near the project would have any impacts on those animals, or on the herd as a whole. The workshop participants agreed by consensus that:

> *"With the planned mitigation, caribou can remain safe on and around the Project site without any impacts on survival or reproduction of the herds."*

During the third caribou workshop, Elders and land users re-evaluated the risk matrix that was produced in the first caribou workshop (Table 9.8-1) following their experience on the Doris site and a review of the existing Doris mitigation measures and those proposed for Phase 2. Elders and land users agreed by consensus that:

> *"With the planned mitigation and monitoring the risk to caribou associated with Phase 2 are acceptable."*

9.8.4.6 Energetics Modeling

TMAC also used western science to determine whether effects on individual caribou encountering the Project could have population-level impacts to caribou herds. Two models were used, the Caribou Cumulative Effects (CCE) Model and the Energetic Assessment Model.

Despite taking different modeling approaches, the two models produced the same results:

- The Hope Bay Project alone will not affect the population size of the Beverly, Ahiak or Dolphin and Union herds.

- The addition of the Hope Bay Project to the current conditions, with disturbance effects from communities and industrial projects does not affect the population size for any of the three herds.
- The addition of the Hope Bay Project to future conditions, with disturbance from communities and all reasonably foreseeable future projects does not affect the population size for any of the three herds.

9.8.4.7 Significance Determination

The first caribou workshop for the Project was held in Cambridge Bay during September 2016. The Elders and land users in the workshop identified 18 potential impacts to caribou, which were rated by the workshop attendees in terms of the likelihood that the impact would occur (unlikely, possible, or expected) and the level of impact on caribou. The level of impact was defined by how many caribou the potential effect could harm (from low to high). The 18 potential impacts identified by Elders and land users were categorized into the seven potential impacts that were evaluated in the effects assessment (Section 9.8.3):

- habitat loss;
- disturbance;
- disruption of movement;
- attraction;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Of these seven potential impacts, three were classified as residual effects after mitigation: habitat loss, disturbance, and disruption of movement. Residual effects are those that have a measureable local scale effect on a parameter. For instance, there will be a small, but measureable loss of habitat.

The following section reviews the residual effects and evaluates whether these potential effects will result in significant impacts on the caribou herds (Table 9.8-24).

Habitat Loss

The Madrid-Boston Project and Hope Bay Project will not interact with any special habitat features, including calving and post-calving areas, eskers, and hills or upland areas used for heat and insect avoidance.

The total area of the Project PDA is 4,189 ha, some of which is considered good quality summer (3,572 ha), fall (1,059 ha), and winter (1,801 ha) habitat. Habitat loss was rated as a residual effect because there is a measurable loss of habitat. This area of habitat loss represents 0.066% of the winter range for Dolphin and Union caribou, and 0.022% of their seasonal range. This area of habitat loss is 0.02% of the winter range of the Beverly and Ahiak herds, and 0.015% and 0.014% of the total ranges, respectively. Overall, the contribution of the Phase 1 PDA to habitat loss, i.e., the Hope Bay Project, adds no more than 0.01% to amount of habitat loss relative to seasonal and annual ranges of the three caribou herds. Research indicates that caribou populations can be limited by predation and habitat quality, and habitat quantity when the amount of available habitat falls below 65% of the herd range (Environment Canada 2012).

Table 9.8-24. Summary of Residual Effects and Overall Significance Rating for Caribou

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction *(positive, variable, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(infrequent, intermittent, continuous)*	**Geographic Extent** *(PDA, LSA, RSA, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Significance** *(not significant, significant)*	**Confidence** *(low, medium, high)*
Madrid-Boston									
Habitat Loss	Negative	Negligible	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	High
Disturbance	Negative	Negligible	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium
Disruption of Movement	Negative	Negligible	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium
Hope Bay Project									
Habitat Loss	Negative	Negligible	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	High
Disturbance	Negative	Negligible	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium
Disruption of Movement	Negative	Negligible	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium

The area of habitat loss due to Madrid-Boston and the Hope Bay Project is small when compared to what is available in the RSA, winter range or total herd range. Caribou are expected to have a low sensitivity to the effect of habitat loss, because over 99% of the range is still available. Caribou may be sensitive to shifts in habitat quality, but changes in habitat quantity are unlikely to affect populations unless they are at an extremely high population size. Even sensitive caribou populations are unlikely to be affected by small areas of habitat loss, particularly when almost all habitat is currently available on the landscape. Therefore, the loss of less than 0.01% in all seasonal and/or annual ranges for the three caribou herds is very unlikely to have an effect on the caribou populations, regardless of the population status, and therefore caribou are considered resilient to this effect.

As such, this residual effect is rated as having a negligible magnitude. This rating is consistent with the conclusions from Elders and land users at the caribou workshops. The duration of habitat loss is long term (beyond the life of the Project) and irreversible because even with reclamation, the habitat will not return to baseline conditions. The frequency of habitat loss is intermittent, with the majority of habitat loss occurring during Construction, and infrequently thereafter as Project infrastructure is expanded. The geographic extent of habitat loss will be confined to the PDA. The confidence of the effect occurring and in the proportion of habitat removed is considered high because the area removed is well understood and the herd ranges have been established using standard techniques. The probability of the effect occurring is likely, as a small but measureable amount of habitat from seasonal ranges of the Dolphin and Union, Beverly, and Ahiak caribou herds will be lost due to the PDAs.

The residual effect of habitat loss for the Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak herds) is **Not Significant** for both Madrid-Boston and the Hope Bay Project.

Disturbance

Both Elders and land users in the caribou workshops, and results from energetics modeling indicated that any disturbance to individual caribou posed a negligible and acceptable risk to caribou populations. For this reason, this residual effect is rated as having a negligible magnitude. This magnitude rating reflects the sensitivity and resilience of the caribou herds (see above). The duration of habitat loss is medium term (ending with Closure) because at that point disturbance due to noise will cease. The frequency of disturbance is intermittent, with Project activities such as passing vehicles, blasting or aircraft landing or departing. The geographic extent of disturbance is likely larger than the 1 km buffer LSA, but will be confined to the RSA.

The confidence of the effect occurring and in the proportion of habitat affected is rated as medium because the exact size of the ZOI is challenging to predict with confidence. It is for this reason that a conservative estimate of a 4 km ZOI was used in the analysis. The probability of the effect occurring is likely because the Project will produce noise and research reports that caribou may react to that disturbance.

The residual effect of disturbance for the Dolphin and Union and the Beverly/Ahiak caribou herds is **Not Significant** for both Phase 2 and the Hope Bay Project.

Disruption of Movement

Elders and workshop participants evaluated the potential for the Project to disrupt caribou movement and evaluated the risk to the caribou population as acceptable. Monitoring reports from the Doris Project indicate that caribou routinely cross the existing roads at the Project site, while scientific literature indicates that caribou will readily cross roads at the Ekati mine in NWT. For this reason, this residual effect is rated as having a negligible magnitude. This magnitude rating reflects the sensitivity

and resilience of the caribou herds (see above). The duration of habitat loss is medium term (ending with Closure) because at that point traffic on the road will cease. The frequency of disruption of movement is intermittent, with Project activities such as passing vehicles. The geographic extent of disturbance is likely larger than the 1 km buffer LSA, but will be confined to the RSA.

The confidence of the effect occurring is rated as medium. The probability of the effect occurring is likely. The Project will produce noise and research reports that caribou may react to that disturbance.

The residual effect of disruption of movement for the Dolphin and Union and the Beverly/Ahiak caribou herds is **Not Significant** for both Phase 2 and the Hope Bay Project.

9.9 CARIBOU – CUMULATIVE EFFECTS ASSESSMENT

9.9.1 Introduction

Cumulative effects were evaluated for each of the caribou herds evaluated in the Effects Assessment (Section 9.8); the Island caribou (Dolphin and Union herd) and Mainland caribou (the Beverly and Ahiak sub-populations). Cumulative effects were evaluated where the residual effects of a Project may overlap and interact with the residual effects of other past, existing or reasonably foreseeable projects or other human activities.

Potential cumulative effects were identified from the results of caribou workshops with Elders and land users, from regional and herd-specific management plans the results of scientific studies and professional experience.

9.9.1.1 Caribou Workshops

TMAC held a series of three caribou workshops with Kitikmeot Elders and land users in September 2016, April 2017 and August 2017 to collect additional Traditional Knowledge on the Project site, share what is being done currently for the Doris project and evaluate the proposed mitigation for the Phase 2 Project. More information on the caribou workshops can be found in Section 9.8.1.1.

During the third caribou workshop in August 2017, Elders and land users identified potential cumulative effects on caribou herds and to rate the relative importance of these effects for caribou. Elders and land users identified the following list of effects from most to least important for caribou herds:

1. predation;
2. hunting;
3. insects;
4. development;
5. climate change;
6. disease; and
7. pollution.

Workshop participants agreed by consensus on the list of cumulative effects and their importance except for one member, who indicated that the Cambridge Bay HTO felt that disease was the leading cause of caribou decline.

9.9.1.2 Management Plans

Herd-specific management plans have been prepared for the Dolphin and Union herd and the Beverly and Qamanirjuaq herds. These management plans identify potential threats to caribou and management objectives. Section 9.8.2.4 describes how the Hope Bay Project meets each of these management objectives. The KIA Mobile Protection Measures addresses mitigation for industrial development. This section focuses on identification of threats to caribou herds.

The Draft Dolphin and Union Caribou Management Plan;

Potential threats were identified and evaluated for the Dolphin and Union population in the management plan for that herd: *Management Plan for the Barren-ground Caribou (Rangifer tarandus groenlandicus), Dolphin and Union population, in Canada* (Environment and Climate Change Canada 2017a). Threats were evaluated following an international standard approach (IUCN) by local communities, organizations and government agencies in a meeting in Kugluktuk (March 2016) and a follow-up meeting in Cambridge Bay (January 2016). This Management Plan considered those identified threats from greatest to least important for the herd:

1. Changes to sea ice affecting migration
    - IUCN Threat #4.3 Shipping Lanes (High Impact)

      Increased ice-breaking marine traffic in the Northwest Passage has the potential to block caribou movements or result in more drownings during their seasonal migration between Victoria Island and the mainland.
    - IUCN Threat #11.1 Habitat Shifting and Alteration (Medium - Low Impact)

      Climate change is leading to longer open-water seasons and thinner ice during fall migration, which has the potential to block caribou movements or result in more drownings.
2. Predation and competition
    - IUCN Threat #8.2 Problematic Native Species (High - Low Impact)

      Communities indicate that predation from wolves has increased over the last 10-20 years and until recently Inuit actively controlled the numbers of wolves. Community members and GN biologists have reported more wolves on Banks and Victoria islands. Community members also report that bald eagles, a predator of calves, are increasing.

      TK holders identified muskox as a source of food and land competition for caribou.

      Research indicates that snow geese, Ross's geese and greater white-fronted geese have increased substantially and are altering the forage availability in the Queen Maud Gulf area, which may alter winter forage for caribou.
3. Harvest
    - IUCN Threat #5.1 Hunting and Collecting (Medium – Low Impact)

      Some committee members felt that harvest should be rated as high-low impact due to uncertainty in the current harvest levels, while others argued that it should be medium-low because the herd is largely inaccessible to harvesters.

4. Parasites, diseases and insect harassment

   - IUCN Threat #8.1 Invasive Non-native* Alien Species (Medium - Low Impact)

     Committee members felt that parasites, disease and insect harassment pose a moderate threat due to climate change and warmer temperatures which can allow the introduction of new diseases or parasites. Communities have reported an increase in diseased caribou.

5. Other habitat changes due to climate change

   - IUCN Threat #11.1 Habitat Shifting and Alteration (Medium - Low Impact)

     Increased temperatures are leading to increased vegetation growth and diversity, but effects of vegetation change on caribou are complex and not clearly understood.

6. Icing events

   - IUCN Threat #11.4 Storms and Flooding (Medium – Low impact)

     Icing events caused by freezing rain or freeze-thaw events, appear to be more common, making it more difficult for caribou to crater and reach their food in winter.

7. Mining

   - IUCN Threat #3.2 Mining and Quarrying (not including roads) (Low Impact)

     The effect of mines was rated as low, but there were concerns over habitat loss, caribou being displaced from their winter range, and increased access for hunting.

8. Roads

   - IUCN Threat #4.1 Roads and Railroads (Low Impact)

     Roads were identified as having a small effect on caribou, but there was concern over the Gray's Bay all season road and the [former] TMAC winter road between Cambridge Bay and Doris[1] interrupting caribou movement and increasing hunter access.

9. Flights

   - IUCN Threat #4.4 Flight Paths – Scheduled Flights (Low Impact)

     The committee determined that flights at high elevation were unlikely to disturb caribou if there were at high elevation, except when landing and taking off.

   - IUCN Threat #6.3 Work and Other Activities (Negligible Impact)

     Low level flights may disturb caribou, particularly during the calving season, in calving areas.

10. Other threats

    The committee determined that several other threats would have "unknown, negligible or no direct effect" on caribou, including airborne pollutants, recreation activities, house and urban areas, utilities, solid wastes, oil and gas drilling and war//civil unrest.

The Beverly Qamanirjuaq Caribou Management Plan

The Beverly caribou sub-population is managed through the *Beverly and Qamanirjuaq Caribou Management Plan 2013-2022* (BQCMB 2014). This plan describes the processes for conducting a vulnerability assessment of the herd and conducting monitoring activities to support the vulnerability assessment. The Plan also provides management direction for harvest based on the vulnerability level of the herd, and for industrial development.

The BQCMP discusses the threats to these herds in the following order:

- harvest;
- wastage during harvest;
- industrial development; and
- fires on the winter range.

9.9.2 Methods and Boundaries

9.9.2.1 Methodology Overview of Cumulative Effects

The methodology for cumulative effects assessment (CEA) is described in Volume 2, Section 4. In general, CEA follows these steps:

1. Identify the potential for Madrid-Boston Project-related residual effects to interact with residual effects from the Existing and Approved Projects within the Hope Bay Greenstone Belt (i.e., the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project) and other human activities and projects within specified assessment boundaries. Key potential residual effects associated with past, existing, and reasonably foreseeable future projects were identified using publicly available information or, where data were unavailable, professional judgment was used (based on previous experience in similar geographical locations) to evaluate expected environmental conditions.
2. Identify and predict potential cumulative effects that may occur and implement additional mitigation measures to minimize the potential for cumulative effects that could cause serious or irreversible harm.
3. Identify cumulative residual effects after the implementation of mitigation measures.
4. Determine the significance of any cumulative residual effects.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 2, Section 4) and wildlife specific definitions (Section 9.5.6). Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 9.5). The only exception is for the attribute “geographic extent” whereby the definitions are related to the CEA boundary for caribou and not the wildlife RSA.

9.9.2.2 Spatial Boundary

The cumulative effects assessment for caribou considers two spatial boundaries: 1) the seasonal ranges of these herds when they are most likely to interact with the Project, and 2) the annual herd ranges (Figures 9.9-1, 9.9-2 and 9.9-3).

9.9.2.3 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

Figure 9.9-1

The Cumulative Effects Assessment Spatial Boundary for the Dolphin and Union (Island) Caribou Herd

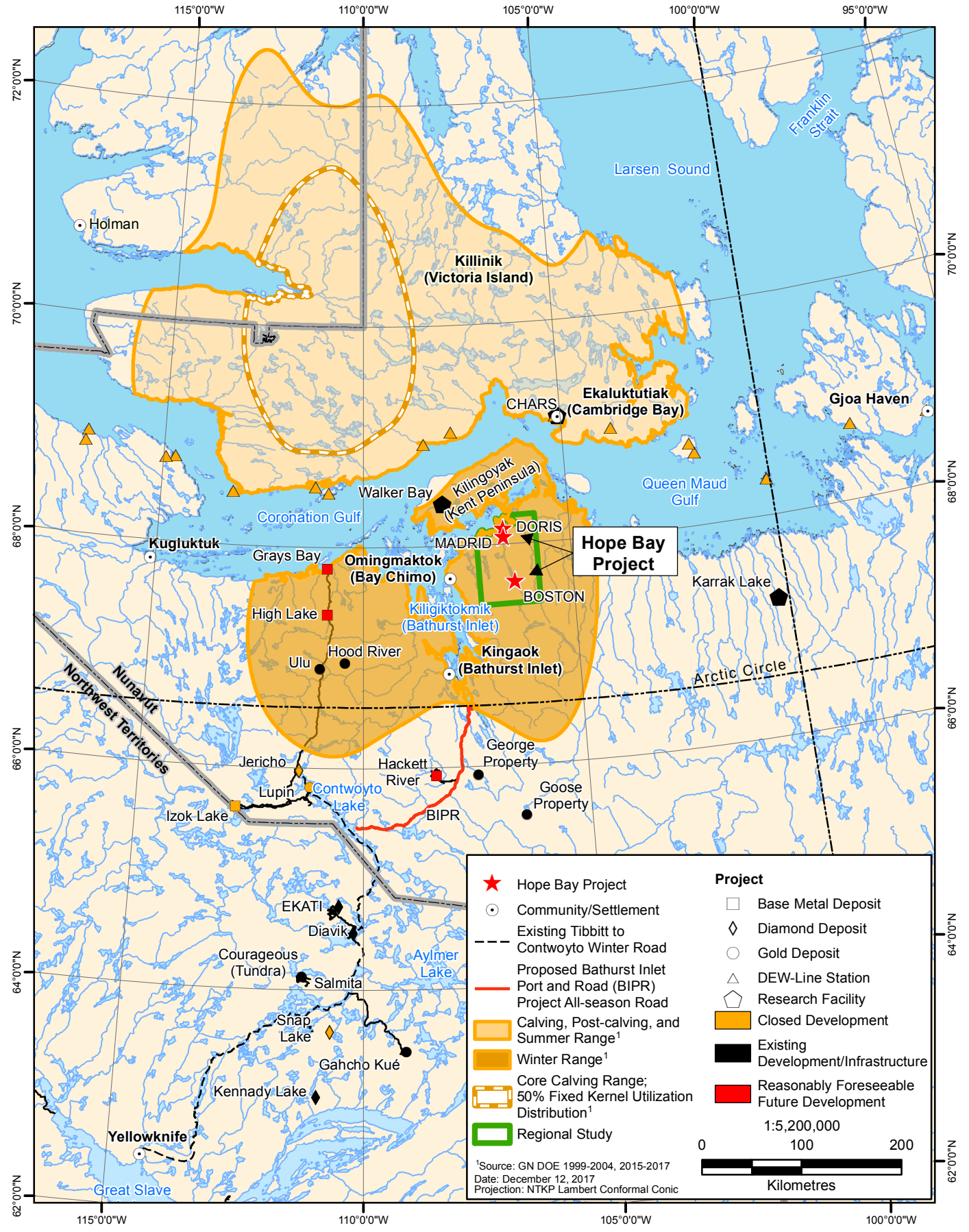


Figure 9.9-2

The Cumulative Effects Assessment Spatial Boundary for the Beverly (Mainland) Caribou Subpopulation

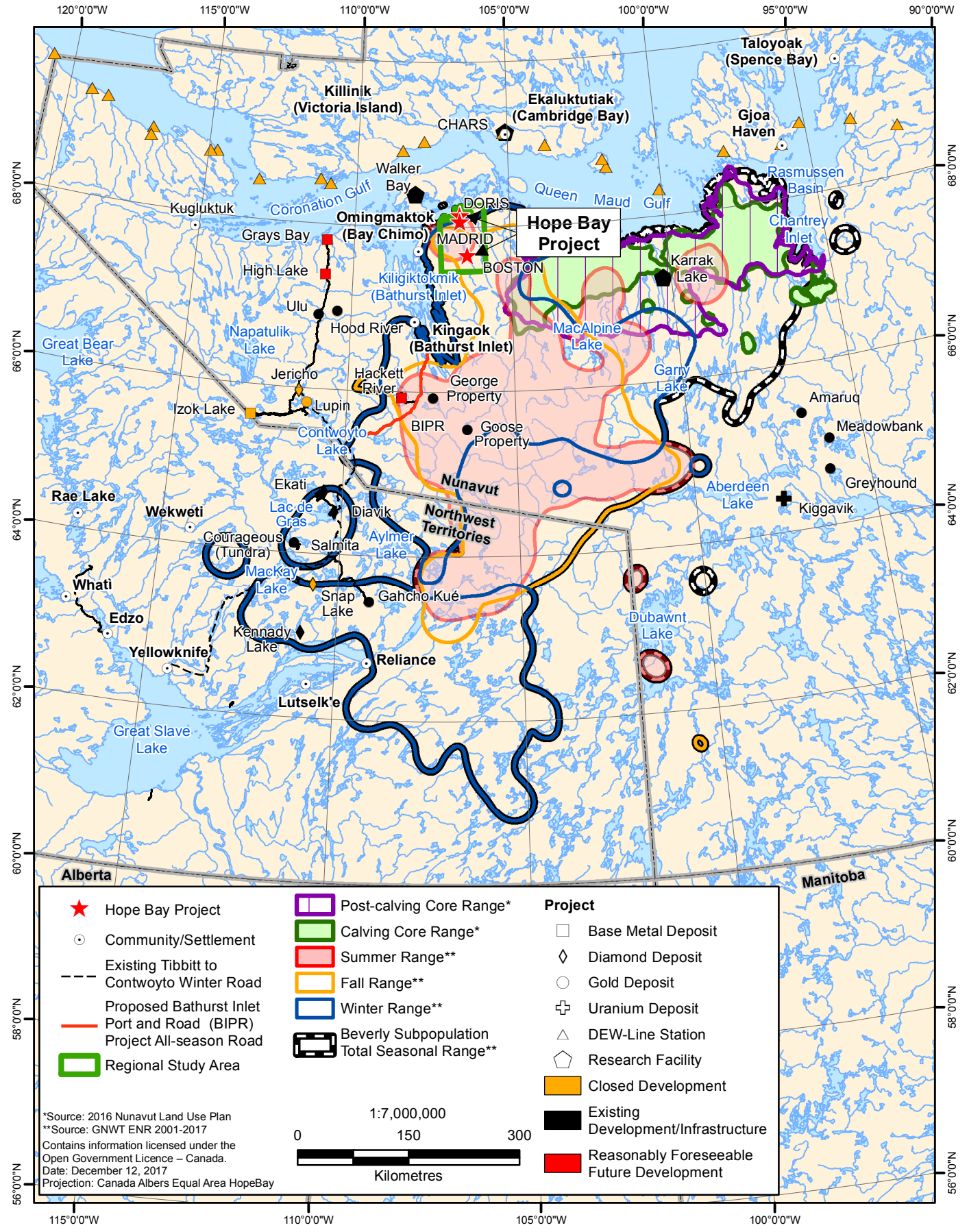
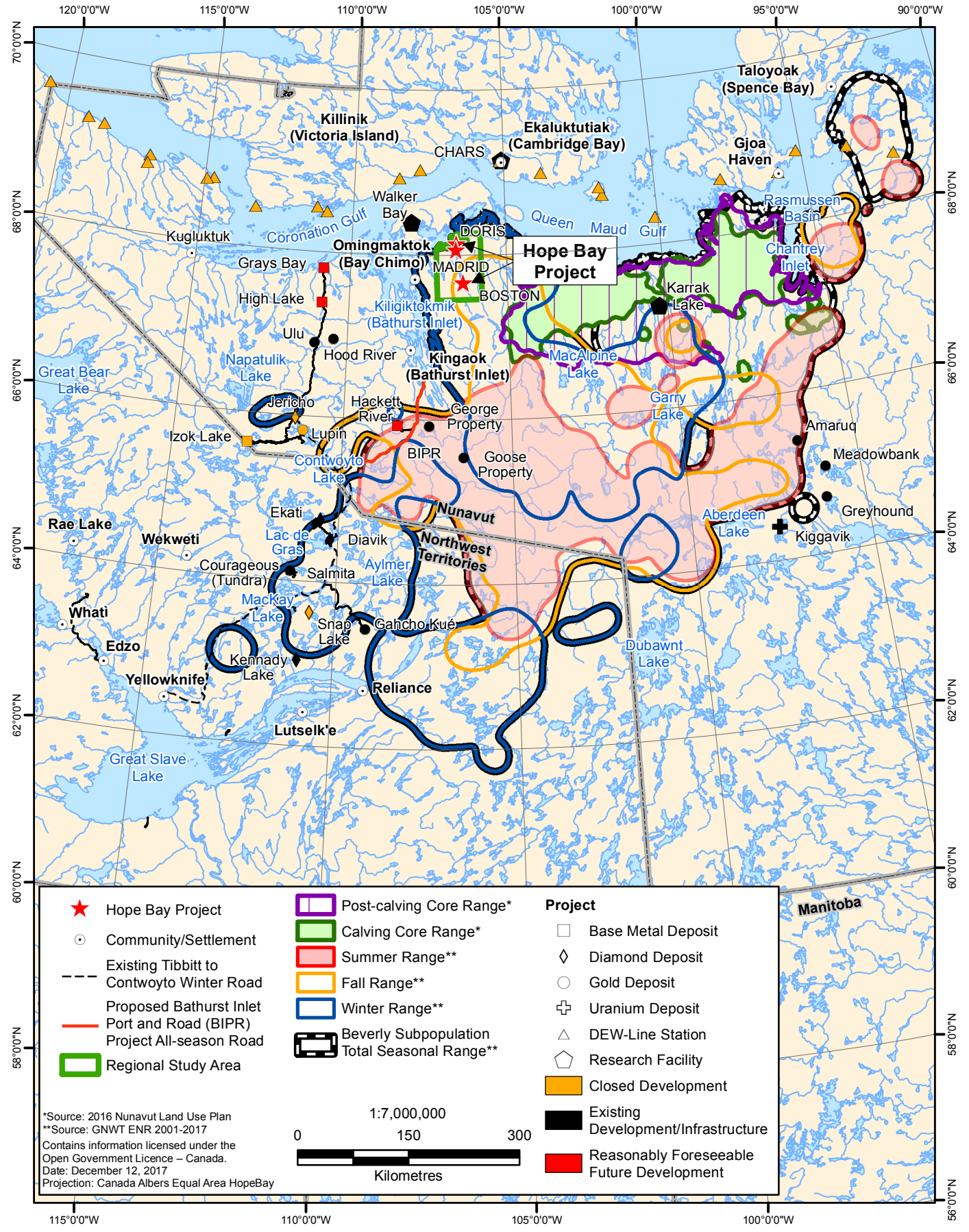


Figure 9.9-3

The Cumulative Effects Assessment Spatial Boundary for the Ahiak (Mainland) Caribou Subpopulation



9.9.3 Potential Interactions of Residual Effects with Other Projects

Three residual Project-related effects were identified during the caribou effects assessment:

- habitat loss;
- disturbance; and
- disruption of movement

The past, present, and reasonably foreseeable future developments that were considered in the CEA for caribou include the projects listed in Table 4.4-1 in Volume 2, Chapter 4 that occur within caribou seasonal and annual ranges. Communities and seasonally occupied settlements were included within the scope of the cumulative effects assessment based on comments received from the GN DOE during the review of the DEIS. For the purposes of evaluation, communities and seasonally occupied settlements are considered to be present developments. Potential interactions between habitat loss due to these industrial projects and climate change are also evaluated.

A total of 11 past, present, and reasonably foreseeable future developments occur in the CEA boundaries of the Dolphin and Union herd; the winter range and annual range (Table 9.9-1, Figure 9.9-1). These communities and projects have the potential to interact with the residual effects of the Project and were included in the assessment.

A total of 14 past, present, and reasonably foreseeable future developments occur in the CEA boundaries of the Beverly caribou; the summer, fall, winter, and annual ranges (Table 9.9-1, Figure 9.9-2). These communities and projects have the potential to interact with the residual effects of the Project and were included in the assessment.

A total of 17 past, present, and reasonably foreseeable future developments occur in the CEA boundaries of the Ahiak caribou; the summer, fall, winter, and annual ranges (Table 9.9-1, Figure 9.9-3). These communities and projects have the potential to interact with the residual effects of the Project and were included in the assessment.

Of note, the Meadowbank Project falls outside of the herd ranges for Beverly and Ahiak caribou and is not considered further in the assessment.

Table 9.9-1. Past, Present, and Reasonably Foreseeable Future Projects with Potential Cumulative Interactions with the Project and the Dolphin and Union (Island) Caribou Herd and Beverly and Ahiak (Mainland) Caribou Sub-populations

Project Time frame	Project Name	Location	Project Type	Potential Cumulative Effects Interactions With Caribou		
				Dolphin and Union herd	Beverly Sub-population	Ahiak Sub-population
Past	Jericho Mine	Nunavut	Diamond mine			X
	DEW-Line Stations	Nunavut	Communications Network	X		X
	Snap Lake Diamond Mine	Northwest Territories	Diamond mine		X	X
	Salmita/Tundra Mine	Northwest Territories	Gold mine		X	X

Project Time frame	Project Name	Location	Project Type	Potential Cumulative Effects Interactions With Caribou		
				Dolphin and Union herd	Beverly Sub-population	Ahiak Sub-population
Present Development Projects	Canadian High Arctic Research Station	Nunavut	Science station	X		
	Hackett River Project*	Nunavut	Exploration		X	X
	Walker Bay Research Station	Nunavut	Research camp	X		
	Karrak Lake Research Station	Nunavut	Research camp		X	X
	Back River (Goose and George Property)*	Nunavut	Exploration		X	X
	Izok Project*	Nunavut	Exploration	X		
	Amaruq Project	Nunavut	Exploration			X
	Hood River Project	Nunavut	Exploration	X		
	Ulu Lake Project	Nunavut	Exploration	X		
	Tibbit to Contwoyto Winter Road	Nunavut, Northwest Territories	Road		X	X
	Ekati Diamond Mine	Northwest Territories	Diamond mine		X	X
	Gahcho Kué Mine	Northwest Territories	Diamond mine		X	X
	Diavik Diamond Mine	Northwest Territories	Diamond mine		X	X
	Courageous Lake*	Northwest Territories	Exploration		X	X
	Kennady Lake	Northwest Territories	Exploration		X	
	Cambridge Bay	Nunavut	Community	X		
	Kingaok	Nunavut	Seasonally Occupied Settlement	X	X	
	Omingmaktok	Nunavut	Seasonally Occupied Settlement	X		X
	Reliance	Northwest Territories	Community		X	X
Reasonably Foreseeable Future	Back River (George Lake and Goose Lake)*	Nunavut	Gold mine	X	X	X
	Bathurst Inlet Port and Road*	Nunavut	All-weather road	X	X	X
	Hackett River*	Nunavut	Base metal mine		X	X
	Izok Corridor (High Lake and Izok Lake)*	Nunavut	Copper, zinc, gold, silver mine (and all weather road)	X		X
	Courageous Lake*	Northwest Territories	Gold mine		X	X

** The Back River, Bathurst Inlet Port and Road, Courageous Lake, Hackett River, and Izok Corridor projects represent those that are presently active in exploration and will be developed into mines and roads in the future. Hence, these projects count as only once to the number present within or near the caribou ranges.*

9.9.4 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for caribou will be similar to those implemented for the Madrid-Boston Project.

9.9.5 Characterization of Cumulative Effect

This section evaluates the potential interactions between the Madrid-Boston Project and other mining developments in Nunavut and Northwest Territories. This section also considers the potential effects of climate change on caribou. Three potential effects were rated as residual effects on caribou populations in Section 9.8.4; habitat loss, disturbance, and disruption of movement. In addition, two protein-energetics models were used to evaluate the cumulative effects of development on caribou populations, both currently and in the future, with and without the Hope Bay Project.

9.9.5.1 Habitat Loss

The Madrid-Boston Project effects assessment identified habitat loss as a residual effect for Dolphin and Union herd and the Beverly and Ahiak sub-populations. Cumulative habitat loss due to all projects in the herd range was calculated through a GIS exercise to examine the total area removed by the Construction of all past, present and reasonably foreseeable development project footprints.

Effects of Climate Change on Habitat and Forage

This section evaluates the potential for climate change to act synergistically with mining development to exacerbate the effects of habitat loss.

Links between ungulate population fluctuations and large-scale climatic patterns, such as the Arctic Oscillation, have been widely documented (e.g. Post and Stenseth 1999; M.C. Forchhammer et al. 2002; Dunne and Quinne 2009; Joly et al. 2011a; GNWT ENR 2016b). Inuit have noted a decline in some barren-ground caribou herds as a result of freezing rain conditions and long term cycles in the populations of caribou. Climate change is thought to be a density independent factor that can alter the carrying capacity of caribou by altering the availability or quality of forage (M. C. Forchhammer et al. 2002; MOR 2006; Joly et al. 2011b; ERM Rescan 2014b).

The abundance and quality of forage are influenced by climate and the effects may differ by season. Future climate scenarios that predict extensions in the growing season could result in a positive effect to caribou (Braden et al. 2008). Increased vegetation biomass could provide caribou with additional forage and result in better overall body condition to withstand harsh winters. In a simulation modelling exercise, an increase in biomass strongly decreased the probability of population die-off because caribou were less prone to starvation (Tews, Ferguson, and Fahrig 2007). However, a prolonged snow free period and longer and warmer summer is expected to affect the timing of insect emergence and the length of time of the summer insect harassment period for caribou, which has negative consequences as animals may spend longer periods of time seeking relief. Higher levels of insect harassment on reindeer herds in Finland have been implicated as a factor influencing calf weights in the fall and early winter. Helle and Tarvainen (1984) reported that the lowest calf weights were experienced in years when a bad winter was followed by a warm summer with severe insect harassment. Over the long term, shrubland and taiga forest could eventually displace Arctic tundra as the growing environment becomes favorable for such species in a process referred to as “shrubification”. This change could adversely affect caribou by reducing the amount of preferred forage (Fauchald et al. 2017) and may also creating competition for food sources with other browsing ungulates, especially during the winter months.

Climate change may also result in more frequent extreme weather events, affecting access to forage. For example, over the last four decades, the Peary caribou herd have experienced significant die-offs as a result of four extreme winter weather events that caused ice to coat vegetation and thicker-than-usual snow cover that made forage inaccessible, leading to malnutrition and starvation (Kuyt 1972; Keith 1983; Hersteinsson and MacDonald 1992; Martin and Bateson 1993; MOR 2006; Olsson, Widén, and Larkin 2008). Reduced food intake can influence pregnancy and calving rates of females. Extreme weather events such as late spring snowfall or late snowmelt can influence access to food and result in lower calf weights or delayed parturition (time of calving), which influences survival of young (Golder Associates 2009; Rescan 2012a; KIA 2015b). Future climate change scenarios predict an increase in the frequency and severity of such extreme weather events. (Hersteinsson and MacDonald 1992; 2006) predicted a 100% increase in the frequency of population die-offs could result from a 25% decrease in forage availability due to extreme weather events caused by climate change.

The frequency of forest fires in the caribou winter range below treeline is largely determined by decadal changes in climate, such as the Arctic Oscillation (Overland and Wang 2005). Assuming that current climatic trends continue (Katz 2010), an increase in fire activity across northern landscapes will further reduce the availability of forested taiga for wintering caribou (Fuller, Mech, and Cochrane 2003; Carmack and Macdonald 2008). Larger and more abundant burns, in addition to fewer older and lichen-rich stands, could significantly reduce the area or connectivity of good-quality habitat on the winter range (Fuller, Mech, and Cochrane 2003; Macdonald and Gunn 2004; Environment and Climate Change Canada 2016). These forests will recover, but lichen supplies will be reduced until recovery is complete.

Climate change scenarios indicate that conditions on the winter ranges may decline in quality, with increasing shrubification, fires and competition with boreal species. In contrast, conditions on the summer range may increase in quality, with increased temperatures, growing season and productivity. Research suggests that forage quality and biomass on the post-calving and summer range is positively correlated with over-winter survival of cows and calves, which may be linked to long term population dynamics (McDonald and Wilcockson 2003; Chen, Russell, et al. 2013).

In summary, there is evidence that the quality of the winter range may decline, while the quality of the summer range may increase. There is no evidence at this time of an overall directional shift across the seasonal ranges towards better or poorer habitat quality and hence on caribou populations. Therefore, no interaction is predicted between the relatively small scale removal of habitat due to industrial projects and climate change.

Evaluation of Cumulative Habitat loss

Habitat loss was calculated for each community, camp and project through a GIS exercise. The current or planned footprints of communities and projects were recorded from government records, monitoring reports or digitized from satellite images. Habitat loss was evaluated in the caribou effects assessment (Section 9.8.3.1) using a Project Development Area (PDA) which was the Project footprint plus a buffer to allow for repositioning of the footprint and to over-estimate the effects of habitat loss for a conservative assessment of effects. The PDA is approximately three times larger than the proposed Madrid-Boston footprint. The calculations made for the cumulative effects assessment were made on the footprint of communities and projects. To be comparable with other projects, the proposed footprint of the Madrid-Boston Project was used in the analysis instead of the PDA.

Island Caribou (Dolphin and Union Herd)

Cumulative effects are evaluated for the winter range of the Island caribou (Dolphin and Union herd) caribou given the spatial overlap between this range and the Project, so the winter range and annual

range are used to evaluate whether a residual effect is expected to occur. The winter range of the Dolphin and Union caribou herd is 6,364,200 ha and the annual range is 19,227,700 ha (Table 9.9-2).

Table 9.9-2. Cumulative Habitat Loss in the Dolphin and Union CEA Boundaries

Project/Timeframe	Project	Winter	Annual
The Project	Existing and Approved Projects*	233	233
	Boston-Madrid	1,463	1,463
	Hope Bay Project	1,696	1,696
Past	DEW-Line Stations	0	39
Present	Cambridge Bay**	0	264
	Hood River Project	5	5
	Kingaok	3	3
	Omingmaktok	1	1
	Ulu Lake Project	5	5
	Walker Bay Research Station	2	2
Reasonably Foreseeable Future	Back River	2	2
	Bathurst Inlet Port and Road	50	50
	Izok Corridor (High Lake and Izok Lake)	615	615
Total Area		2,379	2,682
Range Area		6,364,200	19,227,700
% Range		0.037	0.014

** Refers to the Doris Project, Hope Bay Regional Exploration Project, Madrid Advanced Exploration Program, and Boston Advanced Exploration Program*
***The CHARS Project is captured within the footprint of Cambridge Bay*

On the winter range of Island caribou, the total habitat loss from all past and existing projects is 249 ha without, and 1,712 ha with the Boston-Madrid Project. The total future habitat loss including all past, current and reasonably foreseeable future projects is 916 ha without, and 2,379 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.014% of the winter range without the Project and 0.037% with the Project (Table 9.9-2).

Across the annual range, total habitat loss from past and existing projects without the Project is 551 ha and 2,014 ha with the Project. Accounting for all past, present, and future projects, the total habitat loss is 1,219 ha without the Project and 2,682 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.006% of the annual range without the Project and 0.014% with the Project (Table 9.9-2).

Beverly (Mainland) Caribou Sub-population

The primary period when the Beverly caribou range overlaps the Madrid-Boston Project and all other past, present, and reasonably foreseeable future projects is during winter and so habitat loss for the winter range and annual range are used to evaluate whether a residual effect is expected to occur. The winter range of the Beverly sub-population is 18,013,435 ha and the annual range is 27,570,234 ha (Table 9.9-3).

Table 9.9-3. Habitat Loss in the Beverly Caribou Sub-population CEA Boundaries

Project/Timeframe	Project Name	Total Habitat Lost (ha)			
		Summer Range	Fall Range	Winter Range	Annual Range
The Project	Existing and Approved Projects*	206	4	10	233
	Boston-Madrid	1,119	1,190	1,337	1,463
	Hope Bay Project	1,325	1,194	1,347	1,696
Past	Salmita/Tundra Mine	0	0	106	106
	Snap Lake Diamond Mine	0	0	219	219
Present	Diavik Diamond Mine	0	0	988	988
	Ekati Diamond Mine	0	0	3,225	3,225
	Gahcho Kué Mine	0	0	1,860	1,860
	Karrak Lake Research Station	0	0	0	2
	Kennady Lake	0	0	5	5
	Kingaok	0	0	3	3
	Tibbit to Contwoyto Winter Road	0	0	290	290
Reasonably Foreseeable Future	Back River	885	928	969	969
	Bathurst Inlet Port and Road	195	244	529	529
	Courageous Lake	0	0	2,253	2,253
	Hackett River	1,332	1,454	1,454	1,454
Cumulative Areas					
Total Area		3,738	3,819	13,247	13,598
Range Area		9,822,214	10,928,856	18,013,435	27,570,234
% Range		0.038	0.035	0.074	0.049

** Refers to the Doris Project, Hope Bay Regional Exploration Project, Madrid Advanced Exploration Program, and Boston Advanced Exploration Program*

The total habitat loss from all past and existing projects in the Beverly caribou winter range is 6,705 ha without, and 8,042 ha with the Boston-Madrid Project. The total future habitat loss including all past, current and reasonably foreseeable future projects is 11,910 ha without, and 13,247 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.066% of the winter range without the Project and 0.074% with the Project (Table 9.9-3).

Across the annual range, total habitat loss from past and existing projects without the Project is 6,930 ha and 8,393 ha with the Project. Accounting for all past, present, and future projects, the total habitat loss is 12,135 ha without the Project and 13,598 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.044% of the annual range without the Project and 0.049% with the Project (Table 9.9-3).

Ahiak (Mainland) Caribou Sub-population

The primary period when the Ahiak caribou range overlaps the Madrid-Boston Project area and all other past, present, and reasonably foreseeable future projects is during winter and so habitat loss for the winter range and annual range are used to evaluate whether a residual effect is expected to occur. The winter range of the Ahiak sub-population is 17,153,125 ha and the annual range is 30,409,044 ha (Table 9.9-4).

Table 9.9-4. Habitat Loss in the Ahiak Caribou Sub-population CEA Boundaries

Project/Timeframe	Project Name	Total Habitat Lost (ha)			
		Summer Range	Fall Range	Winter Range	Annual Range
The Project	Existing and Approved Projects*	0	4	233	233
	Boston-Madrid	0	945	1,463	1,463
	Hope Bay Project	0	949	1,696	1,696
Past	DEW-Line Stations	0	0	0	11
	Jericho	0	0	184	184
	Salmita/Tundra Mine	0	0	106	106
	Snap Lake Diamond Mine	0	0	219	219
Present	Amaruq Project	5	0	0	5
	Diavik Diamond Mine	0	0	988	988
	Ekati Diamond Mine	0	0	2,143	2,143
	Gahcho Kué Mine	0	0	284	284
	Karrak Lake Research Station	0	0	0	2
	Tibbit to Contwoyto Winter Road	0	0	461	522
Reasonably Foreseeable Future	Back River	859	873	0	873
	Bathurst Inlet Port and Road	300	253	31	392
	Courageous Lake	0	0	2,253	2,253
	Hackett River	726	1,454	0	1,454
	Izok Corridor (High Lake and Izok Lake)	0	0	40	40
Cumulative Areas					
Total Area		1,890	3,529	8,405	11,172
Range Area		12,440,815	14,768,775	17,153,125	30,409,044
% Range		0.015	0.024	0.049	0.037

** Refers to the Doris Project, Hope Bay Regional Exploration Project, Madrid Advanced Exploration Program, and Boston Advanced Exploration Program*

The total habitat loss from all past and existing projects in the Ahiak caribou winter range is 4,618 ha without, and 6,081 ha with the Boston-Madrid Project. The total future habitat loss including all past, current and reasonably foreseeable future projects is 6,942 ha without, and 10,061 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.040% of the winter range without the Project and 0.049% with the Project (Table 9.9-4).

Across the annual range, total habitat loss from past and existing projects without the Project is 4,697 ha and 6,160 ha with the Project. Accounting for all past, present, and future projects, the total habitat loss is 9,709 ha without the Project and 11,172 ha with the Project. The amount of cumulative habitat loss based on the total area is equivalent to the 0.032% of the annual range without the Project and 0.037% with the Project (Table 9.9-4).

Summary of Habitat Loss

The area of cumulative habitat loss, both without and with the Project, is small compared to either the seasonal or total herd ranges. However, given the importance of caribou to northern communities and concerns over the status of barren-ground caribou populations across the Canadian Arctic and the fact

that habitat loss will result in a small, but measurable effect on caribou habitat, this potential effect was rated as a residual cumulative effect for both Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak sub-populations).

9.9.5.2 Disturbance

The potential effect of disturbance to caribou was rated as a residual effect for both the Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak sub-populations), but was not rated as a significant effect for either Phase 2 or the Hope Bay Project. Potential cumulative effects from past, existing and reasonably foreseeable future projects within the seasonal CEA boundaries for the Dolphin and Union (Island) herd and the Beverly and Ahiak (Mainland) caribou sub-populations are evaluated below.

Calculation of Disturbance

Reduction in Habitat Quality in a Zone of Influence

The caribou effects assessment evaluated the potential for caribou to avoid the Project site in an area termed a zone of influence (ZOI). This area with fewer caribou can be thought of as an area with reduced habitat quality or as indirect habitat loss. The proportion of area with reduced habitat quality near all projects was calculated for communities and all past, present and reasonably foreseeable future projects.

The predicted ZOI surrounding communities and past, present and future projects were determined based on management plans, primarily the *Draft Bathurst Caribou Range Plan* (GNWT ENR 2017), the scientific literature and professional judgement (Table 9.9-5). A single ZOI was used for towns, settlements, and seasonally occupied settlements, closed projects, research camps, and exploration camps (Table 9.9-5).

Small and localized developments were assumed to have the smallest ZOI of 1 km in the present and future case based on the low level of activity that may be occurring in these areas, and these included the DEW Line Stations (closed) and the existing research camps/science stations (CHARS, Karrak Lake, Walker Bay).

Significant, active exploration sites and closed mining developments in the present and future case were assumed to have a 5 km ZOI given the level of human activity that occurs in these features, such as intermittent human presence (i.e., generally not year round), some aircraft support, and temporary or permanent infrastructure. Communities have the largest ZOI of 15 km and seasonally occupied settlements were given a smaller ZOI of 5 km. It should be noted that the CHARS Project (1 km ZOI buffer) is completely within the 15 km ZOI surrounding Cambridge Bay and thus is not considered further in the evaluation of cumulative effects.

For mining activities and roads, three scenarios were calculated. The first scenario was determined through a review of monitoring reports and the scientific literature and determined to be 4 km around mines and 1.5 km around roads. This scenario is discussed as the “likely scenario” since it has the most support in the scientific literature.

Table 9.9-5. Disturbance ZOI Areas Applied to Developments in the Cumulative Effects Assessment

Development Type	Included Developments	Buffer Size (km)	
		Present Case	Future Case
Towns and Settlements	Baker Lake, Cambridge Bay, Lutselk'e, Reliance, Wekweti	15	15
Seasonally Occupied Settlements	Kingaok (Bathurst Inlet), Omingmaktok (Bay Chimo)	5	5
Closed/Past Projects	DEW Line Stations, Snap Lake, Salmita, Tundra	1 or 5*	1 or 5*
Research Camps/Science Station	CHARS, Karrak Lake, Walker Bay	1	1
Exploration Camps	Amuruq, Back River (Goose and George Property), Courageous Lake, Hackett River, Hood River, Izok Corridor (Greys Bay, High Lake, Izok), Kiggavik, Kennady North, Ulu	5	5**
Existing Mines	Existing and Approved Project*** and Diavik, Gahcho Kue, Ekati Diamond Mine, Meadowbank	3 ZOI Scenarios	3 ZOI Scenarios
Existing Roads	Tibbit to Contwoyto Lake Winter Road	3 ZOI Scenarios	3 ZOI Scenarios
Reasonably Forseeable Future Developments	Back River, Courageous Lake, George, Hackett River, Kennady North, Izok Corridor**	n/a	3 ZOI Scenarios
Reasonably Forseeable Future Roads	Bathurst Inlet Port and Road Project	n/a	3 ZOI Scenarios

** Closed mine sites were considered to have a ZOI of 5 km while the smaller DEW line stations were assumed to have a ZOI of 1 km*

*** Several projects currently in the exploration phase will be developed in the future case and thus will have different buffers applied*

**** The Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project*

In addition, the GN requested that two additional scenarios be calculated and discussed in the cumulative effects assessment. Scenario two includes a 5 km buffer surrounding mines and a 1.5 km buffer surrounding roads. Scenario three includes a 14 km buffer surrounding mines and a 4 km buffer surrounding roads. These buffers are considered less likely, since they are reflective of larger industrial projects than the Madrid-Boston Project (Scenario 2) or drawn from either a single source in the scientific literature (Scenario 3) and so do not have the same support from the scientific literature.

- Scenario 1 (likely scenario): 4 km mine/ 1.5 km roads;
- Scenario 2: 5 km mine/ 1.5 km roads; and
- Scenario 3: 14 km mine/4 km roads

The influence of these past, present, and future developments were considered by intersecting the ZOIs with the seasonal ranges of the caribou herds. In some areas, the buffers overlap between developments, such as the Ekati Diamond mine and the Diavik Diamond mine. The areas of overlap were dissolved, with the larger buffers surrounding developments taking precedence over road buffers. Hence, the reported totals for disturbance are areas where overlap have been accounted for.

The evaluation of disturbance is considered in the current case and future case (Table 9.9-5). The Doris Project and Boston exploration camp are considered as part of the existing projects. The addition of the Madrid-Boston Project was considered for both the current and future cases in order to: 1) determine the contribution of the Project to the current case, and 2) determine the contribution of the Project assuming all reasonably foreseeable future projects move forward.

For this exercise and to be precautious, it is assumed that no caribou enter the ZOI area and that the entire ZOI area represents indirect habitat loss. This is a large over-estimate of indirect habitat loss. The wildlife camera program at the Doris Project reported that there are similar densities of caribou near the Doris Project as at control sites further away. Studies of ZOI generally report a 25% to 50% decrease in caribou density near major projects (Section 9.8.3.2).

The areas of habitat around active mines, all season roads, and winter roads that may have reduced habitat quality was compared to the amount of habitat that is available in the seasonal and annual ranges for both the Dolphin and Union (Island) herd and the Beverly and Ahiak (Mainland) caribou sub-populations.

Caribou Encounter Rate and Residency Time in a Zone of Influence

Caribou interactions with the existing Doris Project and proposed Madrid-Boston Project were examined using an encounter rate and residency time analysis.

The Project Development Area (PDA) surrounding the Doris Project (Phase 1), the proposed Madrid-Boston Project (Phase 2) and the additive Hope Bay Project were used to represent the Project location. The analysis used the same ZOIs calculated in Table 9.9-5 with the three ZOI scenarios surrounding mines and roads.

A GIS exercise was used to calculate encounter rate using standard encounter rate techniques. Successive satellite collar locations were connected with a line. A caribou was recorded as "encountering" the Project when that line crossed into the PDA or ZOI. The residency time was calculated as the line length inside the PDA or ZOI, calculated as a proportion of the time between two successive collar locations.

The results of encounter rate and residency time analysis agreed with TK knowledge, information from the caribou workshops, and kernel density mapping conducted for the FEIS. None of the collared female caribou from the three caribou groups interact with the Hope Bay PDA or ZOI during calving, post-calving, or summer. Camera data recorded caribou in the Project RSA during summer, but these animals are typically small groups of males that would not be represented in the collar data because typically only female caribou are collared. Details for each caribou group are presented below.

Indirect Habitat Alteration in a ZOI

Island Caribou (Dolphin and Union herd)

Two spatial boundaries were used for evaluating disturbance to the Island caribou, winter range and the total herd range.

Current Case: The area within the likely disturbance buffer (scenario 1) is 1.08% on the current Dolphin and Union winter range without the Madrid-Boston Project. Adding the Project in the current case would increase this value by 0.24%. ZOI scenarios 2 and 3 produce existing disturbance areas of 1.16%, and 2.00% of the winter range of Beverly caribou. Phase 2 will increase this area by 0.29%, and 1.38%, for scenarios 2 and 3, respectively (Table 9.9-6).

On the annual range, the disturbance buffer under scenario 1 is equivalent to 0.64% of the range without the Madrid-Boston Project, increasing to 0.72% (+0.08%) when the Project is considered. Under ZOI scenarios 2 and 3, the existing disturbance areas are equivalent to 0.67% and 0.94% of the annual range, increasing to 0.76% (+0.09%) and 1.40 (+0.46%), respectively, when the Project is included (Table 9.9-6).

Future Case: The disturbance area without the Project represents 2.40%, 2.55%, and 5.39% of the winter range of Dolphin and Union caribou, with an increase of 0.24%, 0.29%, and 1.38% when the Project is included in Scenarios 1, 2, and 3, respectively (Table 9.9-6). On the annual range, the area inside the ZOIs represents 1.08%, 1.13%, and 2.07% of the habitat due to scenarios 1, 2, and 3, respectively. The addition of the Project would increase these areas by 0.08%, 0.09%, and 0.45% under Scenarios 1, 2, 3, respectively (Table 9.9-6).

Beverly (Mainland) Caribou Sub-population

Two spatial boundaries were used for evaluating disturbance to Beverly caribou, winter range and the total annual range. The winter range is the season when the greatest potential interaction with the Project is expected as determined from satellite collar data (Section 9.8.3.1 and 9.9.5.1). The Project is also evaluated within the annual range to evaluate potential effects at the largest spatial scale possible.

Current Case: The area within the likely disturbance buffer (scenario 1) without the Madrid-Boston Project is 1.16% of the current Beverly winter range. The Phase 2 project will increase this value by 0.08% on the winter range. ZOI scenarios 2 and 3 produce existing disturbance areas of 1.23%, and 2.85% on the winter range of Beverly caribou. Phase 2 will increase this area by 0.11%, and 0.49%, respectively (Table 9.9-7).

On the annual range, there are no additional projects (save for additional area of the Existing and Approved Project) and thus the cumulative disturbance without the Project is the same as on the winter range. The disturbance area without the Project represents 0.80%, 0.86%, and 1.97% of the annual range of Beverly caribou, increasing to 0.86% (+0.06%), 0.93% (+0.07%), and 2.28 (+0.31%) when the Project is included in Scenarios 1, 2, and 3, respectively (Table 9.9-7).

Table 9.9-6. Area of Estimated Disturbance within the Dolphin and Union Caribou CEA Boundaries

		Winter Range					
		Present Case			Future Case		
Project/Timeframe	**Project**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
The Project	Existing and Approved Projects*	26,964	31,804	85,189	26,964	31,804	85,189
	Boston-Madrid	14,858	18,527	88,172	14,858	18,527	88,172
	Hope Bay Project	41,822	50,331	173,361	41,822	50,331	173,361
Present and Future	Back River**	0	0	0	777	1,498	3,543
	Bathurst Inlet Port and Road	0	0	0	721	721	2,244
	Hood River Project	7,679	7,679	7,679	7,679	7,679	7,679
	Izok Corridor (High Lake and Izok Lake)**	18,140	18,140	18,140	100,593	104,343	227,940
	Kingaok	3,568	3,568	3,568	3,568	3,568	3,568
	Omingmaktok	4,649	4,649	4,649	4,649	4,649	4,649
	Ulu Lake Project	7,673	7,673	7,673	7,673	7,673	7,673
	Walker Bay Research Station	310	310	310	310	310	310
Additional Projects/Area in Annual Range							
Past	DEW-Line Stations	1,088	1,088	1,088	1,088	1,088	1,088
Present and Future	Cambridge Bay	53,333	53,333	53,333	53,333	53,333	53,333
Cumulative Areas							
Total Area within Winter Range		83,841	92,350	215,380	167,792	180,772	430,966
% Winter Rage		1.32	1.45	3.38	2.64	2.84	6.77
Total Area within Annual Range		138,262	146,771	269,800	222,213	235,192	485,387
% Annual Range		0.72	0.76	1.40	1.16	1.22	2.52

** Refers to the Doris Project, Hope Bay Regional Exploration Project, Madrid Advanced Exploration Program, and Boston Advanced Exploration Program*

*** Back River and the Izok Corridor Projects are currently in exploration; in the future these projects will be developed.*

Table 9.9-7. Area of Estimated Disturbance within the Beverly Caribou Sub-population CEA Boundaries

		Winter Range					
		Present Case			Future Case		
Project/Timeframe	**Project**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
The Project	Existing and Approved Projects*	14,168	16,292	49,031	14,168	16,292	49,031
	Boston-Madrid	15,121	18,599	88,153	15,121	18,599	88,153
	Hope Bay Project	29,289	34,892	137,184	29,289	34,892	137,184
Past	Salmita/Tundra	309	309	309	309	309	309
	Snap Lake	10,768	10,768	20,582	10,768	10,768	20,582
Present and Future	Back River**	15,465	15,465	15,465	112,527	122,769	283,834
	Bathurst Inlet Port and Road	0	0	0	98,560	98,560	124,556
	Courageous Lake**	16,744	16,744	31,820	25,717	32,031	112,306
	Diavik Mine	13,035	14,303	52,766	13,035	14,303	52,766
	Ekati	36,025	44,707	120,338	36,025	44,707	120,338
	Gahcho Kué	15,086	17,527	76,240	15,086	17,527	76,240
	Hackett River**	7,681	7,681	7,681	38,333	45,461	144,903
	Kennedy Lake	7,599	7,599	7,599	7,599	7,599	7,599
	Kingaok	3,493	3,493	3,493	3,493	3,493	3,493
	Reliance	16,177	16,177	16,177	16,177	16,177	16,177
	Tibbitt to Contwoyto Winter Road	52,564	51,249	112,097	52,564	51,249	112,097
Additional Projects/Area in Annual Range							
The Project	Existing and Approved Projects*	12,796	15,511	28,221	12,796	15,511	28,221
	Boston-Madrid	0	0	0	0	0	0
	Hope Bay Project	12,796	15,511	28,221	12,796	15,511	28,221
Present and Future	Back River**	0	0	0	0	0	603
	Karrak Lake Research Station	0	0	0	309	309	309
Cumulative Areas							
Total Area within Winter Range		224,236	240,915	601,751	459,482	499,845	1,212,384
% Winter Range		1.24	1.34	3.34	2.55	2.77	6.73
Total Area within Annual Range		237,032	256,427	629,971	472,588	515,666	1,241,516
% Annual Range		0.86	0.93	2.28	1.71	1.87	4.50

** Refers to the Doris Project, Hope Bay Regional Exploration Project, Madrid Advanced Exploration Program, and Boston Advanced Exploration Program*

*** Back River, Courageous Lake, and Hackett River Projects are currently in exploration; in the future these projects will be developed*

Future Case: The disturbance area without the Project represents 2.47%, 2.67%, and 6.24% of the winter range of Beverly caribou, with an increase of 0.08%, 0.10%, and 0.49% when the Project is included in scenarios 1, 2, and 3, respectively (Table 9.9-7). On the annual range, the area inside the ZOIs represents 1.66%, 1.80%, and 4.18% of the habitat due to scenarios 1, 2, and 3 in the annual range. The addition of the Project would increase these areas by 0.05%, 0.07%, and 0.32% under Scenarios 1, 2, 3, respectively (Table 9.9-7).

Ahiak (Mainland) Caribou Sub-population

Two spatial boundaries were used for evaluating disturbance to the Ahiak caribou sub-population, winter range and the total annual range. The winter range is the season when the greatest potential interaction with the Project is expected as determined from satellite collar data (Section 9.8.3.1 and 9.9.5.1). The Project is also evaluated within the annual range to evaluate potential effects at the largest spatial scale possible.

Current Case: The area within the likely disturbance buffer (scenario 1) without the Madrid-Boston Project is 1.31% on the current Ahiak winter range. The Phase 2 project will increase this value by 0.08% of the winter range. ZOI scenarios 2 and 3 produce existing disturbance areas of 1.38%, and 3.33% of the winter range of Ahiak caribou. Phase 2 will increase this area by 0.11%, and 0.51%, respectively (Table 9.9-8).

On the annual range, the disturbance area without the Project represents 0.82%, 0.86%, and 2.04% of the range, increasing to 0.86% (+0.04%), 0.92% (+0.06%), and 2.33 (+0.29%) when the Project is included in Scenarios 1, 2, and 3, respectively (Table 9.9-8).

Future Case: The disturbance area without the Project represents 1,42%, 1,54%, and 4.06% of the winter range of Ahiak caribou, with an increase of 0.09%, 0.11%, and 0.51% when the Project is included in Scenarios 1, 2, and 3, respectively (Table 9.9-8). On the annual range, the area inside the ZOIs without the Project represents 1.50%, 1.62%, and 3.84% of the habitat due to scenarios 1, 2, and 3 in the annual range. The addition of the Project would increase these areas by 0.05%, 0.06%, and 0.29% under Scenarios 1, 2, 3, respectively (Table 9.9-8).

Encounter Rate and Residency Time

Encounter rate is measured as the proportion of collared caribou that interact with the zone of influence surrounding existing or proposed projects in the cumulative effects area. Of the animals that interact with a zone of influence, the average number of times that each animal enters the zone is also reported. The residency time is the average duration that caribou that encountered a zone of influence remained in that zone of influence. These values are reported in Tables 9.9-9, 9.9-10 and 9.9-11.

Under the current conditions, the proportion of collars that interact with the hypothetical zones of influence surrounding communities and projects (Table 9.9-5) is 44% for the Dolphin and Union caribou, 42% for the Beverly caribou sub-population and 32% for the Ahiak caribou sub-population. Under future conditions with all reasonably foreseeable projects becoming mines, this proportion increases by 1-2%, per herd.

Residency, the period of time that collared caribou spent inside the zone of influence of communities and projects under the likely scenario (scenario 1) is 3.8 days for the Dolphin and Union caribou herd, 2.1 days for the Beverly caribou sub-population and 2.0 days for Ahiak caribou sub-population. Under future conditions with all reasonably foreseeable projects becoming mines, this proportion increases by approximately 1-2 days for each herd, for total residence times of: Dolphin and Union (4.4 days), Beverly (5.5 days) and Ahiak (3.4 days) (Tables 9.9-9, 9.9-10 and 9.9-11).

Table 9.9-8. Area of Estimated Disturbance within the Ahiak Caribou Sub-population CEA Boundaries

		Winter Range					
		Present Case			Future Case		
Project/Timeframe	**Project**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
The Project	Existing and Approved Projects*	26,964	31,804	85,189	26,964	31,804	85,189
	Boston-Madrid	14,858	18,527	88,172	14,858	18,527	88,172
	Hope Bay Project	41,822	50,331	173,361	41,822	50,331	173,361
Past	Jericho	4,076	4,076	4,076	4,076	4,076	4,076
	Salmita/Tundra	309	309	309	309	309	309
	Snap Lake	12,390	12,390	24,907	12,390	12,390	24,907
Present and Future	Back River**	2	2	2	1,771	3,164	29,683
	Bathurst Inlet Port and Road	0	0	0	5,387	5,387	7,373
	Courageous Lake*	16,744	16,744	31,820	25,717	32,031	95,682
	Diavik Mine	13,035	14,303	52,766	13,035	14,303	52,766
	Ekati	28,071	35,590	101,915	28,071	35,590	101,915
	Gahcho Kué	25,526	25,526	63,132	25,526	25,526	63,132
	Hackett River*	7,681	7,681	7,681	1,169	2,101	17,443
	Izok Corridor (High Lake and Izok Lake)**	0	0	0	9,781	9,781	15,345
	Karrak Lake Research Station	309	309	309	309	309	309
	Omingmaktok	2,032	2,032	2,032	2,032	2,032	2,032
	Reliance	1,018	1,018	1,018	1,018	1,018	1,018
	Tibbitt to Contwoyto Winter Road	85,870	84,555	195,347	85,870	84,555	195,347
Additional Projects/Area in Annual Range							
Past	DEW-Line Stations	632	632	632	632	632	632
Present and Future	Amaruq	8,138	8,138	8,138	8,138	8,138	8,138
	Back River**	0	0	0	84,063	92,192	212,824
	Bathurst Inlet Port and Road	0	0	0	68,193	68,193	79,418
	Gahcho Kué	3,257	3,257	9,751	3,257	3,257	9,751
	Hackett River**	0	0	0	37,164	43,360	127,460
	Tibbitt to Contwoyto Winter Road	12,002	12,002	31,901	12,002	12,002	31,901

Project/Timeframe	Project	Winter Range					
		Present Case			Future Case		
		Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Cumulative Areas							
Total Area within Winter Range		238,887	254,868	658,675	258,284	282,903	784,699
% Winter Range		1.39	1.49	3.84	1.51	1.65	4.57
Total Area within Annual Range		262,916	278,897	709,096	471,734	510,677	1,254,821
% Annual Range		0.86	0.92	2.33	1.55	1.68	4.13

Table 9.9-9. Dolphin and Union Caribou Encounter Rate and Residency Time under Current and Future Conditions with and without the Hope Bay Project

Project	ZOI	% of collars[1]	Average # of encounters per collar[2]	Average Residency (days)[3]	Residency (SE days)[4]	Average Residency (hours)	Average Residency (% of year)	Residency of Average Caribou (% of year)[5]
Current Conditions								
--	1	44.4	3.6	3.8	0.72	91.2	1.04	0.46
Yes	1	47.9	3.8	3.8	0.69	93.1	1.06	0.51
--	2	44.4	3.6	3.8	0.72	93.1	1.06	0.47
Yes	2	49.3	3.9	3.9	0.67	93.9	1.07	0.53
--	3	51.4	4.2	4.7	0.73	114.1	1.30	0.67
Yes	3	52.8	5.4	6.7	0.90	161.6	1.84	0.97
Future Conditions								
--	1	46.5	4.1	4.4	0.70	106.0	1.21	0.56
Yes	1	50.0	4.3	4.4	0.66	106.2	1.21	0.61
--	2	46.5	4.4	4.9	0.77	118.7	1.35	0.63
Yes	2	51.4	4.5	4.8	0.72	116.7	1.33	0.69
--	3	57.6	8.1	13.7	2.33	328.9	3.75	2.17
Yes	3	59.0	9.0	15.2	2.25	366.2	4.18	2.47

[1] Encounters within a year were added.
[2] The average number of encounters (entering the PDA or ZOI) per year.
[3] Of those collars that interacted with a PDA or ZOI, this is the period of time spent in that location. Residency measured as the proportion of line length between two successive collar locations that is inside the PDA or ZOI.
[4] Standard Error of residency time.
[5] The total residency time as a fraction of the total time collars active – represents an "average caribou".

Table 9.9-10. Beverly Caribou Encounter Rate and Residency Time under Current and Future Conditions with and without the Hope Bay Project

Project	ZOI	% of collars[1]	Average # of encounters per collar	Average Residency (days)	Residency (SE days)	Average Residency (hours)	Average Residency (% of year)	Residency of Average Caribou (% of year)
Current Conditions								
--	1	42.2	2.5	2.1	0.30	51.7	0.59	0.25
Yes	1	42.2	2.6	2.1	0.30	52.4	0.59	0.25
--	2	43.1	2.6	2.2	0.32	53.6	0.61	0.26
Yes	2	43.1	2.7	2.2	0.32	54.9	0.62	0.27
--	3	43.1	2.4	8.1	2.03	194.4	2.22	0.96
Yes	3	45.9	2.6	8.3	1.94	200.6	2.29	1.05
Future Conditions								
--	1	39.4	4.7	5.5	0.85	132.8	1.51	0.60
Yes	1	40.3	4.6	5.4	0.84	130.2	1.48	0.60
--	2	40.3	4.5	5.8	0.89	140.3	1.60	0.65
Yes	2	40.3	4.6	5.9	0.89	141.7	1.61	0.65
--	3	47.7	4.4	13.5	2.40	326.0	3.72	1.78
Yes	3	50.4	4.5	13.5	2.28	324.4	3.70	1.87

[1] For an explanation of units, see footnotes on Table 9.9-13.

Table 9.9-11. Ahiak Caribou Encounter Rate and Residency Time under Current and Future Conditions with and without the Hope Bay Project

Project	ZOI	% of collars[1]	Average # of encounters per collar	Average Residency (days)	Residency (SE days)	Average Residency (hours)	Average Residency (% of year)	Residency of Average Caribou (% of year)
Current Conditions								
--	1	31.8	2.5	2.0	0.58	50.2	0.57	0.18
Yes	1	35.1	2.6	2.3	0.55	55.2	0.63	0.22
--	2	31.8	2.3	2.4	0.71	59.1	0.67	0.22
Yes	2	36.2	2.4	2.6	0.64	62.7	0.71	0.26
--	3	32.9	2.6	6.8	2.69	165.3	1.88	0.62
Yes	3	41.7	3.1	8.3	2.19	200.3	2.28	0.96
Future Conditions								
--	1	32.9	3.6	3.4	0.63	80.9	0.92	0.30
Yes	1	37.3	3.5	3.3	0.58	80.0	0.91	0.34
--	2	32.9	3.5	3.6	0.69	87.8	1.00	0.33
Yes	2	38.4	3.4	3.5	0.62	85.3	0.97	0.38
--	3	38.4	4.1	8.6	1.48	206.8	2.36	0.91
Yes	3	47.2	4.3	9.5	1.39	229.5	2.61	1.24

[1] *For an explanation of units, see footnotes on Table 9.9-13.*

An analysis was conducted to determine if the addition of the Hope Bay Project would result in a statistically significant increase in the encounter rate or residency of caribou with the zones of influence surrounding communities and projects. A linear main effects model was fitted to the data where the encounter rate and residency time variables were regressed against the indicator for the existence of the Madrid-Boston Project, herd type, study area, and ZOI scenario. The three caribou herds have different encounter rates, with an estimate of 0.66 (SE = 0.23, p = 0.004; Tables 9.9-9, 10, 11). The addition of the Madrid-Boston Project did not results in a statistically significant increase in encounter rate, with an estimate of 0.23 (SE = 0.15, p = 0.13). However, the addition of all reasonably foreseeable projects in the future did increase encounter rates, with an estimate of 1.68 (SE = 0.16, p <0.0001). The three caribou herds also have different residence times, with an estimate of 1.23 (SE = 0.61, p = 0.04, df = 17; Tables 9.9-9, 10, 11). The addition of the Madrid-Boston Project did not result in a statistically significant increase in residence times with Project ZOIs, with an estimate of 0.37 (SE = 0.41, p = 0.37). However, the addition of all reasonably foreseeable projects in the future did increase residency times, 3.3 (SE = 0.42, p = <0.0001).

Summary of Disturbance

Applying the same disturbance buffers to all mines overestimates the disturbance contribution of small underground mines such as the Hope Bay Project, while underestimating the contribution of larger open pit mines. Hence, the relative contribution of the Hope Bay Project is likely smaller than this analysis suggests.

In the current case, the contribution of the Project accounts for 0.2% or less of the existing predicted disturbance on the winter and annual ranges of the three caribou herds under the likely scenario (4 km mines, 1.5 km roads). Similarly, in the future case, the Project adds 0.2% or less to the predicted

disturbance on the winter and annual ranges of the three caribou herds under the likely scenario (4 km mines, 1.5 km roads).

The crossing rate and residency time analysis indicated that the addition of the Project would not result in a statistically significant increase in encounter rate or residency time for either the current or future cases.

Overall, the areas recorded with the Project ZOI and the cumulative ZOIs of communities and other projects are small compared to the seasonal and annual ranges of the Dolphin and Union (Island) caribou herd and the Beverly and Ahiak (Mainland) sub-populations, but given the importance of caribou, this potential effect of disturbance was rated as a residual cumulative effect.

9.9.5.3 Disruption of Movement

Disruption of movement was rated as a residual effect of the Madrid-Boston Project due to concern for the potential effects of building a new road and the sensitivity of caribou. The cumulative effects for disruption of movement evaluated the proportion of collared caribou that crossed roads and the number of times that they crossed roads. The roads included in the assessment included the existing Tibbitt to Contwoyto Winter Road (TCWR), the winter spur roads from the TCWR to Ekati, Diavik, and Gahcho Kué, and roads within communities. The Meadowbank road falls outside of the herd ranges for this assessment. Future potential roads evaluated included the current winter and all season roads, plus the Izok Corridor all season road, the BIPR all season road, and the winter roads to Back River and Courageous Lake.

This analysis indicates that the absolute proportion of collared caribou that cross roads appears to increase with the Hope Bay Project for the Dolphin and Union herd and Ahiak caribou sub-population, but remain relatively constant for the Beverly caribou sub-population (Table 9.9-12 and 9.9-13). A generalized linear mixed model with a negative binomial distribution was used to evaluate if the crossing rate per collared caribou was affected by either the Hope Bay Project or by the addition of all reasonably foreseeable projects. The crossing rate was different between herds -1.489 (SE = 0.402, p = 0.0002, df = 104). However, the addition of the Hope Bay Project did not increase crossing rates -0.109 (SE = 0.199, p = 0.58), nor did the addition of all other reasonably foreseeable projects 0.016 (SE = 0.193, p = 0.93).

Table 9.9-12. Percent of Collars that Cross Roads in Current and Future Scenarios, with and without the Hope Bay Project

	Dolphin and Union		Beverly		Ahiak	
Project	**Current**	**Future**	**Current**	**Future**	**Current**	**Future**
No Hope Bay	1.4	7.639	15.6	21.1	10.0	13.2
With Hope Bay	9.7	15	19.3	23.8	19.8	24.2

Table 9.9-13. Average Crossings per Collared Caribou that Crossed a Road in Current and Future Scenarios, with and without the Hope Bay Project

	Dolphin and Union		Beverly		Ahiak	
Project	**Current**	**Future**	**Current**	**Future**	**Current**	**Future**
No Hope Bay	2.5	1.5	2.7	6.2	3.7	4.0
With Hope Bay	1.9	1.6	2.8	5.5	3.3	3.4

The Mainland caribou (Beverly and Ahiak sub-populations) that winter in the central barren-ground interact with industrial activity in the Northwest Territories as well as Nunavut and so have higher road crossing rates than the Dolphin and Union caribou. In the future scenario, the Dolphin and Union caribou will interact with the IZOK Corridor road as well as the Project. In the future scenario, the Beverly and Ahiak caribou sub-populations will also interact with the BIPR all season road, Back River winter road, and the TCWR and the spur roads to Ekati, Diavik, Courageous Lake, and Gahcho Kué projects, although it is highly unlikely that all of these projects will be constructed, and if they do that they will operate concurrently.

Mitigations for all season and winter roads are becoming standardized across the Canadian Arctic. Projects are designing road structures that promote caribou crossing, including low height and crossing structures such as ramps and bridges. Projects also typically have vehicle management to warn drivers of caribou on the road, and stop traffic when needed. With these mitigations in place, the potential for adverse effects on caribou populations is diminished. However, due to the concern over this topic, disruption of movement is rated as a residual cumulative effect.

9.9.5.4 Effects on Caribou Populations

The potential effects of the Hope Bay Project on caribou energetics, female reproductive output, and population were modeled to evaluate the potential effects of the Project on the size of the caribou herds. Two modeling approaches were used by two caribou biologists, both regarded as experts in energetics modeling; the Caribou Cumulative Effects Model and the Energetics Assessment Model.

Satellite collar data for the Island caribou (Dolphin and Union herd) and Mainland caribou (Beverly and Ahiak sub-populations) was used to evaluated the encounter rate and residency time of caribou inside the zone of influence of the Project. Three zones of influence were used to calculate encounter rate when discussing disturbance to caribou (Section 9.8.3.2) and are used here as well for the modeling exercise.

Cumulative effects were also evaluated using both models. The effects on caribou energetics, reproductive output and herd size were modeled for the current conditions in each herd's range. Caribou populations were also modeled for future conditions with all reasonably foreseeable projects operating concurrently. Zones of influence for communities, roads and industrial projects are described in Section 9.9. Both current conditions and future conditions were modeled with and without the Hope Bay Project to evaluate the impact of the Project on caribou populations.

Despite taking different modeling approaches, the two models produced the same results:

- The Hope Bay Project alone will not affect the population size of the Beverly, Ahiak or Dolphin and Union herds.
- The addition of the Hope Bay Project to the current conditions, with disturbance effects from communities and industrial projects does not affect the population size for any of the three herds.
- The addition of the Hope Bay Project to future conditions, with disturbance from communities and all reasonably foreseeable future projects does not affect the population size for any of the three herds.

The details of the modeling approaches and results are discussed in Section 9.8.3.8

9.9.6 Significance of Cumulative Residual Effects

After the application of mitigation and management measures, three residual effects were predicted for caribou due to the Madrid-Boston Project in the caribou effects assessment (Section 9.8.4): habitat loss, disturbance, and disruption of movement. These three residual effects were carried forward to the cumulative effects assessment, evaluated in combination with all other current and reasonably foreseeable future projects. All three potential effects were rated as residual cumulative effects and the significance of effects is evaluated in this section and summarized in Table 9.9-14.

9.9.6.1 Habitat Loss

Habitat loss was selected as a residual cumulative effect for the Island and Mainland caribou herds for scenarios with and without Phase 2 Project. Overall, cumulative habitat loss represents <0.1% of the habitat available to these herds in the seasonal ranges that are most likely to interact with the past, present, and likely future projects considered in this assessment, and the Madrid-Boston Project contributes 0.02% or less to the cumulative habitat loss for all caribou herds.

The magnitude of this potential effect is considered to be negligible for the Island caribou (Dolphin and Union herd) and the Mainland caribou (Beverly and Ahiak sub-populations). The proportions of the seasonal and annual herd ranges that will be impacted are very small, and unlikely to result in measurable herd-level population changes. This magnitude rating reflects the sensitivity and resilience of the caribou herds. Caribou are expected to have a low sensitivity to the effect of small areas of habitat loss because currently, there is virtually no existing habitat loss for these herds. Research indicates that the sensitivity to habitat loss occurs at much higher levels of habitat loss (e.g., 35% lost; Environment Canada 2012). Dolphin and Union caribou is currently listed as Special Concern and was upgraded to Endangered by COSEWIC due to concerns over climate change and ice-breaking shipping affecting the winter sea ice used for spring and fall migration by this herd. However, the Dolphin and Union management plan did not identify habitat loss as a high priority threat to the herd; as such, Dolphin and Union caribou are expected to have some resilience to adapt to habitat changes. The Beverly and Ahiak sub-populations are expected to be resilient to the loss of small areas of habitat, given their higher overall population sizes, and their large and flexible herd range (Section 9.2.6.1).

The duration of the effect is long term (beyond the life of the projects). The frequency of habitat loss will be sporadic during Construction phase of projects. The extent of the effect of habitat loss is local as it will occur close to project footprints. The effect is rated as irreversible because even with reclamation activities, the footprint areas will not return to baseline habitat conditions.

The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, because the effect of habitat loss was converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible. Confidence in the area and proportion removed is considered high because the area removed is well understood, as are the seasonal and annual herd ranges from which the proportion of loss is calculated.

As a result, the cumulative residual effect of habitat loss for all caribou herds is concluded to be **Not Significant**.

Table 9.9-14. Summary of Cumulative Residual Effects to Caribou and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Negligible	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Regional	Reversible	Moderate	Medium	N
Disruption of movement	Negative	Low	Medium	Sporadic	Regional	Reversible	Moderate	Medium	N

9.9.6.2 Disturbance

Habitat loss was selected as a residual cumulative effect for the Dolphin and Union, Beverly and Ahiak caribou herds for scenarios with and without Phase 2 Project. Disturbance may cause caribou to avoid project sites, resulting in a zone of influence (ZOI) where fewer caribou occur near projects. Using the likely 4 km ZOI for mines and 1.5 km ZOI for roads scenario, habitat avoidance due to disturbance represents 1.4% or less of the habitat available to these herds in the seasonal ranges that are most likely to interact with the past, present, and likely future projects considered in this assessment in the current case, and 2.6% or less of the habitat available in the future case.

Estimates of habitat loss due to disturbance are likely conservative (i.e., overestimates) because the same disturbance buffer was applied to all projects, regardless of size. The Hope Bay Project is a small underground mine compared to open pit mines in Nunavut and the Northwest Territories.

The effect of disturbance on caribou is considered negative because it has the potential to reduce habitat quality. The area where caribou may be disturbed by communities or industrial activities (with and without the Hope Bay Project) is negligible relative to the amount of habitat in each of the CEA boundaries assessed for caribou. In addition, energetics modeling indicated that the Hope Bay Project would not have an effect on caribou populations under the current or future scenarios.

Under the likely ZOI scenario (scenario 1), the area of habitat within the ZOIs of all projects combined is small, 1.4% or less for all projects combined in the current case and 2.6% or less in the future case. Moreover, a statistical analysis indicated that the addition of the Madrid-Boston Project would not result in increased encounter rates and residency times inside project ZOIs. These disturbance numbers are cautious and conservative, because they use ZOI buffers that have been conservatively chosen to be larger than anticipated effects. The assessment is also conservative by including all reasonably foreseeable projects operating in the future, which is a large over-estimate since most will not be constructed and it is very unlikely that even if they were all constructed that they would all operate concurrently.

Thus, the magnitude of the cumulative residual effect is considered low. This magnitude rating reflects the sensitivity and resilience of the caribou herds (Section 9.9.6.1).

The duration of the effect is medium as the effect will stop when the projects are closed. The frequency is sporadic, as disturbance will occur intermittently during events that produce noise such as blasting, passing vehicles or aircraft overflights. The geographic extent of the effect of disturbance is regional. The effect is considered reversible, because areas will return to existing baseline condition and animals will likely return when the disturbance has ceased.

The probability of the effect occurring is moderate because disturbance is predicted to affect caribou. The confidence of the effect occurring is considered medium because the effect of habitat disturbance was converted into area calculations that used ZOI values that are larger than what is likely actually occurring for caribou. Confidence in the area and proportion disturbed is considered medium as it is anticipated that a much smaller proportion of the area will be disturbed.

As a result, the cumulative residual effect of disturbance for all caribou herds is concluded to be **Not Significant**.

9.9.6.3 Disruption of Movement

Disruption of movement was selected as a residual cumulative effect for the Dolphin and Union, Beverly and Ahiak caribou herds for scenarios with and without Phase 2 Project. Disruption of

movement was evaluated by measuring the proportion of collared caribou that crossed the routes of the Project Boston road, existing roads and proposed roads. Both all season and winter roads were included in the analysis.

A statistical analysis indicated that the crossing rate of caribou would not increase with either the Hope Bay Project or additional reasonably foreseeable future projects. Mitigation for road crossings is relatively standard across the mining industry and studies have shown that this mitigation is successful; 99% of caribou who attempted to cross the Ekati road were successful, and only 1% of caribou turned back from crossing the road. Therefore the magnitude of this potential effect is rated as low magnitude negative effect. This magnitude rating reflects the sensitivity and resilience of the caribou herds (Section 9.9.6.1).

The duration of the effect is medium as the effect will stop when the projects are closed. The frequency is sporadic, as disruption of movement will occur intermittently when caribou encounter roads. The geographic extent of the effect of disturbance is regional. The effect is considered reversible, because areas will return to existing baseline condition and animals will likely return when the disturbance has ceased.

The probability of the effect occurring is moderate because some caribou are reported to hesitate or turn back from crossing roads. The confidence of the effect occurring is considered medium because the scientific understanding of the effect has some uncertainty. Confidence in the effect is considered medium for the same reasons.

As a result, the cumulative residual effect of disruption of movement for all caribou herds is concluded to be **Not Significant**.

9.9.7 Transboundary Effects

The residual effects of habitat loss, disturbance and disruption of movement were evaluated for the Island caribou (Dolphin and Union herd) and the Mainland caribou (Beverly and Ahiak sub-populations) across their seasonal and annual ranges, all three of which extend into the Northwest Territories. The results of this analysis indicated that these residual effects would be Not Significant for all three herds. Since the cumulative effects study area extended into the Northwest Territories, the conclusions of the cumulative effects assessment also apply to transboundary effects and are predicted to be **Not Significant** for the Island and Mainland caribou herds.

9.10 GRIZZLY BEAR – EFFECTS ASSESSMENT

9.10.1 Introduction

Potential Phase 2-related effects on grizzly bear were considered for locations where they may interact with the Project. Potential effects on grizzly bear and grizzly bear habitat were included based on Inuit TK, community concerns expressed at Project scoping meetings, professional judgement, experience at other similar projects in Nunavut and the scientific literature (Section 9.6).

Potential Phase 2 and Hope Bay Project effects were evaluated, making reference to season, and mine Phase (i.e., Construction, Operation and Reclamation/Closure Phases) for grizzly bear. The following potential effects were evaluated:

- habitat loss;
- disturbance;

- disruption of movement;
- attraction to the Project;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Habitat loss for grizzly bears can occur directly where land is modified for the Project footprint, particularly in areas of suitable denning and foraging habitat. For this reason, habitat loss was evaluated in this assessment. Bear habitat will be removed and replaced by infrastructure, and habitat near infrastructure may be degraded during Project Operations within the PDA.

The NIRB guidelines included disturbance due to noise as a potential effect for wildlife, including grizzly bears. Therefore, potential effects due to disturbance were included in the assessment for grizzly bears.

Grizzly bears maintain large home ranges that contain separate seasonal habitats that are used throughout the year. Juvenile bears may disperse over long distances from their natal home ranges to establish their own home range. Disruption to movement was evaluated as a potential effect on grizzly bears because population-level consequences to grizzly bears may arise when movements through home ranges, and movements for dispersal, are disturbed or impeded (Proctor, McLellan, and Strobeck 2002; Proctor et al. 2012).

Direct mortality is typically a result of vehicle strikes with wildlife. Frequency of mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected that the risk of injury or death will increase as traffic volume and vehicle speed increase. Since the Project will use all-season roads, the potential effect of direct mortality is included in the assessment.

Increased access and harvest includes increased mortality due to hunting if access is facilitated by the proposed Madrid to Boston all weather road. In southeastern Alaska, where grizzly bears are legally hunted, there was a direct positive correlation between bear kills by hunters and cumulative kilometres of constructed roads that are open to the public (Titus and Beier 1991). Roads increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, increased access and harvest was included as a potential effect in the assessment.

Camps and landfills may attract grizzly bears and subsequently lead to increased human-bear interactions and grizzly bear mortality. Elders and harvesters who participated in the caribou workshop in September, 2016 in Cambridge Bay identified the potential for bears to be attracted to the Project site as a concern and identified effective mitigation and management as important for the Project to reduce this potential effect on grizzly bears. Scientific studies (Herrero 1985) and TK (KIA 2012) indicate that grizzly bears can be attracted to human settlements in search of food. Benn and Herrero (2002) reported that over 70% of bear mortalities involved habituated bears. Bears are particularly attracted to landfills, as well as aromatic waste material such as oils and aerosols. This attraction to project sites increases the potential for wildlife-human interaction and therefore an increased potential for grizzly bears to become nuisance animals. Thus, the effect of attraction is included as a potential effect in the assessment.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This

potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into Post-Closure.

9.10.2 Identification of Mitigation and Management Measures for Grizzly Bear

9.10.2.1 Mitigation by Project Design

Mitigation by Project design that is applicable to all wildlife includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive wildlife areas;
- ensuring that waste management facilities and Project buildings are wildlife-proof; and
- Maintaining equipment to minimize noise that may disturb wildlife.

9.10.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- Employee education on their responsibilities to reduce potential effects on wildlife;
- Policies that prohibit hunting on site, littering, and feeding of wildlife;
- Avoiding disturbance to wildlife by aircraft;
- Speed limits, giving wildlife the right of way, and dust control on roads;
- Camp management, waste management; and
- Oil and shipboard pollution plans, spill contingency plan, and hazardous materials management.

Mitigation for Habitat Loss

Mitigation and management to reduce the potential effect of habitat loss includes:

- infrastructure will avoid sensitive grizzly bear habitat such as denning habitat, where possible;
- Pre-construction surveys if ground clearing occurs during the specified period. The establishment of a buffer around active grizzly bear dens. Should a 1 km buffer surrounding an active bear den be impractical for construction purposes, TMAC will work with qualified personnel and the GN-DoE to designate an appropriate setback distance for the specific circumstances; e.g. the specific planned activities and risk of disturbance to the den.
- The Nunavut Government will be contacted to determine whether a permit to remove an inactive the den site is required. If so, then a permit will be obtained. Den sites are protected under the *Nunavut Wildlife Act* but evidence suggests that bear dens usually collapse in the spring and do not receive use in multiple years, unlike the den sites of other carnivores; and
- minimize the size of Project.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on grizzly bear includes:

- pre-Construction ground clearing in areas likely to support grizzly bear dens conducted during denning periods for grizzly bears, where possible, to reduce disturbance to grizzly bears;

- construct and maintain equipment to minimize the production of noise – see Volume 4, Section 3;
- monitor and adaptively manage noise;
- pilot education about the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed (Volume 8 Annex V8-8);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to grizzly bears; and
- vehicles restricted to site roads and quarry footprints during Construction and Operations to avoid unnecessary disturbance to grizzly bear habitat.

Mitigation for Disruption to Movement

Mitigation and management to reduce the potential disruption of movement to grizzly bear include:

- setting and enforcing speed limits; and
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area).

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for grizzly bear include:

- enforce speed limits on all Project roads;
- grizzly bear will be given the right-of-way on all roads; and
- employee education of the importance of speed limits and avoiding wildlife.

Mitigation for Increased Access and Harvest

Mitigation and management to minimize the potential for increased access and harvest of grizzly bear include:

- no connection of all-weather roads to any communities
- all Project roads closed to the public; and
- a policy prohibiting hunting by Project staff and contractors while on site.

Mitigation for Attraction

Mitigation and management to minimize potential for grizzly bears to be attracted to the Project infrastructure include:

- all buildings will be wildlife-proof;
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants;
- relevant employees and contractors trained in bear safety procedures;
- a policy of no feeding of wildlife and no littering;

- monitoring of waste management and camps; and
- the development of a problem bear management program to minimize attraction of bears and manage non-lethal responses should any bear become attracted to site.

Mitigation for Exposure to Altered Environmental Media Quality

Mitigation and management measures to reduce the potential for exposure of grizzly bear to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, Annex V1-7, P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);
- fuels and chemicals are stored in wildlife-proof buildings;
- a policy of no feeding, no littering, and no intentional attraction of wildlife developed and communicated to all Project and contractor employees;
- cyanide destruction inside the mill;
- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.10.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for grizzly bear will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, waste management, vehicle-wildlife collisions, water quality and incidental observations.

Monitoring specific for grizzly bear will include:

1. monitoring and reporting the size of the Project footprint;
2. monitoring the camps and buildings to confirm the site is clean and the buildings are wildlife-proof;
3. local-area scans prior to blasting;
4. incidental observations are reported;
5. activity monitoring using motion-triggered cameras to determine if bears are attracted to specific site infrastructure, such as the waste management facility; and
6. monitoring for a zone of influence where bears may be avoiding the Project site.

9.10.3 Characterization of Potential Project-related Effects

9.10.3.1 Habitat Loss

This section evaluates the potential effect of the loss of grizzly bear habitat due to the Construction and Operation of Phase 2

and the Hope Bay Project. The area considered lost is measured within a Project Development Area (PDA), which is the proposed footprint of the Project plus a buffer averaging 250 m radius around infrastructure and 100 m radius around roads. This assessment evaluates the potential loss of grizzly bear habitats identified by Inuit TK, foraging habitat, and special landscape features.

Grizzly Bear Habitat Identified by Inuit TK

The importance of the Bathurst Inlet area for caribou meant that the entire region was also important for carnivore species. TK has noted large increases in numbers of carnivores in recent years, especially wolves and grizzly bears (Banci and Spicker 2016). Elders and harvesters who participated in the caribou workshop identified the same trends in bear population (ERM 2016d). Grizzly bear were important animals for Inuit and there are many legends about them (Banci and Spicker 2016).

TK indicates that grizzly bears were rare in the 1970s. Today, grizzly bears are distributed throughout the west Kitikmeot, and occasionally seen on Victoria Island. The increase in population was especially evident in coastal areas. Inuit thought that frequent forest fires may have been responsible for driving grizzly bears further north.

Typically grizzly bears are seen in spring and fall, during fish spawning runs, and during caribou migration. Grizzly bears are associated with major river systems and their watersheds, as well as the coast. Dens are typically located in upland areas, along river slopes, and along the coast. No denning areas were identified in the LSA; two denning areas were identified near the coasts in the RSA.

Loss of Foraging Habitat

This assessment includes loss of grizzly bear foraging habitat that was measured using habitat suitability modeling. This mapping rated the foraging quality of different vegetation communities in each season and mapped these areas using vegetation mapping conducted as part of the Northwest Territories Department of Resources, Wildlife, and Economic Development (RWED) Ecological Land Classification (ELC) for the Slave Geological Province (Matthews, Epp, and Smith 2001). The methods for habitat suitability mapping are described in detail in the Habitat Suitability Baseline (Rescan 2011h) and summarized in the environmental setting for grizzly bear (Section 9.2.8.2).

The habitat suitability mapping rated grizzly bear habitat for spring, summer, and fall using a four part scale of high, moderate, low and nil. The Project PDAs were overlain on the habitat suitability mapping and the area of good quality habitat (high and moderate habitat combined) is reported relative to the LSA and RSA.

Spring

The total area of good quality habitat lost due to Phase 2 will be 1,338 ha, which is 6.6% of the good quality habitat in the LSA and 0.5% of that in the RSA (Table 9.10-1). This area of habitat loss represents a small proportion of the habitat available to grizzly bears in the RSA. This loss is unlikely to adversely affect grizzly bears.

Table 9.10-1. Good Quality Grizzly Bear Spring Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost (ha)			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		164	164		0.8	0.8		0.1	0.1
Doris + TIA	64	207	271	0.3	1.0	1.3	<0.1	0.1	0.1
Existing Boston Exploration Camp	1		1	<0.1		<0.1	<0.1		<0.1
Madrid North		40	40		0.2	0.2		<0.1	<0.1
Madrid South		34	34		0.2	0.2		<0.1	<0.1
Madrid-Boston Road		893	893		4.4	4.4		0.3	0.3
Total	**66**	**1,338**	**1,404**	**0.3**	**6.6**	**6.9**	**<0.1**	**0.5**	**0.5**

[1] *Area of good quality spring habitat in the LSA = 20,287 ha*
[2] *Area of good quality spring habitat in the RSA = 272,214 ha*
[3] *Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration*

The total area of good quality habitat lost due to the Hope Bay Project will be 1,404 ha, which is 6.9% of the good quality habitat in the LSA and 0.5% of that in the RSA. This area of habitat loss is a small proportion of the habitat available to grizzly bears in the RSA and is very unlikely to adversely affect grizzly bears.

Summer

The total area of good quality summer habitat lost due to Phase 2 will be 3,078 ha, which is 8.1% of the good quality habitat in the LSA and 1.4% of that in the RSA (Table 9.10-2). The total area of good quality habitat lost due to the Hope Bay Project will be 3,198 ha, which is 8.5% of the good quality habitat in the LSA and 1.4% of that in the RSA. This area of habitat loss represents a small proportion of the habitat available to grizzly bears in the RSA and is unlikely to adversely affect grizzly bears.

Fall

The total area of good quality fall habitat lost due to Phase 2 will be 3,195 ha, which is 7.9% of the good quality habitat in the LSA and 1.4% of that in the RSA (Table 9.10-3). The total area of good quality habitat lost due to the Hope Bay Project will be 3,326 ha, which is 8.3% of the good quality habitat in the LSA and 1.5% of that in the RSA. This area of habitat loss represents a small proportion of the habitat available to grizzly bears in the RSA and is very unlikely to adversely affect grizzly bears.

Loss of Winter Denning Habitat

The total area of good quality denning habitat lost due to Phase 2 will be 445 ha and 466 ha for the Hope Bay Project, which is 0.5% of the good quality habitat in the RSA (Table 9.10-4). Denning habitat is abundant on the landscape and the area of habitat loss represents a small proportion of the habitat available to grizzly bears in the RSA, and so is very unlikely to adversely affect grizzly bears of the bear population.

Summary of Habitat Loss

Conservative estimates of habitat loss for grizzly bear indicate that the loss of higher value habitat is up to 1.5% of what is available in the wildlife RSA. The area of higher quality habitat relative to the amount in the average home ranges of male and female grizzly bears amounts to 0.4% and 1.5% of the estimated good habitat in those ranges, respectively, assuming the proportions of good habitat within home ranges are similar to that modelled within the RSA (~45%). In all cases, the actual area lost will be much smaller as the design of the Project footprint is much smaller (approximately 30% of the PDAs) than the PDAs assessed as lost. Though mitigation designed to minimize the mine footprint will reduce habitat loss for grizzly bear, some small amounts of habitat loss may occur and thus **habitat loss is considered a residual effect**.

9.10.3.2 Disturbance

This section evaluates the potential effects of Project-related disturbance on grizzly bears. Phase 2 will produce noise from blasting in above-ground quarries, constant facilities noise, and noise from aircraft. Above ground-blasting is planned for a series of quarries at Doris, Madrid, and Boston sites and along the Boston road. Above-ground blasting will occur during the Construction Phase of Phase 2 and intermittently as borrow material is required during the Operations Phase. Quarries will be used sequentially during Construction. Hence, at any one time, the effects of noise from quarry blasting will occur at only one location. Facility noise will be produced by diesel power generators located inside buildings, ventilation equipment for the underground mine, the indoor mill and the use of heavy equipment and vehicles. Aircraft will land and take off from the Boston and Doris sites at an average of four flights per week total for the two sites.

Table 9.10-2. Good Quality Grizzly Bear Summer Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost (ha)			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		337	337		0.9	0.9		0.2	0.2
Doris + TIA	118	440	557	0.3	1.2	1.5	0.1	0.2	0.3
Existing Boston Exploration Camp	2		2	<0.1		<0.1	<0.1		<0.1
Madrid North		123	123		0.3	0.3		0.1	0.1
Madrid South		105	105		0.3	0.3		<0.1	<0.1
Madrid-Boston Road		2,073	2,073		5.5	5.5		0.9	0.9
Total	**120**	**3,078**	**3,198**	**0.3**	**8.1**	**8.5**	**0.1**	**1.4**	**1.4**

[1] *Area of good quality summer habitat in the LSA = 37,824 ha*
[2] *Area of good quality summer habitat in the RSA = 221,903 ha*
[3] *Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration*

Table 9.10-3. Good Quality Grizzly Bear Fall Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		335	335		0.8	0.8		0.1	0.1
Doris + TIA	129	448	577	0.3	1.1	1.4	0.1	0.2	0.3
Existing Boston Exploration Camp	2		2	<0.1		<0.1	<0.1		<0.1
Madrid North		123	123		0.3	0.3		0.1	0.1
Madrid South		111	111		0.3	0.3		<0.1	<0.1
Madrid-Boston Road		2,178	2,178		5.4	5.4		1.0	1.0
Total	**132**	**3,195**	**3,326**	**0.3**	**7.9**	**8.3**	**0.1**	**1.4**	**1.5**

[1] *Area of good quality fall habitat in the LSA = 40,256 ha*
[2] *Area of good quality fall habitat in the RSA = 224,335 ha*
[3] *Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration*

Table 9.10-4. Good Quality Grizzly Bear Denning Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost (ha)			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		19.9	19.9		0.2	0.2		<0.1	<0.1
Doris + TIA	20.6	97.9	118.6	0.2	1.1	1.3	<0.1	0.1	0.1
Existing Boston Exploration Camp	0.4		0.4	<0.1		<0.1	<0.1		<0.1
Madrid North		16.0	16.0		0.2	0.2		<0.1	<0.1
Madrid South		7.2	7.2		0.1	0.1		<0.1	<0.1
Madrid-Boston Road		303.6	303.6		3.3	3.3		0.4	0.4
Total	**21.0**	**444.6**	**465.6**	**0.2**	**4.9**	**5.1**	**<0.1**	**0.5**	**0.5**

[1] *Area of good quality summer habitat in the LSA = 9,132.2ha*
[2] *Area of good quality summer habitat in the RSA = 86,730.7 ha*
[3] *Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration*

Some research reports that grizzly bears are sensitive to disturbance at their dens, resulting in bears abandoning their dens (H. V. Reynolds, Curatalo, and Quimby 1976) and potentially their young (Schoen et al. 1987), as well as potential displacement from high-quality denning habitats (Craighead Jr. and Craighead 1972; Linnell et al. 2000). However, research has shown that hibernating bears are unlikely to be disturbed by anything but extreme noise events (Amstrup 1993; Linnell et al. 2000). Even the noise resulting from blasting may have a limited effect on hibernating grizzly bears, as the dens are usually acoustically isolated when covered with snow (Linnell et al. 2000). Good quality grizzly bear denning habitat is mapped across roughly one-fifth of the wildlife LSA and RSA, with the highest quality habitat (high value) mapped along major river corridors such as the Koignuk and Angimayak Rivers and along eskers (< 2% of the LSA and RSA). The majority of the good quality habitat near the Project is considered to be moderate value habitat (Figure 9.2-28), which is mapped along smaller watercourses where suitable habitat for denning (i.e., sandy areas) may be more limited (Section 9.2.8.2). Plate 9.10-1 shows an example of habitat along a smaller watercourse that may provide some denning habitat value.



Plate 9.10-1. Potential grizzly bear denning habitat along Boulder Creek(rated as moderate value habitat).

With mitigation, disturbance due to Project-related activities conducted during the denning period (November to May) is not anticipated to result in a residual effect to grizzly bears and is not discussed further.

Recent modeling based on GPS data acquired over a nine-year period determined that grizzly bear home ranges in the foothills of Alberta overlapped open-pit coal mine sites during both inactive and active phases of mining, with the greatest overlap recorded for females with cubs (Cristescu, Stenhouseb, and Boyce 2015). The authors further suggest some level of tolerance by females with cubs relative to males and single females given shorter overall movements within the mine disturbance limit, and a larger proportion of movements within the disturbance limit rather than simply moving through the area.

Females with cubs may be seeking areas near mines as a refuge (Cristescu, Stenhouseb, and Boyce 2015). Habitat selection by grizzly bears was also demonstrated to be highly variable across sexes and reproductive states relative to open pit mining in the foothills of Alberta where grizzly bear densities (4.9 / 1,000 km2; Cristescu et al. 2016) are similar to those in Nunavut and the NWT. Additional telemetry work on grizzly bears that overlapped two active open pit mining operations in the foothills of Alberta concluded that although active mining may present inherent temporary habitat loss and episodic local movement barriers, such as the mining pits themselves, mining land use has not resulted in landscape level movement barriers for grizzly bears (Symbaluk 2008). Continued use of good habitat indicates no sign of displacement and repeated grizzly bear crossings have occurred across the active haul road.

Similarly, observational evidence from large open pit mining operations in the central barrens of the NWT indicates ongoing use of high value habitats in areas adjacent to the mines (e.g., Diavik and Ekati diamond mines). Grizzly bears are regularly observed crossing a 26 km haul road at the Ekati Diamond Mine in the NWT (ERM 2015c). DNA evidence indicates that despite ongoing mining exploration and the operation of two large open pit diamond mine operations since the late 1990s, grizzly bear populations in the NWT are either stable or increasing (ERM 2015c) since the last population estimate in the late 1990s (McLoughlin and Messier 2001). These large open-pit diamond mines are an order of magnitude larger than the Hope Bay Project. Moreover, the Hope Bay Project is an underground mine, further reducing potential disturbance.

Grizzly bears are known to occupy areas of elevated noise and to approach camps and active mines in the Canadian Arctic. In the absence of an observed population level effect from large open pit mines in Alberta and the Slave Geological Province, evidence suggests that the effect of **sensory disturbance is not anticipated to result in a residual effect** on grizzly bears.

9.10.3.3 Disruption of Movement

Grizzly bear will be present and active on the tundra between April and October. The potential for Phase 2 infrastructure to disrupt movement is evaluated in this section. Disruption to movement is evaluated to begin during the Construction Phase of the Project when roads and infrastructure are built and continuing during the Operational and Reclamation and Closure Phases of the Project. During Post-Closure, when traffic ceases, the potential for disruption of movement will likewise cease.

Movement can be disrupted by linear corridors such as roads which can be barriers to movement for some wildlife species (Jalkotzy, Ross, and Nasserden 1997). Data collected from a variety of locations suggests that road traffic on the order of 4,000 to 10,000 vehicles per day begin to impose a barrier to movement to most large wildlife species, whereas roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). Studies of grizzly bear populations living in areas with high traffic roads (e.g., highways) and road networks show that grizzly bear behaviour is affected by traffic volume, with a preference for using areas near and crossing roads with lower overall traffic volumes. For example, in southern Alberta, Northrup et al. (2012) concluded that collared grizzly bears strongly avoided roads with more than 100 vehicles per day and preferred areas near roads where the traffic levels were less than 20 vehicles per day. In Montana, Waller and Servheen (2005) suggested that grizzly bear movements may be inhibited when traffic levels were near 100 vehicles per hour. However, these two studies are conducted in areas where there are extensive road networks, and where a variety of human uses, such as industrial and forestry activities, recreation, and hunting, occur along these road networks. Northrup et al. (2012) did note that recreation and hunting did take place from public roads and trails within the study area, which is likely to influence avoidance behaviour. Therefore, these studies and the observed grizzly bear responses cannot be extended to the Project, which consists of single lane unpaved road that is not connected to any other permanent road

networks and all the surrounding habitats that are used by the grizzly bear population are undeveloped and used on an infrequent basis for hunting. Bears are observed crossing the 29 km haul road at the Ekati Diamond Mine in NWT, which carries traffic in excess of 100 vehicles/day during certain times of the year (e.g., ERM Rescan 2014b).

At peak traffic rates (years 5 and 6) the proposed 53 km road from Boston to Madrid will make up 85% of the Boston to Doris road and will carry approximately 33 return trips per day; 2.8 one-way vehicle trips per hour. The existing 9.5 km road from Madrid to Doris, makes up approximately 15% of the Boston to Doris road, will carry traffic both for Boston and Madrid, with approximately 98 return trips per day during Years 5 and 6; or an average of 8.2 vehicle trips per hour. The existing 4.8 km road from Doris to Roberts Bay, over which fuel and other supplies for Phase 2 are transported, will carry approximately 12 return trips per day during Years 5 and 6, or on average 1 vehicle trip per hour.

Mitigation will include design of the road to be low and have crossing structures, with management of speed limits to 50 kph and wildlife given the right of way. The level of vehicle traffic along all segments of existing and proposed Project roads during the life of the Project is below the traffic volumes reported to cause wildlife to avoid crossing roads as reported by Müller and Berthoud (1997). Traffic volumes along the short segment of existing road between Doris and Madrid are above the level reported by Northrup et al. (2012), although as discussed above that study was conducted in a heavily roaded area that is not comparable to the Project site and bears cross Arctic roads with more traffic. Despite this, and to be conservative, a residual effect is predicted for disruption of movement of grizzly bear.

9.10.3.4 Attraction to the Project

Wildlife attractants refer to Project-related human activities, infrastructure, or environmental changes that are of interest or provide resources to wildlife. Changes in spatial distribution and habitat selection have been observed for species attracted to anthropogenic activity, but mortality is perhaps of greater concern. Grizzly bears may be attracted and become habituated to Phase 2 due to the camps and other facilities that could create odours. Habituated bears can pose a threat to the safety of personnel which often necessitates relocation or destruction of these animals (Gibeau and Herrero 1998). While relocation of habituated or food-conditioned bears reduces the chances of an immediate negative attraction, bears are moved into territories that are either occupied by other bears or have relatively less suitable habitat which may lead to decreased survival (Blanchard and Knight 1995). In some cases, bears that are attracted to human activity centres and are perceived as a threat to life or property are destroyed. The effect of attraction is anticipated to commence upon Construction when the camps are in use and continue throughout Operation and Reclamation/Closure Phases of the Project while odorous materials are present on site.

The management of attraction for bears can be visualizes as a triangle of mitigation and monitoring:

1. The base of the triangle represents management of wastes and camp cleanliness (most frequent). Phase 2 will actively manage wastes and camps, including inspections of waste facilities and camps to reduce the chance of attracting bears. Observations of misdirected wastes or observations of bears near the site will prompt re-assessments of mitigation actions and adaptive management. The majority of management and monitoring is directed here, at the base of the triangle.
2. The middle of the triangle represents responses to observations of bears on site (infrequent). Should bears be observed repeatedly on site, management will include re-assessments of mitigation actions to reduce attractants and may include deterrence for bears.

3. The top of the triangle represents responses to habituated bears (rare). Should bears become habituated and not respond to either enhanced management to remove attractants or active deterrence, then bears may be relocated or destroyed.

The Project will have in place a number of mitigation measures to limit the attractiveness of the site to grizzly bear. These will include standard mitigation techniques such as: incinerating food wastes, managing garbage and scents, etc. Project activities will adhere to the Hope Bay Interim Non-Hazardous Waste Management Plan, Incineration Management Plan and the WMMP (Volume 8, Annex V8-3) which include mitigation measures to store and remove all food wastes and wildlife attractants, erect bear fences in appropriate areas, remove carrion from roads, and monitor the waste management facilities. In addition, Hope Bay Project Hazardous Waste Management Plan ensures that all chemicals will be contained and properly stored so that grizzly bears will not have access to these substances. Mitigation measures such as employee education in wildlife awareness and protocols in dealing with nuisance bears may also be implemented in the WMMP.

A review of existing developments indicates that strict compliance with waste management and site cleanliness policies will result in low incidences of grizzly bears being attracted to project sites. For example, during construction and operations at the Diavik Mine (2000 to present), incidental observations by staff and environment personnel recorded variable numbers of grizzly bear on or near the project site, ranging from 5 individuals up to 97 (Golder 2014). In the same time frame, there was one instance of an attraction-related mortality (2004) at Diavik and four instances where bears were presumed to be attracted to the Diavik site and relocated for safety reasons (2001, 2003, 2012, and 2013). A review of incidents at Diavik indicated that a grizzly bear was trying to access the cafeteria area and was subsequently destroyed for safety reasons (Golder 2014), which may indicate that the bear was attracted to food smells emanating from food preparation areas. No further instances of attraction-related mortality has occurred at Diavik since 2004, though on two recent occasions (2012 and 2013) grizzly bears were relocated for safety reasons (Golder 2014).

At the Ekati Diamond Mine, there was one occasion in 2000 where a sow and a cub were reported to be attracted to the Misery landfill site, and the cub was subsequently destroyed for safety reasons. Review of the incident suggested that the cub was in very poor condition and that food wastes were improperly managed at Misery landfill, which likely caused the hungry bears to seek out the food contained within the landfill (Golder 2001). Since then, the Ekati Diamond Mine has continually improved waste management protocols, and no further incidences of attraction that required relocation or destruction have been recorded (Rescan 2013e; ERM Rescan 2014c; ERM 2015c).

In the years that personnel have been at the Doris Project site (2006 - 2016), the number of grizzly bear incidents and interactions were generally low with the exception of 2009. Excluding 2009, the number of grizzly bear incidents per year ranged from 1 to 7, with an average of 4.5 incidents requiring deterrents per year. However, in 2009 bears were attracted to improper garbage disposal at the Windy camp, following the Closure of Windy camp in late 2008. Frequent bear activity was reported at the vacated Windy camp in the late winter (May) and throughout the Roberts Bay-Airstrip-Doris Site areas during summer. Bears were deterred from these areas. Cambridge Bay Conservation Officers were kept informed of repeat events and assisted the ESR with deterring bears from Windy camp by snowmobile.

Efforts to remove attractants from Windy camp began in 2009. Potential attractants were identified, sorted and removed for incineration or secure storage until shipment off site. As additional preventative measures, a wildlife-attractant-conscious waste management plan was drafted and implemented in 2009. Camp personnel were briefed on wildlife attractant management practices. A Bearwise representative was also brought to site twice in 2009, and in each of the five subsequent years to audit site bear safety conditions, provide recommendations for improvement, assess various

bear fencing options, and to provide bear responder training to separate cross-shifts of on-site staff. Following 2009, the number of reports of bears fell sharply, but remained above pre-2009 levels during 2010 and 2011. This decline was likely a consequence of improved waste management practices. By 2012, the annual Bearwise report concluded that conditions have greatly improved on site largely due to the proper Closure of Boston camp, ongoing decommissioning of Windy camp, and Project-wide improvements to waste management practices.

Since 2013, bear activity in the Project area has been minimal, likely due to continued good waste management practices (Table 9.2-24), with one incident reported in 2014, when a bear approached an exploration drill. However, in 2016 a juvenile bear, likely the newly independent yearling of a female grizzly bear that frequents the fish fence on Roberts Creek, was observed repeatedly at the Doris site. Camp cleanliness and waste management procedures were reviewed and the bear deterred, but it became clear that the bear was habituated and posed a safety risk to Doris Project personnel. After conferring with the KIA and the Cambridge Bay DOE conservation officer, the bear was destroyed and the meat delivered to the Cambridge Bay Wellness Center food bank.

A review of mitigation measures and bear issues at other Arctic mines indicates that problem (or habituated) bears are a rare occurrence when the project adheres to proper waste management and camp cleanliness protocols. Mitigation measures for the Project include a program to exclude grizzly bears from camps using skirting and fencing (where needed), a program of waste management for wildlife, and a camp and waste monitoring program to continuously monitor the site and trigger additional waste and site cleanup activities.

Effective waste and camp management, along with monitoring and adaptive management at Phase 2 sites will reduce the potential for attracting bears, which may become habituated and require deterrence, translocation or destruction. Despite these measures, the effect of attractants has the highest potential to bring grizzly bears into conflict with humans and have direct effects on grizzly bear individuals and possibly population when bears are destroyed. Therefore, the potential effect of **attractants is predicted to result in a residual effect on grizzly bears**.

9.10.3.5 Direct Mortality

This section evaluates the potential for mortality and injury to grizzly bears caused by Phase 2 activities. Potential Project activities that may contribute to direct mortality and injury are generally anticipated to be a result of vehicle strikes. Mortality to grizzly bears may also result when wildlife attracted to Project infrastructure become human habituated and aggressive, and thus pose a threat to human safety. The resulting effects of attraction to the Project are evaluated in Section 9.10.3.4.

To assess the likelihood and population-level significance of grizzly bear mortality and injury resulting from interaction between grizzly bear and the Project, literature from other projects in Nunavut and Northwest Territories (Ekati, Diavik, and Back River) and/or from GN-DOE was reviewed. These sources indicate that there have been no reports of direct mortality to grizzly bear from traffic on site roads at mining developments in the Arctic, including Ekati (ERM Rescan 2013), Diavik (RioTinto 2012), the Doris Project (Rescan 2013d), Meadowbank Mine (Gebauer et al. 2013), and the Tibbit to Contwoyto Winter Road (EBA 2001).

Grizzly bear mortality and injury due to development activities is most often a result of vehicle collisions (Benn, Jevons, and Herrero 2005). Frequency of road mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected that the risk of injury or death increases with vehicle speed. The all-weather local site roads within the PDAs will enforced speed limits of a maximum of 50 km/h. Direct mortality rates of wildlife species have been

shown to drop dramatically below 70 km/h. All wildlife, including bears, will have the right of way on all Project roads. Thus, **mortality due to vehicle strikes is not anticipated to result in a residual effect on grizzly bears**.

9.10.3.6 Increased Access and Harvest

The potential for increased access for hunters and harvest of grizzly bears is due to Phase 2 evaluated in this section. Indirect mortality from increased hunting pressure resulting from Project-related activities is assessed based on the results the socio-economic assessment (Volume 6, Section 3) which reports that an increase in human immigration and hunting is unlikely in the Hope Bay area.

Mitigation measures are in place to prevent public access to Project roads and Phase 2 will have a policy prohibiting hunting by employees on site. In addition, the *Nunavut Wildlife Act* prohibits hunting from a road or within 1 km of a dwelling or settlement, including Phase 2. In addition, unlike many other large mammals, the Government of Nunavut sets a Total Allowable Harvest for grizzly bears. Harvesters must have a permit and report their harvest of grizzly bears. Thus, the total harvest of grizzly bears in the RSA and the grizzly bear management unit is managed by the Government of Nunavut and will not be affected by the Project. Thus, Construction and Operation of the road is not expected to cause an increase in grizzly bear mortality due to facilitation of hunter access and is therefore **not anticipated to result in a residual effect** on grizzly bear.

9.10.3.7 Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to the Permitted Project, Phase 2 and the combined Hope Bay Project and the potential for increased risk of adverse health effects in ecological receptors (e.g., grizzly bear). The assessment determined that Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in caribou due to Project activities. Therefore, the effects of environmental contaminants and bioaccumulation are **not considered as residual effects** on grizzly bear.

9.10.4 Significance of Project-related Residual Effects for Grizzly Bear

Three potential effects were rated as residual effects for grizzly bear; habitat loss, disruption of movement, and attraction to the Project site.

9.10.4.1 Habitat Loss

Baseline studies indicated that there are no grizzly bear dens within the planned PDA. A small amount of area that could be used for dens and for foraging by bears will be removed, but this area is small when compared with the amount of good quality habitat available in the LSA and RSA. The local grizzly bear population inhabiting areas surrounding the Project are considered to have a low to moderate sensitivity to habitat changes within their annual ranges for the following reasons. While loss of habitat is considered to be one of threats to grizzly bear populations prompting its listing by COSEWIC, the primary concern for populations is human-caused mortality including legal and illegal hunting, defense kills, and collisions with vehicles (COSEWIC 2012c). Further, grizzly bears inhabit large home ranges and occur at relatively low population densities (e.g., five bears per 1,000 km2; Dumond, Boulanger, and Paetkau 2015). Results of mark-recapture studies for the Project suggest that up to 52 individuals were using habitat within or just beyond the edge of the RSA across 2010 and 2011 (Section 9.2.8.2, Figures 9.2-24 and 9.2-25). Hence, based on the spatial organization of grizzly bears on the tundra, the number of bears with portions of their annual range overlapped by the Project is expected to be lower than the total recorded during baseline studies. Inuit TK indicate that the coastal areas near the Project are important foraging areas for grizzly bears, a trend partly supported by the results of the

statistical analysis of wildlife camera data in 2016 (Section 9.2.8.3). Hence, it is likely that the annual ranges of multiple individuals overlap along the coastlines where individuals feed on seasonally abundant resources such as seals and char.

The local grizzly bear population is expected to have some resilience to adapt to habitat changes. Overall, the population in Nunavut was estimated at 1,500-2,000 individuals in 2011 (COSEWIC 2012c). The most recent territorial ranking does suggest that Nunavut population may be sensitive to population declines based on the territorial range rank of Vulnerable to Apparently Secure (CESCC 2016), although there is evidence that the population of grizzly bears in the Kitikmeot Region is apparently stable or increasing (GN DOE 2012). This trend is substantiated by Inuit TK, which indicates that grizzly bear have been increasing in numbers and distribution in the west Kitikmeot, particularly in coastal areas (Banci and Spicker 2016). Dumond, Boulanger, and Paetkau (2015) also noted that Kugluktuk residents reported an increasing bear population in western Nunavut. Caribou workshop participants also commented that grizzly bear numbers have been rising and discussed this as a potential cause of caribou declines. Elders and land users in the caribou workshops were not concerned about any potential effects of the Project on bear populations.

Considering the sensitivity and resilience of the local grizzly bear population to habitat changes, the magnitude of this effect is rated as negligible. The maximum 1.5% loss of good quality seasonal habitat due to the Project within the RSA will affect a portion of the individuals with overlapping home ranges, and an expected small portion of the good quality habitat that may be available within those home ranges, but the overall loss is not expected to adversely affect the local population. The duration of habitat loss is long term (beyond the life of the Project) and reversible with effort because grizzly bear may use the reclaimed areas for travel routes, similar to the use of eskers. The frequency of habitat loss is intermittent, with the majority of habitat loss occurring during Construction, and infrequently thereafter as Project infrastructure is expanded. The geographic extent of habitat loss will be confined to the PDA.

The confidence of the effect occurring and in the proportion of habitat removed is considered high because the area removed is well understood, as are the attributes which make good denning and foraging habitat. Confidence in the results of habitat loss on grizzly bear habitat is considered high. Baseline surveys indicated no dens in the PDA. The probability of the effect occurring is likely, as a small but measurable amount of habitat will be lost to the PDA.

The residual effect of habitat loss for grizzly bear is concluded to be **Not Significant** for both the Phase 2 and the Hope Bay Project (Table 9.10-5).

9.10.4.2 Disruption of Movement

Traffic volumes for the Project vary by the section of road, with the existing section between Doris and Madrid, representing roughly 15% of the AWR route between Boston and Doris that will be used for Phase 2, carrying the highest traffic volumes and the longer section that will be built for Phase 2, linking Madrid to Boston, will carry lower traffic volumes overall. The volumes of traffic along the section to Doris to Madrid exceed the levels where it is assumed grizzly bear may avoid roads (>100 vehicles per day), hence, this effect is rated as direct and adverse for grizzly bear.

Table 9.10-5. Summary of Residual Effects and Overall Significance Rating for Grizzly Bear

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2									
Habitat Loss	negative	negligible	long	intermittent	PDA	reversible with effort	likely	not significant	high
Disruption of Movement	negative	low	medium	intermittent	PDA	reversible	likely	not significant	low
Attraction	negative	low	medium	infrequent	PDA	reversible	moderate	not significant	high
Hope Bay Project									
Habitat Loss	negative	negligible	long	intermittent	PDA	reversible with effort	likely	not significant	high
Disruption of Movement	negative	low	medium	intermittent	PDA	reversible	likely	not significant	low
Attraction	negative	low	medium	infrequent	PDA	reversible	moderate	not significant	high

The magnitude of this effect is rated as low, because traffic volumes across the entire length of roads that will carry Phase 2 traffic are variable, with only a short segment above the threshold where movements may be altered. Grizzly bear are expected to have a low to moderate sensitivity to this effect, as disruption of movement due to roads and other linear features are noted as one of the threats to grizzly bear (COSEWIC 2012c), although road density as well as traffic volumes on these roads is the main concern. Maintaining road density below 0.6 km/km^2 is proposed as a management target/threshold for grizzly bear, based on the research conducted by (Mace et al. 1996) that showed that grizzly bears preferred habitats with road densities below this threshold. (Northrup et al. 2012) proposed that maintaining road density below the 0.6 km/km^2 threshold as well as limited traffic volume to less than 20 vehicles/day should be considered when making management decisions for grizzly bear habitat. The road density at the Project will be far below 0.6 km/km^2. The local population is also considered to have resilience to this effect, as multiple sources suggest that the grizzly bear population in the area is at least stable if not increasing (Section 9.10.4.1).

The duration of disruption of movement is medium term and reversible because traffic will cease following closure of the Project. The frequency is intermittent, given that traffic volumes will vary along sections of road and during different years. The geographic extent is contained to the PDA. The probability of the effect occurring is likely, as traffic volumes along a short section of the AWR will carry traffic volumes above thresholds, although the confidence in assessment is medium, given that there are few applicable studies for grizzly bear to determine whether movements may be altered at the projected traffic volumes. The residual effect of disruption of movement on grizzly bear is **Not Significant** for both Phase 2 and the Hope Bay Project (Table 9.10-5).

9.10.4.3 Attraction

The effect of attraction of the Project on grizzly bears can be direct and adverse if bears attracted to the site become habituated to the site. Monitoring reports from existing developments suggest that with proper waste management protocols, such as contained within the WMMP (Volume 8, Annex V8-3) minimal numbers of individuals may become attracted to the Project and no problem bears that require destruction should be anticipated. Consistent with the Permitted Project, a yearly average of 4.5 incidences with grizzly bear requiring deterrents is anticipated through the life of the Hope Bay Project. Human-caused mortality is considered to be the major threat to grizzly bear populations (COSEWIC 2012c); however, evidence from the Project and other operating mines in the Arctic suggest that destruction of habituated bears is a rare occurrence. Considering the above, the local grizzly bear population is considered to have a moderate sensitivity to human activities and the effect of attraction. The local population is also considered to have resilience to this effect, as multiple sources suggest that the grizzly bear population in the area is at least stable if not increasing (Section 9.10.4.1) and no problem bears are expected to be removed from the local population. Elders and land users in the caribou workshops commented that the bear population is increasing and were not concerned about potential effects on grizzly bears due to the Project. For this reason, the magnitude of the effect of attractants on grizzly bear is rated as low.

The geographic extent is contained to the Project footprint. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used, but not after Reclamation and Closure. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is moderate, contingent on rigorous application of mitigation and management measures in relation to waste and attractant management. The confidence in the assessment is high, as it is well documented that bears are not attracted to mining camps that have implemented standard waste management protocols. The residual effect of attractants on grizzly bears is concluded to be **Not Significant** (Table 9.10-5).

9.11 GRIZZLY BEAR – CUMULATIVE EFFECTS ASSESSMENT

Two potential effects were rated as residual effect for grizzly bear; habitat loss and attraction to the Hope Bay Project and subsequently becoming habituated with an increased risk of destroying the animal. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.11.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of grizzly bears are described in Section 9.5.7.

9.11.1.1 Spatial Boundary

The cumulative effects assessment for grizzly bear considers a spatial boundary set by the average home range size of a female grizzly, which is approximately 2,000 km^2. Assuming that this home range is roughly circular, that yields a diameter of approximately 50 km. A 50-km buffer was applied to the Hope Bay Project to determine if other Projects may interact with the same grizzly bears that interact with the Hope Bay Project (Figure 9.11-1).

9.11.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.11.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Sections 9.10.3 and 9.10.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for grizzly bear and cumulative effects for this VEC are not considered further.

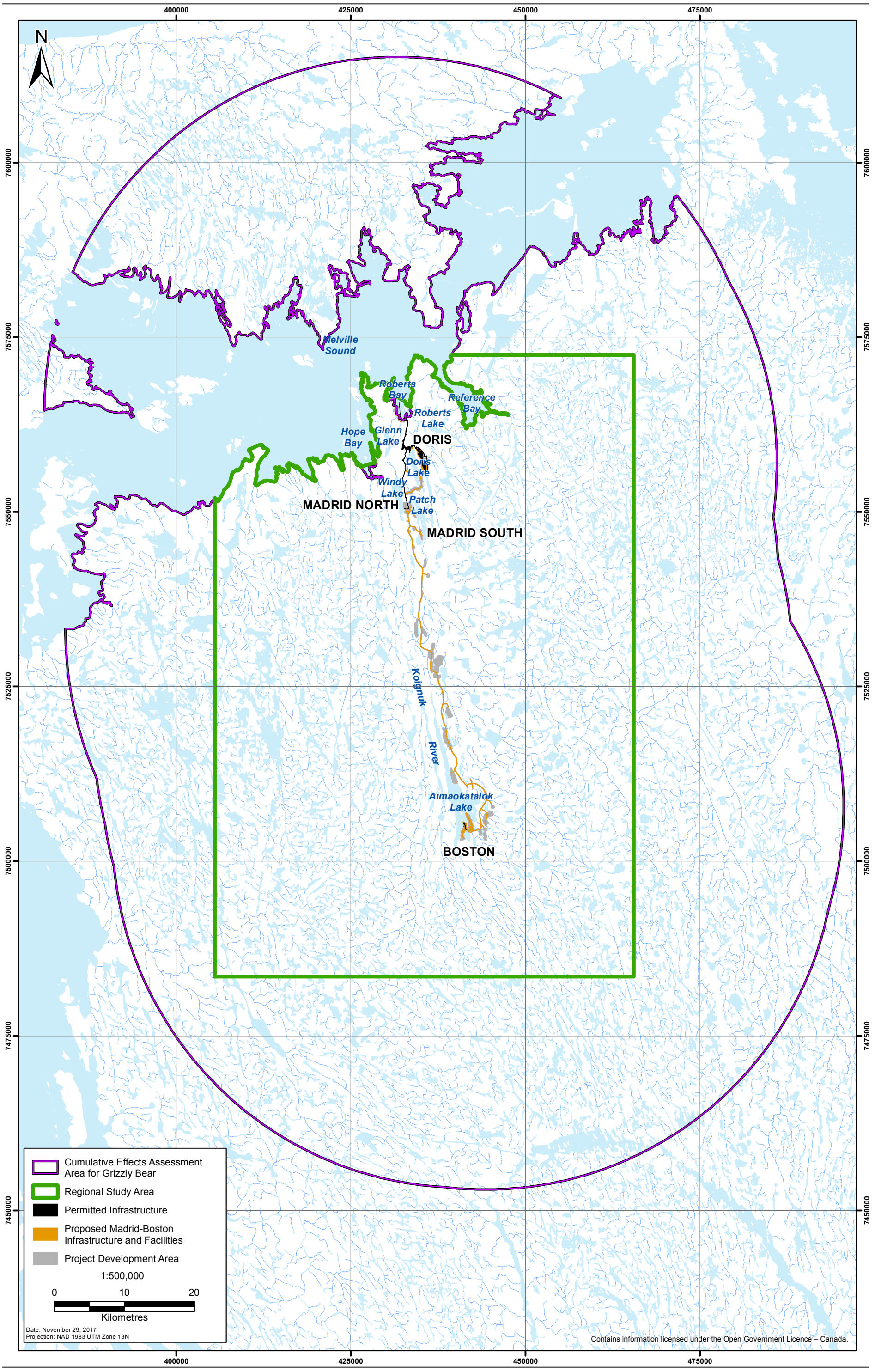
9.12 MUSKOX- EFFECTS ASSESSMENT

9.12.1 Introduction

The potential effects of Phase 2 on muskox within the RSA are assessed in this Section. Potential effects for all wildlife VECs were identified in Section 9.6. Potential effects on muskox and muskox habitat were included based on Inuit TK, community concerns expressed at meetings, professional judgement, experience at other similar projects in Nunavut and the scientific literature (Section 9.6). Potential Phase 2 and Hope Bay Project effects were evaluated, making reference to season and mine phase (i.e., Construction, Operation and Reclamation/Closure Phases) for muskox. Interactions of muskox with Project components were evaluated to determine which of the following potential effects may occur (Table 9.6-5):

- habitat loss;
- disturbance;
- disruption of movement;
- attraction to the Project;
- direct mortality;

Figure 9.11-1
Cumulative Effects Assessment Spatial Boundary for Grizzly Bear



- increased access and harvest; and
- changes in environmental media quality.

Habitat loss will occur in all areas where new infrastructure overlaps suitable habitat, which may include the expansion of the Roberts Bay, TIA facilities and the construction of the new Boston road and Boston facility. This potential effect will begin during Construction and last through to Post-Closure of Phase 2.

Noise and the presence of personnel, vehicles, and other activities near muskox may cause disturbances which can result in behavioral changes in muskox, which may reduce feeding time, increase stress, reduce reproductive potential, or cause avoidance of disturbed areas (McLaren and Green 1985). This potential effect will begin with Construction and continue through the Operations and Closure, and cease in Post-Closure.

As compared to other arctic ungulates (e.g., caribou) muskox occupy small seasonal home ranges and can undergo movements up to 140 km between seasonal ranges used for calving and wintering, and areas used during the summer and fall rut (P. E. Reynolds 1998; Gunn and Fournier 2000). The potential for the Boston site and the all-season roads to disrupt movement of muskox is also evaluated. This potential effect is evaluated as beginning in Construction and ending at Closure when vehicle travel on roads will cease.

Direct mortality and injury on muskox from vehicle strikes may also occur due to the increase in roads and is therefore evaluated in this assessment. This potential effect is evaluated as beginning in Construction and ending at Closure when vehicles will stop traveling on Phase 2 roads.

Increased access and harvesting was identified by the GN as a potential concern for game species when hunters are attracted to the Project site for logistical reasons and to use the Boston road as a travel route. This potential effect would begin at Construction and continue into Post-Closure.

Phase 2 infrastructure such as all season roads may attract muskox due to their ease of travel, which could subsequently lead to increased vehicle-muskox interactions and muskox mortality. This potential effect could begin during Construction and end at Closure when roads are used infrequently.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into Post-Closure.

Each potential effect is described in the following sections, and then evaluated as to whether or not it will occur with proposed mitigation and management. When potential effects are likely to occur they are further evaluated to determine if a residual effect will remain after mitigation actions are implemented.

9.12.2 Identification of Mitigation and Management Measures for Muskox

The WMMP (Volume 8, Annex V8-3) outlines the mitigation and management actions that will be implemented to reduce or eliminate the potential effects on wildlife including muskox. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Phase 2-related effects to muskox.

9.12.2.1 Mitigation by Project Design

Mitigation by Project design that is applicable to all wildlife includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive areas for wildlife;
- ensuring that waste management facilities and buildings are wildlife-proof; and
- maintaining equipment to minimize noise that may disturb wildlife.

Mitigation by Phase 2 Project design specific to ungulates includes:

- Roads will be constructed with crossing structures to facilitate ungulate movement over the road bed.

9.12.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding of wildlife;
- open water shipping will conform to all applicable laws and regulations;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil and shipboard pollution plans, spill contingency plan and hazardous waste management.

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- minimize disturbance to vegetation communities;
- infrastructure will avoid sensitive muskox habitats, where possible; and
- minimize the size of the Project footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on muskox includes:

- construct and maintain equipment to minimize the production of noise – see Noise and Vibration (Volume 4, Section 3) and Noise Abatement Plan (Volume 8 Annex V8-8);
- monitor and adaptively manage noise – see Noise Abatement Plan (Volume 8 Annex V8-8); and
- pilot education about the potential negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed (Volume 8, Annex V8-3).

Mitigation for Disruption to Movement

Mitigation and management to reduce the potential for disruption of movement to muskox include:

- ungulate crossing structures on roads; and
- design criteria to limit snowbanks.

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for muskox include:

- enforce speed limits on all Project roads;
- muskox will be given the right-of-way on all roads;
- maintaining clean Project sites where any equipment or materials that could entangle or entrap wildlife are safely stored;
- ceasing blasting if muskox are within the fly-rock safety zone; and
- survey of the airstrip prior to aircraft landing or departure to ensure that there are no muskox that may be disturbed and run onto the runway.

Mitigation for Increased Access and Harvest

Mitigation and management to reduce the potential for increased access and harvest of muskox include:

- no connection of all-weather roads to any communities;
- closure of all Phase 2 roads to the public; and
- a policy prohibiting hunting by Project staff and contractors while on site.

Mitigation for Attraction

Mitigation and management to reduce the potential for muskox to be attracted to Phase 2 development include:

- a policy of no wildlife feeding; and
- waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of muskox to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);
- fuels and chemicals are stored in wildlife-proof buildings;

- cyanide destruction inside the mill; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.12.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for muskox will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, waste management, vehicle-wildlife collisions or other incidents, water quality and incidental observations.

Monitoring specific for muskox will include:

1. monitoring and reporting the size of the footprint;
2. local-area scans prior to blasting;
3. reporting of wildlife incidents;
4. reporting of wildlife observations;
5. zone of influence monitoring using motion-triggered cameras.

9.12.3 Characterization of Potential Project-related Effects

9.12.3.1 Habitat Loss

This section evaluates the potential effects of habitat loss on muskox due to Phase 2 and the Hope Bay Project. Potential effects associated with habitat loss will likely occur in areas where Phase 2 infrastructure overlaps suitable muskox habitat. The proposed location of infrastructure is designed to minimize and avoid wildlife sensitive areas and to minimize the number of individual infrastructure footprints and overall Phase 2 footprint. However, some habitat loss and degradation may still occur.

The potential for degradation of vegetation near infrastructure due to dust generated from development was assessed in the Human Health and Environmental Risk Assessment (Volume 6, Section 5). This analysis did not predict any residual effects on vegetation due to dust and therefore no effects on muskox habitat due to dust are expected. Moreover, the use of PDAs will account for any edge effects that may extend beyond the Phase 2 footprint.

Methods

Muskox habitat loss within the wildlife RSA was calculated based on the overlap of the PDA with habitat suitability modelling results for muskox. The PDA was designed to accommodate shifts in final infrastructure layout and thus actual area developed, and subject to habitat loss, will be much smaller as determined by the final design infrastructure and placement. The area of good quality habitat lost within the PDAs is then evaluated relative to: 1) the LSA, 2) the RSA, 3) the proportion of an average seasonal home range, and 4) the number of individuals that may be affected by the loss, assuming a density of 7 animals/1,000 km^2 (Dumond 2007). The home range averages are based on Alaska populations as Nunavut populations have not been widely studied (Gunn and Fournier 2000).

Results

A total of 2,868 ha of good winter/spring habitat for muskox will be lost in the PDA due to Phase 2, which is 8.3% of the LSA and 2.0% of the RSA (Table 9.12-1). A similar area of good summer/fall habitat, 3,476 ha will be lost within the PDA, which represents 7.6% of the LSA and 1.1% of the RSA (Table 9.12-2). The Hope Bay Project will remove 2,949 ha of good winter/spring habitat (8.6% of LSA, 2.1% of RSA) and 3,630 ha of good summer and fall habitat (8.0% of LSA, 1.1% of RSA).

Table 9.12-1. Good Quality Muskox Winter and Spring Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		211	211		0.6	0.6		0.1	0.1
Doris + TIA	80	336	416	0.2	1.0	1.2	0.1	0.2	0.3
Existing Boston Exploration Camp	1		1	< 0.1		< 0.1	<0.1		<0.1
Madrid North		55	55		0.2	0.2		<0.1	<0.1
Madrid South		109	109		0.3	0.3		0.1	0.1
Madrid-Boston Road		2,156	2,156		6.3	6.3		1.5	1.5
Total	81	2,868	2,949	**0.2**	**8.3**	**8.6**	**0.1**	**2.0**	**2.1**

1: Area of good quality summer habitat in the LSA = 34,411 ha
2: Area of good quality summer habitat in the RSA = 141,209 ha
3: Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration

Table 9.12-2. Good Quality Muskox Summer and Fall Habitat Lost due to Phase 2 and Hope Bay Project

Project Component	Habitat Lost (ha)			LSA (%)[1]			% RSA[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site		339	339		0.7	0.7		0.1	0.1
Doris +TIA	151	477	628	0.3	1.0	1.4	<0.1	0.1	0.2
Existing Boston Exploration Camp	2		2	<0.1		<0.1	<0.1		<0.1
Madrid North		138	138		0.3	0.3		<0.1	<0.1
Madrid South		125	125		0.3	0.3		<0.1	<0.1
Madrid-Boston Road		2,396	2,396		5.2	5.2		0.7	0.7
Total	154	3,476	3,630	**0.3**	**7.6**	**8.0**	**<0.1**	**1.1**	**1.1**

1: Area of good quality summer habitat in the LSA = 45,657 ha
2: Area of good quality summer habitat in the RSA = 328,236 ha
3: Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration

The total area of the PDA is 4,285 ha. This represents 61% of a muskox home range, using a winter home range of 7,000 ha (P. E. Reynolds 1998). Using a density of 7 muskox/1,000 km^2 this amount of habitat loss will affect 0.3 muskox home ranges. Habitat loss due to the PDA represents 0.02% of MU MX-11, which is 21,151,867 ha.

Phase 2 will remove approximately 61% of 0.3 muskox home ranges. Phase 2 Construction will remove 2.0% and 1.1% of good quality winter/spring and summer/fall habitat in the RSA, respectively. On the scale of the RSA, this area of habitat loss is trivial. However, muskox often have fairly small home ranges and so habitat loss on a more local scale has higher potential to result in residual effects. As a consequence, to be conservative, **habitat loss is rated as a residual effect** for muskox.

9.12.3.2 Disturbance

Human activities such as travel on snow machines, walking or driving vehicles can cause disturbance to muskox resulting in flight response, behavioral changes, which can cause avoidance behaviours of areas with greater human activity (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). This section evaluates the potential effect of disturbance on muskox.

Disturbance of muskox will occur throughout the life of Phase 2, with disturbances ranging in duration from intermittent (e.g., blasting and aircraft flights) to persistent (e.g., presence of humans and ground vehicles movement). During the Construction and Operation Phases, noise may be generated by vehicles, blasting in quarries, stockpiling of materials, vehicle traffic, and power generation. Intermittent aircraft noise will also occur during all Project phases.

Few studies have been conducted to directly determine the effects of disturbance on muskox. For instance, there are few collaring studies, and aerial surveys return very low number of muskox, making calculation of a zone of influence challenging. For example, the aerial surveys conducted as part of the baseline and WMMP monitoring studies for the Doris Project reported less than 10% as many muskox as caribou during aerial surveys. Moreover, the scale of muskox responses to noise and vibration are not thoroughly studied, so there are no thresholds to compare to noise modeling. Some biologists feel that muskox are sensitive to disturbances, while practitioners in the field report muskox routinely becoming habituated to exploration camps and active mine sites. Muskox are regularly reported close to the Doris Project site.

In the absence of direct evidence of the degree to which muskox may respond to disturbances from the Project site, this assessment will use the same avoidance area, or zone of influence area, as calculated for caribou (Section 9.8.3.2). This represents a conservative assessment because muskox are known to acclimate to camps and are routinely observed near projects. For this reason, only the most likely scenario, which is a ZOI of 4 km surrounding the mine site and 1.5 km surrounding roads, is considered (See Section 9.8.3.2 for further details on ZOIs)

The area of good quality winter and spring habitat indirectly affected by the Phase 2 is 10,566 ha and 20,916 ha for the Hope Bay Project. For summer and late fall habitat, the area of good quality winter and spring habitat indirectly affected by the Phase 2 is 13,709 ha and 31,629 ha for the Hope Bay Project. Overall, the total amount of habitat that may be disturbed regardless of habitat quality by the Phase 2 is 16,709 ha and 45,481 ha for the Hope Bay Project. These areas represent approximately 0.1 to 0.2% of the muskox management unit MU MX-11 (Table 9.12-3).

Due to the proportion of the good quality habitat in the RSA that may be utilized less by muskox if they are avoiding Phase 2 and Hope Bay Project, this potential effect **is rated as a residual effect**.

Table 9.12-3. Good Quality Muskox Habitat Area in ZOI Scenario 1: 4 km from Mine and 1.5 km from Roads

	Habitat (ha)	Area Affected (ha)			% of the RSA		
Season	RSA	Phase 1[1]	Phase 2	Total	Phase 1	Phase 2	Total
Winter/Spring	141,209	10,349	10,566	20,916	7.3	7.5	14.8
Summer/Fall	328,236	17,920	13,709	31,629	5.5	4.2	9.6
Total	491,824	28,772	16,709	45,481	5.9	3.4	9.2

1: Phase 1 refers to the Approved Projects, including the Doris Project and Madrid North exploration

9.12.3.3 Disruption of Movement

This section evaluates the potential for Phase 2 and the Hope Bay Project to affect the seasonal and local-scale movements of muskox in the RSA.

Movement may be disrupted by linear corridors such as roads which have been shown to create temporary or permanent barriers to movement in various wildlife species (Jalkotzy, Ross, and Nasserden 1997). Developments may also alter muskox movement patterns if avoidance occurs for Project areas of high noise and sensory disturbance. Muskox will be present and active on the tundra all year and thus may interact with infrastructure, the all-season roads, and other access roads within the PDA.

Disruption to movement may begin during the Construction Phase of the Project when roads and infrastructure are built and continuing during the Operational and Reclamation and Closure Phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine Closure.

This effect has not been extensively studied for muskox, therefore the assessment relied on evaluations of disruption of movement for other ungulate species. A study of caribou movement in Alberta indicated that roads were not a barrier to movement unless traffic was present (Dyer et al. 2002b). Studies in Alaska reported that caribou crossing of a pipeline was impeded by a traffic rate of 20 vehicles per hour (W. A. Smith and Cameron 1985) and 32 vehicles per hour (Murphy and Curatolo 1984). In Alaska and Arctic Canada, ungulate movements are deflected by high traffic volumes and a snow bank height greater than 0.5 m along winter roads (Rescan 2007).

At peak traffic rates (years 5 and 6) the proposed 53 km road from Boston to Madrid will make up 85% of the Boston to Doris road and will carry approximately 33 return trips per day; 2.8 one-way vehicle trips per hour. The existing 9.5 km road from Madrid to Doris, makes up approximately 15% of the Boston to Doris road, will carry traffic both for Boston and Madrid, with approximately 98 return trips per day during Years 5 and 6; or an average of 8.2 vehicle trips per hour. The existing 4.8 km road from Doris to Roberts Bay, over which fuel and other supplies for Phase 2 are transported, will carry approximately 12 return trips per day during Years 5 and 6, or on average 1 vehicle trip per hour. This traffic is below the traffic volumes reported to cause road avoidance by other ungulate species for the majority of the road. Muskox also do not undergo long-range seasonal movements like caribou do. Traffic is therefore not anticipated to disrupt muskox movement.

Mitigation and management measures to reduce effects of disruption of movement include enforcement of speed limits, reduction of speed or halt of trucks when muskox herds are observed near or on the road, and designed criteria to limit snowbanks. As a consequence of the planned mitigation and management measures and traffic levels on the Project roads, the potential effects of disruption of movement due to Phase 2 are considered small. However, due to concern over this potential effect it is rated as a **residual effect** for muskox.

9.12.3.4 Attraction

This section evaluates the potential for muskox to be attracted to Phase 2 roads as travel routes which facilitate easier travel and lower snow depths in winter. Due to the physical presence of the Project and associated noise and disturbance, muskox are generally expected to avoid the Project infrastructure (Section 9.12.3.2). Even if muskox are attracted to the Project site, standard mitigations including speed limits, giving wildlife the right of way on roads, monitoring for and disseminating muskox observations to drivers, camp hygiene, and controls on water quality will prevent muskox from becoming injured. Therefore, following mitigation measures **no residual effects of attraction are expected for muskox for Phase 2 or Hope Bay Project.**

9.12.3.5 Direct Mortality

The potential for mortality and injury of muskox as a result of collisions with vehicles was evaluated. No muskox-vehicle collisions have been recorded at the Doris Project nor at other arctic mines. The likelihood of vehicles collision with muskox is therefore expected to be low to nil. Truck speed limits are set at a maximum of 50 km/h which is lower than the threshold found to be associated with higher vehicle-ungulate collision (70 km/h; Seiler 2005; Ng, Nielson, and St Clair 2008). In addition, wildlife will be given the right of way to safely cross and exit the road corridor will further lessen the probability of vehicle strikes. Given that direct mortality to muskox is extremely unlikely due to vehicle collision and that mitigation is expected to be successful at further reducing the chances of direct mortality, **no residual effects of direct mortality are predicted due to either Phase 2 or the Hope Bay Project.**

9.12.3.6 Increased Access and Harvest

This section evaluates the potential for mortality of muskox resulting from increased hunting facilitated by easier access. The current Doris Project records hunters who use the Project area and stop at the Doris site to visit. Hunters are required to report to the security office to declare their weapons. Section 89(1) of the *Nunavut Wildlife Act* prohibits a person from discharging a firearm along or across a trail, road, or highway or within 1 km of a dwelling or building such as the Hope Bay Project for safety reasons.

The socioeconomic assessment (Volume 6, Section 3) indicates that human immigration and hunting is unlikely to increase as a result of Phase 2. The number of these visits was typically less than 10 per year until 2011 when Omingmaktok was no longer permanently occupied. Since that time, the number of groups visiting the Doris site has fallen to one to two hunting groups per year. Discussions with hunters who visit the Doris site indicate that most groups are hunting predators for their furs.

It is reasonable to assume that the primary reason for traveling to the site will remain the same in future – as a stopover en-route to Omingmaktok and to hunt predators. The construction of the Boston road will not provide new access to any new hunting areas because this area is already readily accessible by snow-machine by traveling down the Akinngak River to Aimaokatalok (Spyder Lake). Phase 2 is unlikely to change these movements and hunting patterns. Therefore, the potential effect of increased access and harvest of muskox is **not considered a residual effect** for Phase 2 or the Hope Bay Project.

9.12.3.7 Environmental Media Quality

The Human Health and Ecological Risk Assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to activities prior to any development in the Hope Bay belt, due to the Approved Projects and due to the Hope Bay Project as a whole on ecological receptors (e.g., muskox). The assessment determined that Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse

health effects in muskox due to Project activities. **Therefore, the potential effects of changes in environmental media quality are not considered as a residual effect on muskox for either Phase 2 or the Hope Bay Project**.

9.12.4 Significance of Project-related Residual Effects for Muskox

The effects assessment identified three residual effects for muskox; habitat loss, disturbance, and disruption of movement, which are summarized in Table 9.12-4.

9.12.4.1 Habitat Loss

Construction of Phase 2 will alter 2,868 ha of good quality winter/spring habitat and 3,476 ha of summer/fall habitat, which is 2.0% and 1.1% of the RSA, respectively. The Hope Bay Project will remove 2, 949 ha of good winter/spring habitat (2.1% of RSA) and 3, 630 ha of good summer and fall habitat (1.1% of RSA). Overall, 61% of 0.3 muskox home range will be affected by the Project. This is 0.01 to 0.02% of the muskox management unit MU MX-11.

This projected area of habitat loss is a small proportion of available habitat in the RSA and the local muskox management unit. This area of loss is unlikely to cause a measurable decline in the muskox population in the RSA or MU MX-11 because the local muskox population is expected to have a low sensitivity to this effect. Muskox are not considered a species at conservation concern federally and are currently listed as Apparently Secure in Nunavut, meaning that the Nunavut population at are fairly low risk of extirpation but there are possible cause for some concern due to local recent declines, threats, or other factors. The local muskox population is expected to have good resilience to adapt to the loss of a small area of habitat. While current population trends for MU MX-11 are not available given the relatively new designation of management units, Leclerc (2015a) suggested that muskox numbers in the western portion of the management unit, near Kugluktuk, had increased based on the 2013 survey results and prior study, and Inuit TK also indicates that muskox numbers in the Elu Inlet area have increased (Banci and Spicker 2016). These observations suggest that the local muskox population is likely stable if not increasing. As such, this residual effect is low magnitude. The duration of habitat loss is long term (beyond the life of the Project) because even with reclamation, the habitat will not return to baseline conditions. The frequency of habitat loss is intermittent, with the majority of habitat loss occurring during Construction, and infrequently thereafter as Project infrastructure is expanded. The geographic extent of habitat loss will be confined to the Project Development Area. Some habitat loss will be reversible with effort, but other areas will be irreversible because they will not return to baseline conditions. As such the effect as a whole is rated as irreversible.

The probability of the effect occurring is likely, as a small but measurable amount of muskox will be lost due to the footprint. The residual effect of habitat loss for muskox is concluded to be **Not Significant** for both Phase 2 and the Hope Bay Project.

The confidence of the effect occurring and in the proportion of habitat removed is high because the area removed is well understood and muskox are known to be present in the RSA. Confidence in the results of habitat loss on the muskox population is considered medium. The area lost is small compared to availability in the RSA and muskox management unit and unlikely to have population-level consequences for the population.

Table 9.12-4. Summary of Residual Effects and Overall Significance Rating for Muskox

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2									
Habitat Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	High
Disturbance	Negative	Low	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium
Disruption of Movement	negative	low	medium	intermittent	PDA	Reversible	likely	Not Significant	Medium
Hope Bay Project									
Habitat Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	High
Disturbance	Negative	Low	Medium	Intermittent	RSA	Reversible	Likely	Not Significant	Medium
Disruption of Movement	negative	low	medium	intermittent	PDA	Reversible	likely	Not Significant	Medium

9.12.4.2 Disturbance

Disturbance to muskox was evaluated by a using a potential zone of influence for caribou of 4 km for the mine site and 1.5 km for roads and evaluating that area against the RSA and muskox management units. If muskox avoid habitat due to disturbance, then the area affected by Phase 2 outside of the existing ZOI areas for Phase 1 range from 3 to 7.5% of the RSA, or 0.1 % of the muskox management unit MX-11. The larger Hope Bay Project would result in an area affected of 9 to 15% of the RSA which is ~0.1 to 0.2% of the muskox management unit. This area is likely an overestimate of potential effects on muskox. Muskox have been observed using habitat regularly near the Doris Project and appear to be partially habituated to the Project, likely because it does not pose a predation or mortality risk from hunting.

The area of disturbance due to the Hope Bay Project is small when compared to the RSA or muskox management unit. Furthermore, the local muskox population is expected to have a low sensitivity to this effect, given their present conservation status (Section 9.12.4.1). The local population is also expected to have good resilience to adapt to habitat changes in relation to disturbance, as the population appears to stable if not increasing, and evidence suggests that muskox may also habituate to disturbances, such as has been observed at the Project. As such, this residual effect is rated as having a low magnitude. The duration of disturbance is medium term (ending with Closure) because at that point disturbance due to noise will cease. The frequency of disturbance is intermittent, with Project activities such as passing vehicles, blasting or aircraft landing or departing. The geographic extent of disturbance is likely larger than the 1 km buffer LSA, but will be confined to the RSA. Disturbance will be reversible at Closure when noise and other disturbances cease.

The probability of the effect occurring is likely. The Project will produce noise and research reports that ungulates may react to that disturbance. The residual effect of habitat loss for muskox is concluded to be **Not Significant** for both Phase 2 and the Hope Bay Project.

The confidence of the effect occurring and in the proportion of habitat affected is rated as medium because exact size of the zone of influence is challenging to predict with confidence. It is for this reason that a large, 4 km zone of influence around the mine site and 1.5 km around roads was used in the analysis.

9.12.4.3 Disruption of Movement

Traffic volumes for the Project vary by the section of road, with the existing section between Doris and Madrid, representing roughly 15% of the AWR route between Boston and Doris that will be used for Phase 2, carrying the highest traffic volumes and the longer section that will be built for Phase 2, linking Madrid to Boston, will carry lower traffic volumes overall. Road crossing studies of caribou were used to infer crossing response of muskox. Based on these studies on caribou, the effect is considered negative but of low magnitude.

The local muskox population is expected to have a low sensitivity to this effect, given their present conservation status (Section 9.12.4.1). The local population is also expected to have good resilience to adapt, as the population appears to stable if not increasing. The duration of disruption of movement is medium term (ending with Closure) because at that point traffic on the road will cease. The frequency of disruption of movement is intermittent, with Project activities such as passing vehicles. The geographic extent of disturbance is local as the effect is primarily associated with the road interactions. Disturbance will be reversible at Closure when traffic on the road ceases. The confidence of the effect occurring is rated as medium. The probability of the effect occurring is likely as some muskox are predicted to encounter the road.

The residual effect of disruption of movement for the muskox is concluded to be **Not Significant** for both Phase 2 and the Hope Bay Project.

9.13 MUSKOX – CUMULATIVE EFFECTS ASSESSMENT

Two potential effects were rated as residual effects for muskox; habitat loss and disturbance. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.13.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of muskox are described in Section 9.5.7.

9.13.1.1 Spatial Boundary

The cumulative effects assessment for muskox considers a spatial boundary set by the average home range size of a muskox, which is approximately 22,300 ha (P. E. Reynolds 1998). Assuming that this home range is roughly circular, that yields a diameter of approximately 16.8 km. A 16.8 km buffer was applied to the Hope Bay Project to determine if other Projects may interact with the same muskox that interact with the Hope Bay Project (Figure 9.13-1).

9.13.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.13.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Section 9.12.3 and 9.12.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for muskox and cumulative effects for this VEC are not considered further.

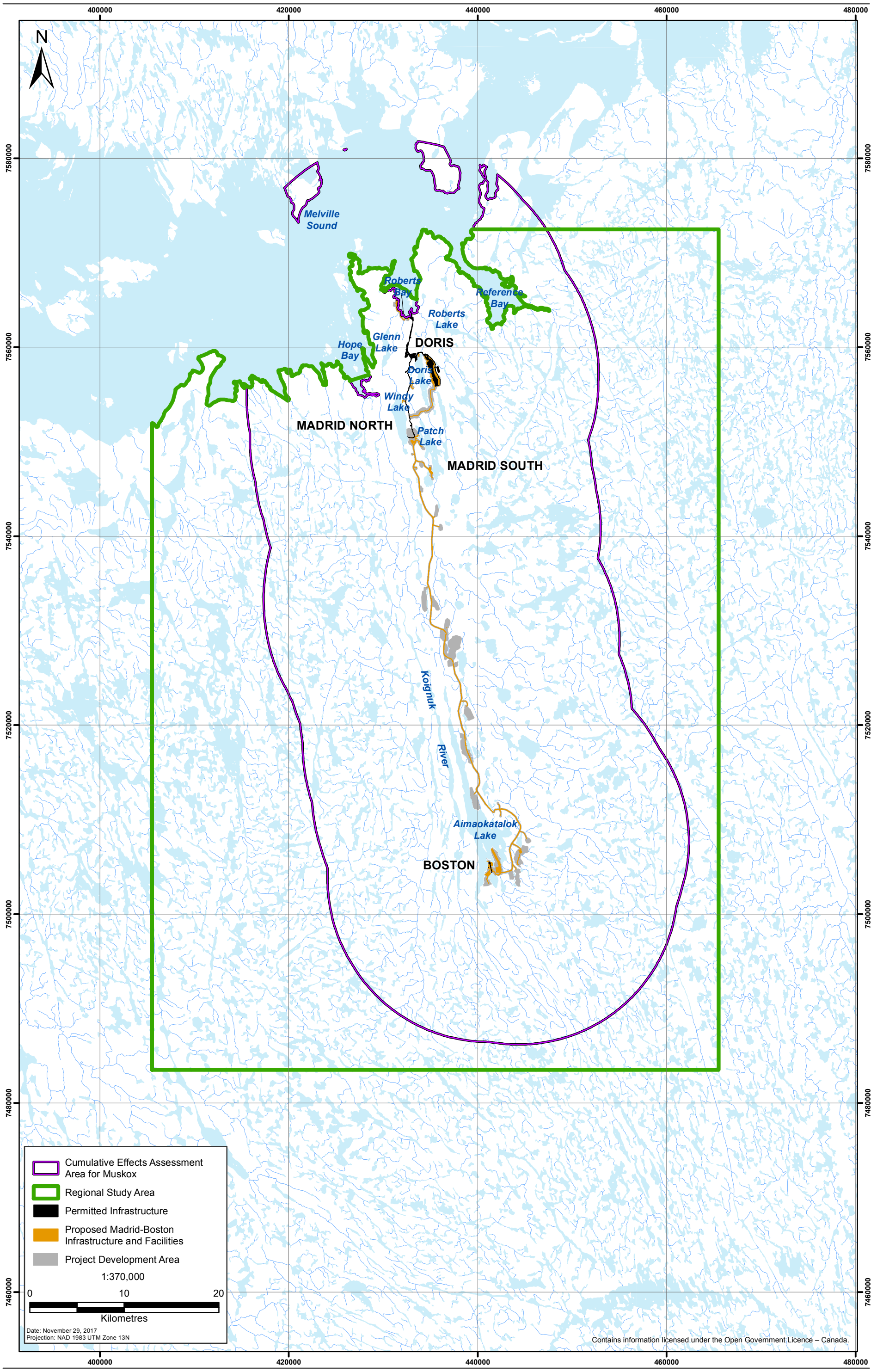
9.14 FURBEARERS – EFFECTS ASSESSMENT

9.14.1 Introduction

The potential effects of Phase 2 and Hope Bay Project on furbearers within the wildlife RSA are assessed in this section. Potential effects for all wildlife VECs were identified in Section 9.6. Furbearers include two potential indicator species: wolverine and grey wolf. The population of grey wolves in Nunavut is largely dependent on the supply of caribou and the assessment of potential effects on caribou is uses as a proxy for grey wolves. The assessment of furbearers therefore considers wolverine as the indicator species.

Inuit TK indicates that wolverine use the wildlife RSA (Banci and Spicker 2016). Inuit generally regarded wolverines as pests however their value in the fur trade made them sought after by hunters and trappers (V. Banci and R. Spicker 2012). Data from wolverine harvests indicate that Bathurst Inlet is a main site for wolverine hunting in the West Kitikmeot (Mulders 2000) and some Elders believe that snowmachines have made them easier for Inuit to capture and kill (Banci and Spicker 2016).

Figure 9.13-1
Cumulative Effects Assessment Spatial Boundary for Muskox



Potential effects on furbearers were included based on Inuit TK, community concerns expressed at scoping meetings, professional judgement, experience at other similar projects in Nunavut and the scientific literature (Section 9.6). Potential Phase 2 and Hope Bay Project effects were evaluated, making reference to season and mine phase (i.e., Construction, Operation and Reclamation/Closure Phases) for wolverine. Interactions of wolverine with Phase 2 components were evaluated to determine which of the following potential effects may occur (Table 9.6-6):

- habitat loss;
- disturbance;
- disruption of movement;
- attraction;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Wolverine will experience habitat loss from developments where new infrastructure overlaps suitable denning habitat (May 2006, 2012). This potential effect will begin during Construction and last through post-Closure of Phase 2.

Disturbance to wolverine could occur as a result of Phase 2 if it results in changes to abundance and distribution of prey species including caribou and muskox (Sections 9.8 and 9.12). The potential for the Boston site and the all season roads to disrupt movement or cause direct mortality from vehicle strikes is also evaluated; beginning in Construction and ending at Closure.

Attraction was also evaluated; camps and landfills may also act as attractants to wolverine, which could subsequently lead to increased human-wolverine interactions and wolverine mortality (COSEWIC 2014b). The Government of Nunavut identified increased access and harvesting as a potential concern if hunters are attracted to the Phase 2 site and use the Boston road as a travel route, a potential effect beginning at Construction and continuing into post-Closure.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into post-Closure.

9.14.2 Identification of Mitigation and Management Measures for Wolverine

The WMMP (Volume 8, Annex V8-3) outlines the mitigation and management actions that will be implemented to reduce or eliminate potential effects on wildlife including wolverine. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Phase 2-related effects to wolverine.

9.14.2.1 Mitigation by Project Design

Mitigation by Project design that is applicable to all wildlife is discussed in Section 9.7 and includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive areas for wildlife;

- ensuring that waste management facilities and Project buildings are wildlife-proof; and
- maintaining equipment to minimize noise that may disturb wildlife.

9.14.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding of wildlife;
- open water shipping will conform to all applicable laws and regulations;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil and shipboard pollution plans, spill contingency plan and hazardous waste management.

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- Project infrastructure designed to avoid known denning areas and good denning habitat, where possible;
- If a wolverine or wolf den site is located within Project footprints and cannot be feasibly avoided during construction, the den site will be avoided until it is no longer actively used. A permit to remove the den site when it is not actively used will be obtained through the Nunavut Government in compliance with the *Nunavut Wildlife Act*; and
- minimize the size of the Phase 2 footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on wolverine includes:

- construct and maintain equipment to minimize the production of noise – see Volume 4, Section 3;
- monitor and adaptively manage noise;
- pilot education about the potential negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed (Volume 8, Annex V8-3);

Mitigation for Disruption to Movement

Mitigation and best management practices to reduce the potential for disruption of movement to wolverines include:

- enforce speed limits of 50 km/h on all Project roads; and
- wildlife, including wolverine, will be given the right-of-way on all roads.

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for wolverine include:

- set and enforce speed limits of 50 km/h on all Project roads;
- wolverine will be given the right-of-way on all roads;
- maintaining clean Project sites where any equipment or materials that could entangle or entrap wildlife are safely stored; and
- ceasing blasting if wolverines are within the fly-rock safety zone.

Mitigation for Increased Access and Harvest

Mitigation and management to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 3) and the WMMP (Volume 8, Annex V8-3) and may include:

- no connection of all-weather roads to any communities;
- all Project roads closed to the public;
- a policy prohibiting hunting by Project staff and contractors while on site; and
- by law, nobody can hunt within 1 km of Project infrastructure.

Mitigation for Attraction

Mitigation and management reduce the potential for wolverine to be attracted to Phase 2 and development include:

- all buildings will be wildlife-proof;
- a policy of no wildlife feeding;
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants;
- no littering;
- monitoring of waste management and camps; and
- the development of a problem wildlife management program to minimize attraction of wildlife and manage non-lethal responses should any wolverines become attracted to site.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of wolverines to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);

- fuels and chemicals are stored in wildlife-proof buildings;
- cyanide destruction inside the mill; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.14.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for wolverine will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, trappers, waste management, vehicle-wildlife collisions, water quality and incidental observations.

Monitoring specific for wolverine will include:

1. monitoring and reporting the size of the as-built Project footprint;
2. monitoring the camps and buildings to confirm the site is clean and the buildings are wildlife-proof;
3. incidental observations are reported; and
4. monitoring for a zone of influence using wildlife cameras.

9.14.3 Characterization of Potential Project-related Effects

9.14.3.1 Habitat Loss

This section evaluates the potential effects of habitat loss on wolverine due to Phase 2 and the Hope Bay Project within the RSA. Inuit TK identified rocky areas, crevices and cliffs as wolverine habitat (Banci and Spicker 2016). Wolverines are known to be solitary and to use large home ranges and to place their den sites in suitable habitat away from infrastructure (May et al. 2012). The proposed infrastructure was located to avoid wolverine denning habitat, but some habitat loss may still occur.

Habitat loss was measured as the area of suitable denning habitat in the PDA relative to the LSA and RSA. Denning habitat was mapped as suitable or not suitable using habitat suitability modelling (Rescan 2011h). Suitable denning habitat was identified in the TEM for the LSA and the ELC for the Slave Geological Province for the RSA (Matthews, Epp, and Smith 2001).

Results

Suitable denning habitat occurs in 19% of the LSA and 35% of the RSA (Table 9.14-1). The LSA (56,340 ha) is comparable to a large home range for an adult male wolverine (66,500 ha; Mulders 2000). There was one wolverine den identified within the LSA, 4.9 km from existing infrastructure. The total area of suitable denning habitat lost in the Phase 2 PDA, including Madrid, Boston, and the Roberts Bay laydown is projected to be 901 ha (Table 9.14-2), which represents 8.4% of that in the LSA and 0.5% in the RSA.

Table 9.14-1. Area of Wolverine Suitable Denning Habitat in the Wildlife LSA and RSA of the Hope Bay Project

	Local Study Area		Regional Study Area	
Suitability Rating	Area (ha)	Percent (%)	Area (ha)	Percent (%)
Suitable	10,667	18.9	173,360	35.2
Not Suitable	45,673	81.1	313,620	63.8
Total	56,340		486,980	

Table 9.14-2. Wolverine Suitable Denning Habitat Lost in the Wildlife LSA and RSA due to the Hope Bay – Phases 1 and 2

Project Component	Habitat Lost			LSA (%)[1]			RSA (%)[2]		
	Phase 1[3]	Phase 2	Total	Phase 1	Phase 2	Total	Phase 1	Phase 2	Total
Boston Site	0	125	125	0	1.2	1.2	0	0.1	0.1
Doris Site	15	86	102	0.1	0.8	1	<0.1	<0.1	0.1
Existing Boston Exploration Camp	3	0	3	<0.1	0	<0.1	<0.1	0	<0.1
Madrid North	0	72	72	0	0.7	0.7	0	<0.1	<0.1
Madrid South	0	34	34	0	0.3	0.3	0	<0.1	<0.1
Madrid-Boston Road	0	585	585	0	5.5	5.5	0	0.3	0.3
Total	19	901	920	**0.2**	**8.4**	**8.6**	**<0.1**	**0.5**	**0.5**

[1] *Area of suitable denning habitat in the LSA = 10,666.8 ha*
[2] *Area of suitable denning habitat in the RSA = 173,359.9 ha*
[3] *Phase 1 refers to the Permitted Project, including the Doris Project and Madrid North exploration*

In total, the Hope Bay Project (the Permitted Project and Phase 2) will result in the loss of 920 ha of wolverine denning habitat. This represents 8.6% of the suitable denning habitat within the LSA and 0.5% of the suitable denning habitat within the RSA.

Summary of Potential Habitat Loss Effects

Mitigation includes siting Phase 2 infrastructure to avoid known wolverine dens, pre-clearing surveys if construction during the denning season and compliance with the *Nunavut Wildlife Act* if a den is found. Wherever feasible, reclamation will be conducted to restore habitat upon Closure. The amount of habitat loss due to Phase 2 is reduced because Phase 2 will use existing Doris Project infrastructure such as Doris site, Doris airstrip, Roberts Bay offloading facility, and the Madrid North and South sites. This minimizes the footprint of new development and reduces the area of habitat affected. In addition, the PDA overestimates the amount of habitat that will be lost as a result of Phase 2. Clearing will likely only occur on less than 30% of the PDA which will be determined once the Project layout is finalized.

With mitigation in place, a small area of suitable denning habitat will be affected for wolverine; approximately 0.5% of the RSA. Moreover, baseline studies indicated that the nearest wolverine den is approximately 4.5 km from the Phase 2 site and will therefore not be directly affected. This area of habitat loss is small but measurable, and so **a residual effect is predicted to occur for Phase 2**.

The Hope Bay Project will result in the loss of 0.5% of the suitable denning habitat in the RSA. The same mitigation proposed for Phase 2 has been carried out for the Permitted Project. No wolverine dens identified during baseline studies have or will be directly affected by the Hope Bay Project. The area of habitat loss is small but measurable, and so **a residual effect is predicted to occur for the Hope Bay Project**.

9.14.3.2 Disturbance

Phase 2 will produce some noise from blasting, facilities and aircraft (see Section 9.8.2 for more information). Wolverine are reported to be sensitive to human disturbance; with their home ranges correlated with remoteness from human development (May et al. 2006; Copeland et al. 2010). However, wolverine are known to occupy areas of elevated noise and to approach camps and active mines in Nunavut and Northwest Territories (Section 9.14.3.4). Furthermore, May et al. (2006) found that wolverine habitat selection within established home ranges was without regard of infrastructure. Therefore, **no residual effects** are predicted for wolverine due to Phase 2 or the Hope Bay Project.

9.14.3.3 Disruption of Movement

This section evaluates the potential for Phase 2 infrastructure to disrupt wolverine movement because roads can act as barriers to movement in many wildlife species (Jalkotzy, Ross, and Nasserden 1997). Connectivity has been shown to be important to maintaining viability in wolverine populations with wolverine re-occupying den sites or denning areas for several years (Copeland et al. 2010). Wolverine will be present and active in the RSA throughout the year and thus may interact with the all-season road connecting the Doris, Madrid, and Boston PDAs, access roads within the PDAs, and other site infrastructure. This effect is evaluated for the Construction through the Reclamation Phase when traffic on the Boston road ceases.

Studies report that vehicle traffic to the order of 4,000 to 10,000 vehicles per day can impose a barrier to movement for large wildlife species (Müller and Berthoud 1997), while roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). Few studies exist that have investigated the response of wolverine to roads and traffic, and those that have are not directly applicable to the Project. For example, a study of radio-collared wolverine in Idaho Copeland et al.

(2010) showed that wolverine avoided roads but traffic volumes were not investigated. In Norway, May et al. (2006) concluded that wolverines avoided both private and public roads but again traffic volumes were not investigated. However, in both studies, wolverine movements were examined in a varied landscape including lowland valley areas and adjacent mountainous areas. The study areas included private and public land, had road networks including paved highways, unpaved roads, and trails, and multiple land uses were noted as taking place, e.g., hunting and outdoor recreation. Copeland et al. (2010) did note that wolverines were most commonly associated with high-elevation remote habitats in the study area, which is 81% road-less, and that presence cannot likely be attributed to the avoidance of people, roads, or development. While these studies may have shown avoidance for roads by wolverine, it is possible that this avoidance may be attributable to the overall habitat selection for areas where roads were generally absent – alpine areas. Wolverine habitat selection in the tundra is expected to be different than in mountainous areas, and in the absence of relevant literature for wolverine, thresholds for traffic volumes developed for grizzly bear are used (>100 vehicles per day; Section 9.10.3.3).

The proposed 53 km Phase 2 road from Boston to Madrid will make up 85% of the Boston to Doris road and will carry approximately 33 return trips per day during peak traffic years (years 5 and 6); 2.8 vehicles per hour. The existing 9.5 km road from Madrid to Doris, makes up approximately 15% of the Boston to Doris road, will carry traffic both for Boston and Madrid, with approximately 98 return trips per day during Years 5 and 6; 8.2 vehicle trips per hour. The existing 4.8 km road from Doris to Roberts Bay, over which fuel and other supplies for Phase 2 are transported, will carry approximately 12 return trips per day during Years 5 and 6, or on average 1 vehicle trip per hour. This traffic is below the traffic volumes reported to cause most wildlife to avoid crossing roads.

Mitigation and management measures to reduce disruption of movement include enforcement of speed limits to limit noise and disturbance to wolverine and giving wildlife the right of way on the road. To be conservative, and using a threshold of 100 one way-trips per day a **residual effect** is predicted for wolverine.

9.14.3.4 Attraction to the Project

Wildlife attractants refer to Project-related human activities, infrastructure, or environmental changes that are of interest or provide resources to wildlife. Changes in spatial distribution and habitat selection have been observed for species attracted to anthropogenic activity, but mortality is perhaps of greater concern. Wolverine may be attracted to food sources, lubricants, and other odours at mining camps (COSEWIC 2014b). Wolverine occurrences and deterrence actions have been recorded at a variety of mines in Nunavut and Northwest Territories each year, including mortalities at the Meadowbank gold mine in Nunavut and Diavik Diamond mine in Northwest Territories (COSEWIC 2014b). The effect of attraction is anticipated to commence upon Construction when the camps are in use and continue throughout Operation and Reclamation/Closure Phases of Phase 2 while odorous materials are present on site.

Phase 2 activities will adhere to a Hope Bay Interim Non-hazardous Waste Management Plan (Volume 1, P4-13), the Incineration Management Plan (P4-16), and the WMMP (Volume 8, Annex V8-3). These plans include mitigation measures to store and remove all food wastes and wildlife attractants, erect fences in appropriate areas, remove carrion from roads, and monitor the waste management facilities. In addition, the Hope Bay Project Hazardous Waste Management Plan (P4-15) ensure that all chemicals will be contained and properly stored so that wolverine will not have access to these substances. Mitigation measures such as employee education in wildlife awareness and protocols in dealing with nuisance wildlife may also be implemented in the WMMP.

Long term monitoring at the Doris site has recorded incidental sightings of wolverine in all years between 2009 and 2016 and during most months of the year (Section 9.2.9.2). Wolverines were more commonly detected between February and May relative to the summer months, likely due to their high visibility against the snow and increased time spent in search of food. Wolverine attraction has been observed at the Doris Project infrastructure. Since 2007, the majority of attraction events involved wolverines' attraction to waste management and landfill facilities.

In November of 2010, one to three wolverines were recorded daily at either the Roberts Bay or Doris site by camp personnel. Noise deterrents and rubber bullets were used in response to deter wolverines. The waste management building at Roberts Bay was identified as the focus of the wolverines' attention in 2010. A skirting barrier was then installed to prevent wolverines from getting under the building and prevent denning opportunities. Staff at Doris Site evaluated the buildings for known and potential entry points for wolverines.

A review of mitigation measures and wildlife issues at other Arctic mines indicates that habituated wolverine are a rare occurrence when the project adheres to proper waste management and camp cleanliness protocols. Mitigation measures for the Project include a program to exclude wolverine from camps using skirting and fencing (where needed), a program of waste management for wildlife, and a camp and waste monitoring program to continuously monitor the site and trigger additional waste and site cleanup activities.

Effective waste and camp management, along with monitoring and adaptive management at Phase 2 sites will reduce the potential for attracting wolverines, which may become habituated and require deterrence, translocation or destruction. Despite these measures, the effect of attractants has the highest potential to bring wolverine into conflict with humans and have direct effects on wolverines and possibly wolverine populations if individuals are destroyed. Therefore, to be conservative, the potential effect of **attractants is predicted to result in a residual effect on wolverine** for both Phase 2 and Hope Bay Project.

9.14.3.5 Direct Mortality

This section evaluates the potential for direct mortality of wolverine due to traffic collisions. Monitoring at the Doris Project and other mining projects in Nunavut and Northwest Territories (Diavik, Ekati, Jericho, and Snap Lake) were reviewed. Two wolverine mortalities have been reported at mining developments in the North including one at Jericho in 2005 and one at Snap Lake in 2009. In the years during which personnel have been at Doris (2006 to 2016), there have been no reports of wolverine mortality from any causes, including vehicle collisions and aircraft strikes (Section 9.2.9.3).

Mitigation measures will include a speed limit of a maximum of 50 km/h to limit the potential for Phase 2 traffic to cause mortalities for wolverine. Wildlife mortalities must be reported immediately to the ESR Department and mortality of VECs, larger fauna, or those resulting from interaction with Project activity will be reported directly to GN DOE and KIA, as necessary. Given that direct mortality of wolverine is extremely unlikely and mitigation is expected to be successful at further reducing the changes of direct morality, **no residual effects of direct mortality are predicted** due to either Phase 2 or the Hope Bay Project**.**

9.14.3.6 Increased Access and Harvest

This section evaluates the potential for Phase 2 to facilitate access and thus result in increased hunting of wolverine. Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the RSA (Volume 6, Section 3). Thus, indirect mortality of wolverine due to increased hunter access from Phase 2 is not anticipated. Hope Bay Project policy

prohibits public access on site roads and hunting by employees on site. In addition, the *Nunavut Wildlife Act* prohibits hunting from a road or within 1 km of a dwelling or settlement, including Phase 2. Thus, Construction and Operation of site roads are not expected to cause an increase in wolverine mortality due to facilitation of hunter access and therefore **no residual effect of increased access and harvest is predicted** for Phase 2 or for the Hope Bay Project.

9.14.3.7 Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to activities prior to any development in the Hope Bay belt, due to the Approved Projects and due to the Hope Bay Project as a whole on ecological receptors (e.g., furbearers). The assessment determined that Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in wolverine due to Project activities. **Therefore, the potential effects of changes in environmental media quality are not considered as a residual effect on wolverine for either Phase 2 or the Hope Bay Project.**

9.14.4 Significance of Project-related Residual Effects for Wolverine

Three residual effects were predicted for wolverine; habitat loss, disruption of movement, and attraction to the Project site.

9.14.4.1 Habitat Loss

Baseline studies indicated that there are no wolverine dens within the planned PDA. A small amount of area that could be used for dens in the future will be removed, however, but this area is small when compared with the amount of rocky habitat suitable for making dens in the LSA and RSA. Moreover, the density of wolverines is not thought to depend on the availability of den sites, since wolverine can den in snow drifts and other features independent of the availability of rocky outcrops. The local wolverine population is expected to have a low sensitivity to this effect. Wolverine are sensitive to habitat loss at the scale that is observed in the south with multiple land uses (COSEWIC 2014b), however the population is expected to have good resilience to small areas of habitat loss, where over 99% of habitat is still available in the RSA.

The local wolverine population is expected to have good resilience to adapt to habitat changes. Overall, the population in Nunavut was estimated at 2,000 to 2,500 individuals (COSEWIC 2014b) and the population of wolverine in the Kitikmeot Region is reported to be fairly stable and robust (Cardinal 2004; Banci et al. 2005 in COSEWIC 2014).

Considering the above sensitivity and resilience of the local wolverine population to habitat changes, the magnitude of this effect is rated as negligible. The duration of habitat loss is long term (beyond the life of the Project) and reversible with effort because with Reclamation, the habitat will function as den sites. The frequency of habitat loss is intermittent, with the majority of habitat loss occurring during Construction, and infrequently thereafter as Project infrastructure is expanded. The geographic extent of habitat loss will be confined to the PDA.

The confidence of the effect occurring and in the proportion of habitat removed is considered high because the area removed is well understood, as are the attributes which make good denning habitat. Confidence in the results of habitat loss on wolverine habitat is considered high. Baseline surveys indicated no dens in the PDA. The probability of the effect occurring is likely, as a small but measurable amount of habitat will be lost to the PDA. The residual effect of habitat loss for wolverine is concluded to be **Not Significant** for both Phase 2 and the Hope Bay Project (Table 9.14-3).

Table 9.14-3. Summary of Residual Effects and Overall Significance Rating for Wolverine - Phase 2

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2									
Habitat Loss	negative	negligible	long	intermittent	PDA	reversible with effort	likely	Not significant	high
Disruption of Movement	negative	low	medium	intermittent	PDA	Reversible	likely	Not significant	low
Attraction to Project Site	negative	low	medium	intermittent	PDA	reversible	likely	Not significant	high
Hope Bay Project									
Habitat Loss	negative	negligible	long	intermittent	PDA	reversible with effort	likely	Not significant	high
Disruption of Movement	negative	low	medium	intermittent	PDA	Reversible	likely	Not significant	low
Attraction to Project Site	negative	low	medium	intermittent	PDA	reversible	likely	Not significant	high

9.14.4.2 Disruption of Movement

Traffic volumes for the Project vary by the section of road, with the existing section between Doris and Madrid, representing roughly 15% of the AWR route between Boston and Doris that will be used for Phase 2, carrying the highest traffic volumes and the longer section that will be built for Phase 2, linking Madrid to Boston, will carry lower traffic volumes overall. The volumes of traffic along the section to Doris to Madrid are below the levels where most wildlife will continue to cross the road, but using a conservative value of (>100 vehicles per day), this effect was rated as direct and adverse for wolverine.

The magnitude of this effect is rated as low, because traffic volumes across the entire length of roads that will carry Phase 2 traffic are variable, with only a short segment above the threshold where movements may be altered. Wolverine are expected to have a low sensitivity to this effect because it appears that avoidance of roads may be less prevalent in the northern populations (COSEWIC 2014). The local population is also considered to have resilience to this effect, given that the population in the area is considered to be stable and robust (Section 9.14.4.1).

The duration of disruption of movement is medium term and reversible because traffic will cease following closure of the Project. The frequency is intermittent, given that traffic volumes will vary along sections of road and during different years. The geographic extent is contained to the PDA. The probability of the effect occurring is likely, as traffic volumes along a short section of the AWR will carry traffic volumes above thresholds, although the confidence in assessment is low, given that there are no applicable studies for wolverine to determine whether movements may be altered at the projected traffic volumes. The residual effect of disruption of movement on wolverine is **Not Significant** for both Phase 2 and the Hope Bay Project (Table 9.14-3).

9.14.4.3 Attraction to the Project

The effect of attraction of Phase 2 to wolverine is characterized as direct and adverse if wolverine which are attracted to the site become habituated. Monitoring reports from Existing developments suggest that with proper waste management protocols, such as contained within the Wildlife Mitigation and Monitoring Program (WMMP; Volume 8, Annex V8-3) minimal numbers of individuals may become attracted to Phase 2 and no problem wolverine requiring destruction should be anticipated. The local wolverine population is considered to have a moderate sensitivity to this effect, as conflicts with resource development sites, e.g., attraction, is listed as one of the main threats to wolverine in northern Canada, along with the effects of harvest and declines in caribou as a food source (COSEWIC 2014). However, wolverine are expected to have a lower overall sensitivity to the further negative effects of attraction, e.g., destruction of problem animals, collisions, given that few wolverine mortalities have been reported at operating mines in NWT and Nunavut. The local population is also considered to have resilience to this effect, given that the population in the area is considered to be stable and robust (Section 9.14.4.1) and no problem wolverines are expected to be removed from the local population.

For this reason, the magnitude of the effect of attractants on wolverine is rated as low. The geographic extent is contained to the PDA. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used, but not after Reclamation and Closure. The frequency of wolverine attraction will be intermittent and reversible in the long term. The probability of the effect occurring is likely as wolverine have continued to be observed at the Doris mine and other northern mines despite application of mitigation and management measures in relation to waste and attractant management. The confidence in the assessment is high, as it is well documented that wolverine are attracted to mining camps though rare to result in mortality. The residual effect of attractants on wolverine is **Not Significant** for both Phase 2 and the Hope Bay Project (Table 9.14-3).

9.15 FURBEARERS – CUMULATIVE EFFECTS ASSESSMENT

Two potential effects were rated as residual effects for furbearers: habitat loss and attraction. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.15.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of furbearers are described in Section 9.5.7.

9.15.1.1 Spatial Boundary

The cumulative effects assessment for wolverine uses a spatial boundary set by the average home range size of a male wolverine, which is approximately 66,600 ha (Magoun 1985; Mulders 2000). Assuming that this home range is roughly circular, that yields a diameter of approximately 29.1 km. A 29.1 km buffer was applied to the Hope Bay Project to determine if other Projects may interact with the same wolverine that interact with the Hope Bay Project (Figure 9.15-1).

9.15.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.15.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Section 9.14.3 and 9.14.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for wolverine (furbearers) and cumulative effects for this VEC are not considered further.

9.16 RAPTORS – EFFECTS ASSESSMENT

9.16.1 Introduction

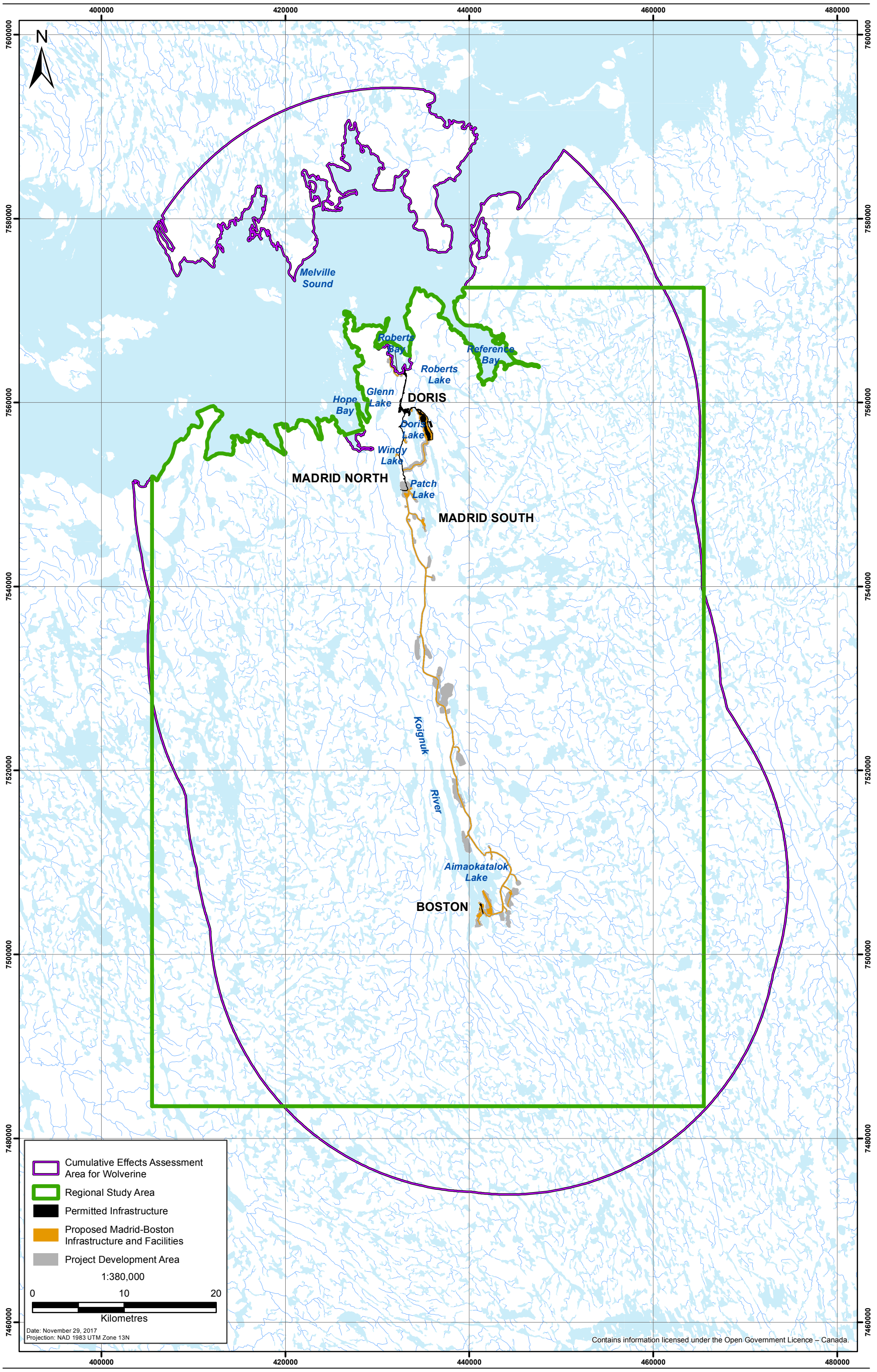
The potential effects of Phase 2 on raptors in the RSA are assessed in this section. Potential effects for all wildlife VECs were identified in Section 9.6.

The raptors VEC includes two species at risk; peregrine falcon which is a cliff-nesting species and short-eared owl which is a ground-nesting species (CESCC 2016; Government of Canada 2017). In addition, golden eagle are listed as Vulnerable in Nunavut (CESCC 2016). All of the raptor species in the RSA are cliff-nesting, with the exception of short-eared owl, snowy owl, and northern harrier. The assessment of raptors therefore evaluates the potential effects on cliff-nesting and ground-nesting raptors with special reference to peregrine falcon and short-eared owl, where appropriate.

Potential effects on raptors were included based on Inuit TK, community concerns expressed at meetings, professional judgement, experience at other similar projects in Nunavut and the scientific literature (Section 9.6). Potential Phase 2 and Hope Bay Project effects were evaluated, making reference to season and mine phase (i.e., Construction, Operation and Reclamation/Closure Phases) for raptors. Interactions of raptors with Project components were evaluated to determine which of the following potential effects may occur (Table 9.6-7):

- habitat loss;

Figure 9.15-1
Cumulative Effects Assessment Spatial Boundary for Wolverine (Furbearers)



- disturbance;
- disruption of movement;
- attraction to the Project;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Habitat loss will occur in all areas where new infrastructure overlaps with suitable habitat, which may include the expansion of the Roberts Bay and TIA facilities and the Construction of the new Boston road and Boston facility. This potential effect will begin during Construction and last through to Post-closure of Phase 2.

The potential for noise and the presence of personnel, vehicles, wind turbines, and other activities near raptor habitat to cause disturbances, which may alter regular raptor behaviour or cause avoidance of the site were evaluated. This potential effect will begin with Construction and continue through the Operations and Closure, and cease in post-Closure.

Tall structures with lights such as communications towers, transmission lines, and wind turbines can disrupt the movements of raptors (Erickson, Johnson, and Young Jr 2005). This potential effect is evaluated as beginning in Construction and ending in Closure when wind turbine infrastructure and the transmission line are decommissioned.

Direct mortality and injury from vehicle and aircraft strikes and collisions with wind turbine infrastructure and the transmission line was also evaluated for raptors. This potential effect is evaluated as beginning in Construction and ending at Closure when vehicles will stop traveling on Phase 2 roads, wind turbines cease operation, and tall structures are removed.

Increased access and harvesting was identified by the GN as a potential concern for game species when hunters are attracted to the Project site for logistical reasons and to use the proposed Project road to Boston as a travel route. However, Inuit TK indicates that hunters do not typically harvest raptors and so this potential effect is not considered further.

The potential for raptors to be attracted to the camps and Phase 2 Project infrastructure due to a potential for higher abundance of prey, waste, and suitable structures for cliff nesting species was also evaluated. This potential effect is would begin during Construction and end at Closure when the attractants will no longer be present on site.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into post-Closure.

Each potential effect is described in the following sections, and then evaluated as to whether or not it will occur with proposed mitigation and management. When potential effects are likely to occur they are further evaluated to determine if a residual effect will remain after mitigation actions are implemented.

9.16.2 Identification of Mitigation and Management Measures for Raptors

9.16.2.1 Mitigation by Project Design

Mitigation by Project design that is applicable to all wildlife includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive areas for wildlife;
- ensuring that all waste management facilities and Project buildings are wildlife-proof;
- maintaining equipment to minimize noise that may disturb wildlife; and
- construct tall structures using best management practices presented by the Avian Power Line Interaction Committee (APLIC 2006).

9.16.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding of wildlife;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil pollution plans, spill contingency plan and hazardous waste management.

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- minimize disturbance to vegetation communities;
- clearing and Construction at sensitive locations for ground-nesting raptors to occur outside of the sensitive time periods (breeding period) or to be accompanied by nest survey during sensitive periods;
- infrastructure will avoid identified cliff nesting habitat, where possible;
- If a raptor nest is located within Project footprints, the nest site will be avoided until it is no longer actively used (see also Mitigation for Disturbance);
- A permit from GN DOE will be obtained should the Project need to dissuade raptors from nesting on quarry walls or an inactive nest be removed; and
- minimize the size of the Phase 2 footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on raptors includes:

- construct and maintain equipment to minimize the production of noise – see Noise and Vibration (Volume 4, Section 3) and Noise Abatement Plan (Volume 8 Annex V8-8);

- monitor and adaptively manage noise – see Noise Abatement Plan (Volume 8 Annex V8-8);
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 8, Annex V8-3); and
- no-disturbance buffers surrounding active raptor nests identified during Construction.

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for raptors include:

- enforce speed limits on all Project roads;
- prompt removal of roadkill along all-weather roads;
- maintaining clean Project sites where any equipment or materials that could entangle or entrap wildlife are safely stored;
- monitoring of wind turbines for raptor mortality will be conducted for a period of two years of wind turbine operations during spring and fall migration, as per recommendations in Environment Canada (2007b). As a precautionary measure, adaptive management to reduce the potential effect will be triggered if the number of bird mortalities due to turbine strikes exceeds suggested guidelines (i.e., more than 2 raptors per year; OMNR 2011) or if any raptor species of conservation concern is recorded as experiencing mortality due to the turbines.
- in compliance with the Nunavut *Wildlife Act*, and under appropriate territorial permitting requirements, use of deterrents to dissuade raptors from nesting in quarries if nesting attempts observed in areas of active blasting; and
- clearing and construction at sensitive locations for ground-nesting raptors to occur outside of the nesting period, or if unavoidable, to be accompanied by nest surveys.

Mitigation for Increased Access and Harvest

Mitigation and management to reduce the potential for increased access and harvest of raptors and other wildlife include:

- no connection of all-weather roads to any communities;
- closure of all Phase 2 Project roads to the public; and
- a policy prohibiting hunting by Project staff and contractors while on site.

Mitigation for Attraction

Mitigation and management to reduce the potential for raptors to be attracted to Phase 2 Project development include:

- all building will be wildlife-proof;
- a policy of no wildlife feeding;
- prompt removal of roadkill along all-weather roads;
- monitoring of quarries for raptors attempting to nest; and
- use of deterrents to dissuade raptors from nesting in quarries if nesting attempts observed in areas of active blasting.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of raptors to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);
- fuels and chemicals are stored in wildlife-proof buildings;
- cyanide destruction inside the mill; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.16.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for raptors will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, waste management, vehicle-wildlife collisions or other incidents, water quality and incidental observations. Monitoring specific for raptors will include:

1. monitoring and reporting the size of the footprint;
2. local-area scans prior to blasting;
3. reporting of wildlife incidents
4. reporting of wildlife observations;
5. monitoring of quarries to determine if raptors are attempting to nest there;
6. monitoring of nesting sites to determine if disturbance from the Project is affecting occupancy or productivity of nests; and
7. monitoring of wind turbines and transmission line for raptor mortality.

9.16.3 Characterization of Potential Project-related Effects

9.16.3.1 Habitat Loss

This section evaluates the potential effects of habitat loss on raptors due to Phase 2 and the Hope Bay Project. Raptor territories in the RSA are well documented as a result of 10 years of baseline studies and monitoring for the Doris Project. Potential effects associated with habitat loss will likely occur in areas where Phase 2 Project infrastructure overlaps suitable raptor habitat. The proposed location of infrastructure takes raptor habitat into consideration and is designed to minimize and avoid wildlife sensitive areas (Section 3). However, some habitat loss and degradation may still occur.

Raptor habitat within the wildlife RSA was mapped using habitat suitability modelling with a two class rating system of suitable versus not suitable (Rescan 2011h). Assessment of the effect of habitat loss for raptors was based on:

1. Loss of cliff nesting sites identified through baseline studies and long term monitoring of the Doris Project. Cliff nesting sites were evaluated because they are fixed in space and physically constrained by topography and the location of cliffs.
2. Loss of suitable habitat for short-eared owl - area of suitable spring nesting and summer brooding habitat in the PDA, as a proportion of that area in the LSA and RSA.

The PDA includes five existing raptor nests but only one will is predicted to be lost within the Phase 2 footprint (Table 9.16-1). A rough-legged hawk nest last occupied in 2013 is situated along the cliffs on the western boundary of the TIA. The cliffs delineate the boundary of the TIA and thus activities associated with tailings storage may result in habitat loss at this location. This nest was noted as marginal during 2013, the last year that the nest site was occupied (Table 9.16-1); the nest site has been surveyed since 2004 and was not occupied in any other year. Three rough-legged hawk nests are situated along cliffs within the PDA but outside of potential footprints (Table 9.16-1). Though these fall within the PDA, the nests were identified on cliffs on the PDA boundary and thus are not anticipated to be cleared for Construction. A common raven nest is situated on the existing Boston camp infrastructure. The existing Boston camp is already considered lost and thus no additional habitat loss is anticipated for this location. Therefore, only one nest site within the PDA is likely to experience habitat loss – one rough-legged hawk nest within the expanded Phase 2 Project TIA that has been occupied inly 1 year in the past 13 years.

Table 9.16-1. Cliff-nests Located within the PDA

Project Area	Species	Territory ID	Years Surveyed Occupied
Tailings Impoundment Area	Rough-legged hawk	206	2013
Madrid North - TIA Road	Rough-legged hawk	212	2007, 2009-2014
Madrid North	Rough-legged hawk	214	2013
Madrid North - Waste Rock Pile	Rough-legged hawk	216	2007, 2009, 2013, 2014
Boston Camp	Common raven	509	2009-2011, 2013

Foraging habitat for cliff-nesting raptors was considered to be all vegetated ecosystems which are likely to support prey species such as upland birds, arctic ground squirrels, lemmings and other small mammals, as well as wetland and waterbodies that support waterfowl and shorebirds throughout the spring, summer, and fall. Vegetated ecosystems that may support terrestrial prey species comprise 72% of the LSA and 87% and the RSA and are thus not considered to be a limiting factor for raptors. Similarly, wetlands and waterbodies used by waterfowl and shorebirds are widely distributed in the RSA (Section 9.2), and thus this type of foraging habitat for raptors is also not limiting in the RSA.

Based on habitat suitability modeling for the short-eared owl, 3,353 ha of suitable spring nesting habitat for ground-nesting raptors will be removed within the PDA (Table 9.16-2) and 3,456 ha of suitable summer brooding rearing habitat (Table 9.16-3). This represents 8.3% of the suitable spring nesting habitat within the wildlife LSA and 1.7% in the wildlife RSA and 8.1% and 1.7% for the summer brood rearing habitat (Tables 9.16-2 and 9.16-3). A large portion of the LSA and RSA are considered suitable short-eared owl habitat yet short-eared owls have rarely been observed during baseline studies and long-term monitoring at Doris.

Table 9.16-2. Short-eared Owl Suitable Spring Nesting Habitat Lost in the Wildlife LSA and RSA due to the PDA

	Suitable Habitat Available		Suitable Habitat Lost due to PDA		Suitable Habitat Lost due to Hope Bay Project	
Area	Amount (ha)	% Area	Area (ha)	% of Habitat	Area (ha)	% of Habitat
Local Study Area	40,279	71.5	3,353	8.3	3,486	8.7
Regional Study Area	198,843	40.4	3,353	1.7	3,486	1.8

Table 9.16-3. Short-eared Owl Suitable Summer Brooding and Rearing Habitat Lost in the Wildlife LSA and RSA due to the PDA

	Suitable Habitat Available		Suitable Habitat Lost due to PDA		Suitable Habitat Lost due to Hope Bay Project	
Area	Amount (ha)	% Area	Area (ha)	% of Habitat	Area (ha)	% of Habitat
Local Study Area	42,411	75.3	3,456	8.1	3,608	8.5
Regional Study Area	200,975	40.9	3,456	1.7	3,608	1.8

To date, the Permitted Developments have not resulted in loss of any nest for cliff-nesting raptors. Therefore, the total number of cliff-nesting raptors affected by the Hope Bay Project is equal to the number affected by Phase 2. In total, the Hope Bay Project will result in the loss of 3,486 ha of suitable short-eared owl spring nesting habitat (Table 9.16-2) and 3,608 ha of summer brood rearing habitat is associated with the Hope Bay Project (including Phase 2 infrastructure) (Table 9.16-3).

Summary of Potential Habitat Loss Effects

Wherever feasible, Reclamation will be conducted to restore habitat upon Project Closure. The amount of habitat loss due to Phase 2 is reduced because Phase 2 will use existing Doris Project infrastructure such as Doris site, Doris airstrip, Roberts Bay offloading facility, and the Madrid North and South sites. This minimizes the footprint of new development and reduces the area of habitat affected. In addition, the PDA overestimates the amount of habitat that will be lost as a result of Phase 2. Clearing will likely only occur on approximately 30% of the PDA with the exact extent determined once the Project layout is finalized. Mitigation is anticipated to reduce but not completely eliminate the effect of habitat loss to raptors, and **thus a residual effect is predicted to occur for Phase 2 and the Hope Bay Project**.

9.16.3.2 Disturbance

The potential for Phase 2 to result in disturbance to raptors through noise or human presence was evaluated. Some studies have reported that disturbance can cause behavioural changes or changes in spatial distribution (Martínez-Abraín et al. 2010; Strasser and Heath 2013). Signs of disturbance include nest abandonment, avoidance of an area, sudden flight of startled adults, or premature fledging of juvenile birds. Moderate responses include increased vigilance and nest defense behaviour, which frequently involves initiation of flight by incubating or brooding adults (reviewed in Whittington and Allen 2008; Pagel, Whittington, and Allen 2010).

Research indicates that some raptor species can habituate to noise disturbance (e.g., successful nesting within 500 m of firing ranges; Lehman et al. 1999; Schueck, Marzluff, and Steenhof 2001; e.g., use of active military ranges) and some have been documented successfully fledging young each year from nests sites on the walls of active open pits at the Ekati diamond mine (e.g., Rescan 2012b, 2013e; ERM 2017b). The presence, motion, and noise generated from operating wind turbines can disturb

raptors, however many studies conclude that raptor displacement and avoidance of wind turbine areas is minimal (Madders and Whitfield 2006; Powlesland 2009).

Two methods were used to evaluate potential disturbance effects on raptors in the RSA.

1. Direct, observational data was used, based on the results of the long-term Doris Project monitoring program for raptors as part of the WMMP.
2. A literature review was conducted of the distance at which raptors are reported to respond to disturbances.

Long-Term Monitoring for the Doris Project

Long-term monitoring of four species of raptors as well as common raven, a functional raptor, for the Doris Project has been conducted between 2004 and 2016 to determine if disturbance from the Project altered the territory occupancy (use of territory by a breeding pair in the spring), breeding (proportion of occupied territories where young of any age are recorded during the summer productivity survey) or productivity (proportion of nests with confirmed breeding [young present] where young determined to be at least 80% of fledging age). The RSA has a large number of raptor nesting sites, such that most pairs of raptors have a territory that includes multiple nesting sites, only one of which is used each year. This analysis provides a rigorous assessment of potential effects of the Doris Project during potential effect years (2009 to 2011), and in the vicinity of the Doris Project (< 1,500 m from infrastructure).

Comprehensive analyses were conducted using a GAMM regression (Zuur et al. 2010) to assess whether or not distance from infrastructure had a differential effect on raptor territory occupancy or breeding activity. The differential change was assessed within 1.5 km and outside 1.5 km during potential effect years (years with construction activity) and non-effect years (years with little or no construction activity). As well, the pattern of occupancy rates across distance from infrastructure, as a continuous measure, was compared in potential effect and non-effect years. There was no evidence of a Project-related effect on raptor occupancy, and some evidence of a localized (<1.5 km from infrastructure) effect on raptor breeding during the potential effect years. There was not sufficient data to assess raptor productivity statistically. For a complete description of the analyses and results, see the 2016 WMMP report (ERM 2017a).

Flight Initiation Distance and Home Range Size

Literature suggests that 1.5 km is a robust estimate of the distance from activities at which raptors may experience threat from disturbances that is severe enough to initiate flight as a form of nest defense (flight initiation distance; FID). This distance (1.5 km) mirrors the recommended set back distance for limiting disturbance to raptor nests within the Northern Land Use Guidelines for seismic operations (Aboriginal Affairs and Northern Development Canada (AANDC) 2011) and is consistent with available literature (Richardson and Miller 1997; Whittington and Allen 2008; Martínez-Abraín et al. 2010; Aboriginal Affairs and Northern Development Canada (AANDC) 2011; Keeley and Bechard 2011).

Fifty-one raptor territories were identified within 1.5 km of proposed Phase 2 infrastructure (Table 9.16-4). However, it is unlikely that all 51 territories could be occupied in any given year; territory occupancy rates, as recorded during raptor monitoring for the Doris Project, in 2013 through 2015 were generally less than 50% (Section 9.2.10.2). The raptor territories in the RSA commonly include multiple nest sites, with a single nest site occupied in a given territory each year. Many of the territories which may experience disturbance effects include nest sites both within and outside of the 1.5 km FID. This suggests that multiple options for nesting remain even when a portion of a territory experiences disturbance effects.

Migratory standwatch surveys during the spring and fall of 2017 and long-term monitoring for the Doris Project indicated that some raptors forage and nest near the proposed wind turbine sites (Section 9.2.10.2). The short-eared owl, a ground-nesting species of conservation concern, was observed at the Doris survey site during spring migration surveys, and the ground-nesting snowy owl occurs in the area and has the potential to nest in the vicinity of the wind turbines (EDI 2017), although no nests have been reported for this species during 10-years of bird monitoring (Section 9.2.10.2). Among the 51 raptor territories that were identified within 1.5 km of proposed Phase 2 infrastructure, 14 territories were within 1.5 km of wind turbines (Table 9.16-4). The nearest raptor territory to wind turbine infrastructure was a rough-legged hawk nest located 141.2 m from the wind turbine pad in the Doris area (Table 9.16-4). This territory has been active in 2 of the 4 years monitored (2012-2015), despite its close proximity (24.3 m) from the Doris-Windy AWR, and may be in lower quality breeding habitat.

The majority of studies that indicate disturbance effects are conducted at larger scale wind farm facilities; impacts of a small wind farm (< 10 turbines) are expected to have minimal effects on individuals or populations (Drewitt and Langston 2006; Madders and Whitfield 2006; Powlesland 2009). With only two wind turbines proposed at the Project site for each of the three areas within the LSA that are situated several kilometres apart, the disturbance to raptors associated with the construction and operation of the wind turbines is expected to be minimal.

An additional two raptor territories were within 1.5 km of existing Doris infrastructure. Therefore, an additional two pairs may have already been exposed to disturbance due to Doris development and Operation (Table 9.16-4). Thus, up to 53 raptor territories will interact with the Hope Bay Project.

Table 9.16-4. Raptor Territories within Disturbance Buffers for Proposed Infrastructure

Species	Distance to Nearest Phase 2 Component (m)	Nearest Phase 2 Component	Inside PDA
Common raven	0.0	Existing Boston Exploration Camp	Yes
Rough-legged hawk	0.0	Tailings Impoundment Area	Yes
Rough-legged hawk	12.1	Quarry AH	No
Common raven	45.6	Crown Pillar Recovery Trench	No
Rough-legged hawk	119.2	Madrid North-TIA Road	No
Rough-legged hawk	135.4	Quarry Z	No
Rough-legged hawk*	141.2	Wind Turbine Pad	No
Rough-legged hawk	146.1	Madrid-Boston Road	No
Peregrine falcon	157.6	Quarry Z	No
Rough-legged hawk	159.7	Quarry Z	No
Gyrfalcon	166.4	Quarry Z	No
Rough-legged hawk	197.4	Madrid-Boston Road	No
Common raven	199.8	Madrid-Boston Road	No
Gyrfalcon	199.8	Madrid-Boston Road	No
Gyrfalcon	219.4	Madrid-Boston Road	No
Peregrine falcon	220.8	Madrid-Boston Road	No
Golden eagle	222.9	Madrid-Boston Road	No
Rough-legged hawk	227.6	Quarry T	No
Rough-legged hawk	230.8	Madrid-Boston Road	No
Common raven	239.0	Secondary Road	No

Species	Distance to Nearest Phase 2 Component (m)	Nearest Phase 2 Component	Inside PDA
Rough-legged hawk*	279.4	Madrid-Boston Road	No
Peregrine falcon*	305.8	Vent Raise Access Road	No
Peregrine falcon	307.5	Madrid-Boston Road	No
Rough-legged hawk	401.9	Crown Pillar Recovery Trench Access Road	No
Golden eagle*	435.6	Madrid-Boston Road	No
Gyrfalcon*	435.7	Madrid-Boston Road	No
Rough-legged hawk	444.6	Crown Pillar Recovery Trench Access Road	No
Rough-legged hawk*	470.3	Doris Fresh Water Intake	No
Peregrine falcon*	483.6	Madrid-Boston Road	No
Peregrine falcon	539.5	Crown Pillar Recovery Trench Access Road	No
Peregrine falcon	543.0	Quarry M	No
Golden eagle	549.0	Quarry M	No
Common raven*	549.1	Doris Fresh Water Intake	No
Peregrine falcon*	552.3	Doris Fresh Water Intake	No
Rough-legged hawk	561.9	Quarry M	No
Rough-legged hawk*	592.5	Quarry AH	No
Golden eagle	604.4	Tailings Impoundment Area	No
Gyrfalcon*	606.3	Quarry AH	No
Peregrine falcon*	606.3	Quarry AH	No
Rough-legged hawk*	708.0	Doris Fresh Water Intake	No
Rough-legged hawk	791.7	Madrid North-TIA Road	No
Gyrfalcon	791.7	Madrid North-TIA Road	No
Peregrine falcon	827.4	Crown Pillar Recovery Trench	No
Common raven	858.6	Crown Pillar Recovery Trench Access Road	No
Rough-legged hawk*	964.6	Madrid North-TIA Road	No
Common raven	998.8	Crown Pillar Recovery Trench Access Road	No
Gyrfalcon	1,007.8	Madrid-Boston Road	No
Peregrine falcon	1,007.8	Madrid-Boston Road	No
Rough-legged hawk	1,311.7	Madrid-Boston Road	No
Peregrine falcon	1,311.7	Madrid-Boston Road	No
Rough-legged hawk	1,486.0	Boston Water Discharge	No

** raptor territories located within 1.5 km of a wind turbine*

No-disturbance buffers surrounding active raptor nests identified during Construction will reduce the potential effects of disturbance. Mitigation for disturbance is expected to lower but not completely eliminate the effect of disturbance to raptors. Thus, a **residual effect of disturbance is predicted** for raptors.

Summary of Potential Disturbance Effects

Mitigation to reduce potential effects of disturbance on raptors will include designing and purchasing equipment to minimize noise and maintaining appropriate flight elevations and setbacks from raptor nests. Mitigation is anticipated to reduce but not completely eliminate the effect of disturbance caused by Phase 2 on raptors. Long term monitoring of the Doris Project reported that mitigation measures have largely been successful and no effects of disturbance were observed on raptor nest occupancy. However, to be conservative, **a residual effect of disturbance on raptors is predicted to occur for Phase 2 and the Hope Bay Project**.

9.16.3.3 Disruption of Movement

Disruption to movement may occur should raptors alter their local flight path or migration route to avoid wind turbines (Powlesland 2009). Research indicates that this is a concern at large windfarms . Powlesland (2009) identified seabirds and soaring raptors as potentially vulnerable to collisions with turbines due to their slow maneuverability. Extended rows of wind turbines in large wind farms can act as barriers to local or seasonal movements of birds (Langston and Pullan 2003), particularly if the spacing between adjacent wind turbines is less than 200 m apart (Percival 2001).

During migratory standwatch surveys, several raptors were observed at turbine height (i.e., between 50 and 200 metres above ground level) but far fewer raptors were observed within the potential zone of interaction with wind turbines (i.e., flying between 50 and 200 metres above ground level and on a flight trajectory towards the wind turbines), where diversion around infrastructure would be necessary to avoid collision with wind turbines (Section 9.2.10.2). During spring surveys, 30% of raptors (seven of 23 raptors observed) were flying at turbine height in the Doris area during spring, and only 14% (n=1) of raptors flying at turbine height were within the potential zone of interaction. During fall surveys, 53% of raptors (14 of 26 raptors observed), five of which (36%) were within the potential zone of interaction with the wind turbine at the Doris and Boston area. Raptor diversion distances around wind turbines are expected to be minimal because the three wind turbine sites are located several kilometers apart (range 6.5 km to 35.8 km) with adjacent turbines being a minimum of 530 m apart. Migration through the area is broad front (i.e., no concentrated movement "corridor"), and not hindered by landscape features. No residual effects of disruption to movement are therefore predicted for raptors due to the wind turbines. With mitigation and management outlined in the WMMP**, no residual effects of disruption of movement are predicted for raptors due to Phase 2 or the Hope Bay Project**.

9.16.3.4 Attraction to the Project

This section evaluates the potential for raptors to be attracted to Phase 2 due to road kill of small mammals along roads, and to the rock faces of quarries as nesting sites. The carrion consuming raptors such as rough-legged hawk, golden eagle, and bald eagle could theoretically be attracted to roadsides if roadkill is frequent and not managed. This could increase the potential for collisions of raptors with vehicles (Whittington and Allen 2008). The removal of any road kill from roads and controlled speed limits of a maximum of 50 km/h will reduce this potential effect. No collisions between vehicles and raptors have been reported at the Doris Project. Thus, the potential for road kill to attract raptors is not considered further.

The rock faces created at quarries may provide nesting habitat for cliff-nesting raptor species. Nesting raptors have been documented at other Arctic mines including Ekati, Diavik, Meadowbank and Mary River mines and at other mines globally. Quarry walls may provide cliff faces suitable for cliff-nesting raptors. The use of quarries by nesting raptors (and common ravens) has the potential to affect Operation, as the *Nunavut Wildlife Act* prevents the destruction of nests occupied by a bird or its eggs.

The Ekati mine is located in an area of tundra with very few cliff areas. This mine includes several open pits which are substantially larger (over 1 km wide) and deeper than the proposed Phase 2 quarries. Monitoring at these open pits indicates that up to three pairs of raptors may attempt to nest in an open pit in any given year (e.g., Rescan 2012b, 2013e).

In contrast, the Doris Project has quarries which are similar in size to those proposed for Phase 2. To date, there are no incidental reports of raptors attempting to or successfully nesting on these quarry walls. The individual faces of the quarry walls are approximately 10 m tall, making them relatively poor quality nesting habitat. The large number of naturally-occurring cliff nesting sites in the RSA likely make the quarries an undesirable nesting location for raptors.

The WMMP includes monitoring of quarry walls for evidence of nesting raptors. If nesting attempts are observed within areas of active blasting, mitigation will be triggered and deterrents will be used to dissuade raptors from nesting in quarries. Deterrents may include noise deterrence, removal of nesting material prior to egg laying, or physical deterrents placed over established nest sites without eggs. Ekati mine has employed a similar program using noise and physical deterrents which has been successful in preventing establishment of nests within active pits. Potential nesting pairs (including peregrine falcon, common raven, and rough-legged hawk) have returned to attempt to nest within an active pit but have been successfully deterred (ERM 2015c). No cases of mortality or injury have been observed at Ekati as a result of deterrence methods.

Raptors are unlikely to be attracted to the quarry walls of Phase 2 for three reasons. The Doris Project has used similar quarries as the proposed Phase 2 Project for several years without any records of raptors attempting to use the quarries for nesting. The relatively low quarry wall height reduces the quality, and attractiveness, of the quarries as nesting habitat. Finally, due to the geology in the RSA, there are abundant nesting locations available for raptors. With mitigation and management outlined in the WMMP, **no residual effects of attraction are predicted for raptors due to Phase 2 or the Hope Bay Project**.

9.16.3.5 Direct Mortality

The potential for direct mortality of raptors due to 1) vegetation clearing and construction, 2) due to collisions with vehicles, 3) collisions with aircraft, 4) collisions with tall structures (wind turbines, towers and guy-wires) were evaluated.

Mitigation measures for the Project are expected to eliminate the effect of mortality and injury due to vegetation clearing. These measures include preferential ground clearing outside of the nesting period and pre-clearing nest surveys prior to clearing during the nesting periods. Thus, mortality and injury of raptors is not expected to occur as a result of ground clearing.

No raptor-vehicle collisions have been recorded in the 11 years of monitoring at the Doris Project and thus raptor collisions with ground vehicles servicing Phase 2 are not expected to occur. This is also consistent with monitoring at other operating mines in the Arctic. Monitoring at the Ekati mine reports that one rough-legged hawk, one common raven, and one short-eared owl have been struck by vehicles in nearly 20 years of operation (ERM Rescan 2014c). Other operating Arctic mines such as Snap Lake, Diavik, Jericho, and Meadowbank have reported no vehicle-related mortality of raptors in recent years (Golder 2008b; Gebauer 2010; Golder 2014, 2015). Removal of small mammal carcasses will be employed at Phase 2 (Volume 8, Annex V8-3), which will lessen the potential for raptor scavenging along road routes, thereby limiting the potential for raptor collisions.

The potential for collisions between aircraft and raptors has been monitored at other Arctic mines. The overall likelihood of raptors being stuck by aircraft servicing the Project is expected to be very low, as Doris as well as several operating mines in the region (e.g., Ekati, Snap Lake, Diavik) have recorded zero incidences of a raptor-aircraft collision (ERM Rescan 2014c; Golder 2014; ERM 2015c; Golder 2015). The monitoring for birds is conducted prior take-off and land for safety of personnel but will also mitigate potential effects on raptors. In flight raptor-aircraft collisions are expected to be very rare, as all aircraft associated with the Project will avoid raptors (and other birds) and maintain minimum flight altitudes above 300 m when possible (with the exception of take-off and landing), which is well above the altitude where the majority of collisions are known to occur (Blackwell and Wright 2006).

Large birds such as raptors are sometimes at risk of electrocution, as these birds are known to use transmission line structures for perching or nesting and have wingspans that may allow them, on some older and lower voltage designs, to touch both the conductor and the ground wire or structure at the same time (APLIC 2006). The risk of electrocution is mostly based on the type of transmission line and the configuration of electrical hardware and support structures (Lehman, Kennedy, and Savidge 2007). Mitigation has proved successful in managing direct mortality due to electrocutions. Any transmission lines constructed during Phase 2 will be constructed using best management guidelines presented by the Avian Power Line Interaction Committee (APLIC 2006) to minimize any effects on bird populations. Monitoring at other Arctic mines has not reported any raptor mortalities due to strikes on towers or guy-wires, and mitigation is expected to be successful at further reducing the chances of collisions with towers and guy-wires (APLIC 2006).

The potential for direct morality of raptors species due to interactions with tall structures such as wind turbines, transmission lines, towers and guy-wires is relatively low in comparison to other species groups (i.e., passerines) since raptors and common ravens are better able to manoeuvre around structures (Manitoba Hydro 2010; Otter et al. 2014). Raptor collisions with tall structures can occur under certain circumstances, typically when infrastructure is installed on cliffs or ridge tops used for soaring, towers are tall, the area is prone to fog, night time migration pathways intersect infrastructure, and towers are located such that red flashing aviation warning lights are required, that can temporarily blind raptors and other birds (Kingsley and Whittam 2005; Powlesland 2009; National Wind Coordinating Collaborative (NWCC) 2010). When combined with high bird abundance and regularly used areas (e.g., migration corridors, approach flyways to nests), these circumstances can increase the collision risk for birds.

Raptor collisions with wind turbines have been be reported in low numbers at other projects in Canada (Bird Studies Canada 2017) and elsewhere in North America (American Wind Wildlife Institute (AWWI) 2017). Across 83 wind energy projects in Alberta, Ontario, and Atlantic Canada, 9.4% (324 individuals) of all bird mortalities were of raptors, corresponding to average annual raptor mortality estimates of 0.09 ± 0.02 birds/turbine in Alberta, 0.24 ± 0.004 birds/turbine in Ontario and 0 ± 0 birds/turbine in Atlantic Canada species (Bird Studies Canada 2017). At a wind energy site in operation in the Arctic (Diavik Project) that consists of four 9.2 megawatt wind turbines, post-construction monitoring has reported zero raptor strikes since the turbines began operating in 2012 (D. Wells, RioTinto, personal comm).

At the Hope Bay Project, the conditions that increase collision risk with wind turbines are either not met by Phase 2, or are predicted to occur infrequently throughout the raptor migration and breeding period. The proposed wind turbine locations for the Project are situated away from topographical features that would be likely to attract or focus raptors movement; baseline studies indicated that migration through the Project area is broad-front with no apparent barriers to, or concentrated areas of movement (Section 9.2.10.2). Based on the TMAC daily runway weather report (TMAC, unpublished data), there are only two days in each of the months of August, September and October (months with shortened photoperiod) when the ceiling was less than 640 feet (200 meters), which would only marginally

increase the potential for raptor collisions with the wind turbines due to poor weather during nocturnal migration.

Baseline studies during migration confirmed that some raptor species do fly at heights and along trajectories where they could intersect with the proposed wind turbines, representing 14% (n=1) of 23 raptors observed flying at turbine height in the Doris area during spring migration and 36% (n=5) of the 26 raptors recorded flying at turbine height in the Doris and Boston area during fall migration (Section 9.2.10.2).

The overall raptor mortality rates due to collisions with wind turbines are low in Canada and raptor movement through the Project area is broad-front with no topographic features constraining movement near the wind turbines, and there are few territories are near the proposed wind turbines. There is a small potential of increased mortality risk for raptors in the Project area due to collision with wind turbine blades. Thus, a **residual effect of direct mortality is predicted** for raptors due to Phase 2 and the Hope Bay Project.

Summary of Potential Mortality Effects

Direct mortality to raptors due to vegetation clearing and construction, collisions with vehicles, and collisions with aircraft are extremely unlikely and mitigation is expected to be successful at further reducing the chances of direct morality. Raptor mortality may occur during operation due to collisions with wind turbines or powerline however the proposed wind turbines are situated away from topographical features likely to attract raptors (e.g., ridge tops) and migration through the Project area is broad-front with no apparent barriers to, or concentrated areas of movement. Mitigation by design is anticipated to reduce the effect of direct mortality to raptors; however, fatality rates can be site-specific and variable. Mitigation is anticipated to reduce but not completely eliminate the effect of mortality caused by Phase 2 on raptors therefore; **a residual effect of direct mortality on raptors is predicted to occur for Phase 2 and the Hope Bay Project**.

9.16.3.6 Changes in Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to activities prior to any development in the Hope Bay belt, due to the Approved Projects and due to the Hope Bay Project as a whole on ecological receptors (e.g., raptors). The assessment determined that Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in raptors due to Project activities. **Therefore, the potential effects of changes in environmental media quality are not considered as a residual effect on raptors for either Phase 2 or the Hope Bay Project.**

9.16.4 Significance of Project-related Residual Effects for Raptors

Three potential effects were rated as residual effects for raptors; habitat loss, disturbance, and direct mortality. This section evaluates the significance of these residual effects, which are summarized in Table 9.16-5.

9.16.4.1 Habitat Loss

The construction and operation of Phase 2 and the Hope Bay Project will result in five cliff nesting sites being located within the PDA, and the likely loss of one of these nest sites. However, this nest site was deemed poor quality during surveys and has only been occupied one year in the last 13 years of monitoring. Loss of some suitable short-eared owl habitat will also occur in the PDA.

Table 9.16-5. Summary of Residual Effects and Overall Significance Rating for Raptors

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2 Project									
Habitat loss	Negative	Low	Long	Infrequent	PDA	Reversible with effort	Likely	Not significant	High
Disturbance	Negative	Low	Medium	Intermittent	RSA	Reversible	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not significant	Medium
Hope Bay Project									
Habitat Loss	Negative	Low	Long	Infrequent	PDA	Reversible with effort	Likely	Not significant	High
Disturbance	Negative	Low	Medium	Intermittent	RSA	Reversible	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not significant	Medium

This loss of habitat will be a negative effect for raptors, with negligible magnitude for cliff-nesting raptors and low magnitude for short eared owl. The magnitude for cliff-nesting raptors is rated as negligible as it is expected that the local community has a low to moderate sensitivity to habitat changes. The cliff-nesting raptor community is composed of species that are widespread and abundant and are not of conservation concern, i.e., species that are listed as Secure in Nunavut, as well as species that are listed territorially and federally, such as golden eagle, gyrfalcon, and peregrine falcon. These species that are of conservation concern federally may be the more sensitive to habitat changes, although the main threat to the only species listed under Schedule 1 of SARA, peregrine falcon, is the use of pesticides and toxic chemicals that could cause population declines (Environment and Climate Change Canada 2017b). Habitat loss and disturbance as a result of development activities for peregrine falcon are listed as overall low concern and low severity threats, given that development projects are subject to environmental assessments that contain mitigation to avoid and/or minimize effects to the species and that jurisdictions may also protect nest sites by law, e.g., under *Wildlife Act* (Environment and Climate Change Canada 2017b). The cliff-nesting raptor community is expected to have some resilience to adapt to habitat changes because the community is composed of species that are not currently at risk and thus can be considered to have stable or increasing populations, and the populations of those more sensitive species (peregrine falcon) appear to be stable in the Canadian arctic (Section 9.2.10.1). The magnitude of the effect is rated as low for short-eared owl because of the species sensitivity and resilience to the potential effect. Loss and alteration of nesting and winter habitat across the Canadian range of short-eared owls is considered to be one of the major threat to the species (COSEWIC 2008; Environment Canada 2016). Therefore, the local short-eared owl is expected to be sensitive to habitat changes but this is expected to be a low sensitivity since overall the loss accounts for less than 2% of the available good quality nesting and brood-rearing habitat within the RSA. The local population is expected to have some resilience to adapt to habitat change based on the Canadian population trends, as current population trends for Nunavut are not known. While Canadian population trends do indicate that the population appears to have declined over the last five decades, there is evidence that the population has stabilized recently (between 2002 to 2012) (COSEWIC 2008; Environment Canada 2016).

Habitat loss for raptors will occur during Construction of Phase 2 and continue through post-Closure and so will be of long-term duration. Habitat loss will occur infrequently during Construction as the Project is built and is limited to the PDA. Closure and Reclamation of the site will reverse the effect of habitat loss in some areas, but not in other areas where no reclamation is planned or possible. The residual effect of direct habitat loss is therefore expected to be **Not Significant**. Confidence is this assessment is high, because raptor habitat is well documented for this area.

Habitat loss was predicted as a residual effect for the Hope Bay Project. The Hope Bay Project will not result in any additional loss of any cliff-nesting habitat for raptors beyond what is lost as a consequence of Phase 2. The magnitude of this effect is rated as low because only 8.4% of suitable short-eared owl habitat in the LSA and 1.7% in the RSA will be affected for nesting habitat and 8.4% and 1.7% for brooding rearing habitat. All other ratings are predicted to be the same as the Phase 2 Development. The residual effect of direct habitat loss is therefore expected to be **Not Significant**. Confidence is this assessment is high, because raptor habitat is well documented for this area.

9.16.4.2 Disturbance

Long term effects monitoring of raptors for the Doris Project reported no effects of disturbance in terms of territory occupancy; occupancy was no different between potential effect and non-effect years at territories within 1.5 km of the Project than at a greater distance away. There was some indication of a differential probability of breeding in occupied territories within 1.5 km of infrastructure between potential effect and non-effect years, with higher breeding probability in non-effect years.

However, this result should be interpreted with caution since there were large confidence intervals associated with the probability of breeding at territories within 1.5 km of infrastructure during non-effect years. Noise or presence of wind turbines may deter raptors from using habitat close to these structures. In order to be conservative, this potential effect was rated as a residual effect.

The residual effect of disturbance due to Phase 2 was rated as a negative residual effect with low magnitude because of the results of the Doris Project monitoring and the expected sensitivity and resilience of the local raptor populations (Section 9.16.4.1). The duration was rated as medium-term, for the life of Phase 2. The frequency would be intermittent, due to passing aircraft, blasting, or passing vehicles. The geographic extent of the residual effect is limited to the RSA following a literature review of potential effects of disturbance on raptors showing that disturbance effects may extend out to 1.5 km from the source. The residual effect is rated as reversible with Closure of the Project. The probability is moderate and the residual effect is **Not Significant**. The confidence is rated as high because the results of the long term monitoring results indicate that there have not been any disturbance effects on raptor occupancy due to the Doris Project. Few raptors would potentially be affected, and these raptors make up a very small proportion of the total population in the RSA and so there is little chance of population-level effects on this VEC.

The residual effect of disturbance due to the Hope Bay Project was given the same ratings as that of Phase 2. The magnitude of the potential effect was rated as negligible because the results of long-term monitoring at the Doris Project indicated that there have been no effects of disturbance on raptor occupancy to date. Likewise, the analysis using the literature value of 1.5 km for FID indicated that there would be few effects on raptors. Overall, the residual effect of disturbance on raptors due to the Hope Bay Project was rated as **Not Significant**. The confidence was rated as high for the same reasons provided above for Phase 2.

9.16.4.3 Direct Mortality

Post-construction monitoring conducted at wind turbines in the Arctic (Diavik Diamond Mine) has reported zero avian strikes (D. Wells, RioTinto, personal comm), however raptor fatalities have been reported at larger wind farms in southern Canada. To be conservative, as fatality rates can be site-specific, the potential effect of direct mortality for raptors was rated as a residual effect. The resiliency of raptors to this effect is considered to be moderate, with local populations of species of conservation concern (peregrine falcon, short-eared owl and golden eagle) having a lower capacity to recover from loss of individuals since other studies have concluded that wind turbines are unlikely to cause population level effects if projects are not built in important habitats and there is no mortality of species at risk (Zimmerling et al. 2013). The sensitivity is expected to be moderate given the cliff-nesting raptor community is composed of species that are not currently at risk or more sensitive species (peregrine falcon) appear that to be stable in the Canadian arctic, whereas the ground nesting species, the short-eared owl, is experiencing population declines (Section 9.2.10.1). Collisions with infrastructure was identified as a limiting factor known to contribute to morality of adults, though is likely not a significant long-term factor in the species' decline (COSEWIC 2008).

The potential direct mortality due to Phase 2 is a negative residual effect with low magnitude because migration through the Project area is broad-front, with no barriers for raptor movement that would concentrate movements through the rotor swept areas; and based on the results from post-construction monitoring of other wind turbines operating in the Arctic in which no avian strikes have been reported. This is a medium duration effect occurring while the turbines are operational, during the life of the Project. The frequency will be continuous, and the geographic extent of the effect is confined to the turbine locations. The residual effect is fully reversible because when the turbines are decommissioned, the added mortality risk is eliminated. Post-construction monitoring will allow for

adaptive management of turbines if fatalities are reported. The probability is moderate and the residual effect is not significant. The confidence is medium, as post-construction monitoring indicates that raptor fatalities from wind turbines in the Arctic are unlikely. Very few raptors are likely to be affected, and these raptors make up a small proportion of the total population in the RSA, so there is low risk and it is unlikely that population-level effects on raptors will be observed.

The residual effect of direct mortality due to the Hope Bay Project was given the same ratings as that of Phase 2. The Hope Bay Project will not result in any additional direct mortality for raptors beyond that indicated for Phase 2. The magnitude of the potential effect was rated as low due to the reasons provided for Phase 2. Overall, the residual effect of direct mortality on raptors due to the Hope Bay Project was rated as **Not Significant**. The confidence was rated as medium for the same reasons provided above for Phase 2.

9.17 RAPTORS – CUMULATIVE EFFECTS ASSESSMENT

Three potential effects were rated as residual effects for raptors; habitat loss, disturbance, and direct mortality. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.17.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of raptors are described in Section 9.5.7.

9.17.1.1 Spatial Boundary

The cumulative effects assessment for raptors considers the RSA as the spatial boundary. The RSA is large enough to encompass entire summer home ranges of raptors and a representative set of the regional population.

9.17.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.17.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Section 9.16.3 and 9.16.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for raptors and cumulative effects for this VEC are not considered further.

9.18 WATERBIRDS – EFFECTS ASSESSMENT

9.18.1 Introduction

The potential effects of Phase 2 on waterbirds within the wildlife Regional Study Area (RSA) are assessed in this Section. Potential effects for all wildlife VECs were identified in Section 9.6.

Potential effects on waterbirds were included based on Inuit TK, community concerns expressed at meetings, professional judgement, experience at other similar projects in Nunavut and scientific literature (Section 9.6). Potential Phase 2 and Hope Bay Project effects were evaluated, making

reference to season and mine phase (i.e., Construction, Operation and Reclamation/Closure Phases) for waterbirds. Interactions of waterbirds with Phase 2 Project components were evaluated to determine which of the following potential effects may occur (Table 9.6-8):

- habitat loss;
- disturbance;
- disruption to movement;
- attraction to the Project;
- direct mortality;
- increased access and harvest; and
- changes in environmental media quality.

Habitat loss will occur in all areas where new infrastructure overlaps with suitable habitat, which may include the expansion of the Roberts Bay and TIA facilities and the Construction of the new Boston road and Boston facility. This effect will begin during Construction and last through to post-Closure of the Project.

Noise and the presence of personnel, vehicles, aircraft, wind turbines, and other activities near waterbird habitat may cause disturbances, which may alter their regular behaviour or cause avoidance of the site. This potential effect will begin with Construction and continue through the Operations and Closure, and cease in post-Closure.

Tall structures with lights such as communications towers, transmission lines, and wind turbines can alter the movements of raptors (Erickson, Johnson, and Young Jr 2005). This potential effect is evaluated as beginning in Construction and ending in Closure when wind turbine infrastructure and the transmission line are decommissioned and removed.

Direct mortality and injury from vehicle and aircraft strikes, and collisions with turbine infrastructure and powerlines was evaluated for raptors. This potential effect is evaluated as beginning in Construction and ending at Closure when vehicles will stop traveling on Phase 2 roads, aircraft are no longer required, and wind turbines and the transmission line will cease operations.

Increased access and harvesting was identified by the Government of Nunavut as a potential concern when hunters are attracted to the Project site for logistical reasons and to use the proposed Project road to Boston as a travel route. This potential effect would begin at Construction and continue into post-Closure.

There is potential for waterbirds to be attracted to TIA and any other areas used as water storage. This potential effect is would begin during Construction and end at Closure when water storage will no longer be used.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into post-Closure.

Each potential effect is described in the following sections, and then evaluated as to whether or not it will occur. When potential effects are likely to occur they are further evaluated to determine if a residual effect will remain after mitigation actions are implemented.

9.18.2 Identification of Mitigation and Management Measures for Waterbirds

9.18.2.1 Mitigation by Project Design

Mitigation by Project design that is applicable to all wildlife includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive areas for wildlife;
- ensuring that all waste management facilities and Project buildings are wildlife-proof; and
- maintaining equipment to minimize noise that may disturb wildlife.

9.18.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding of wildlife;
- open water shipping will conform to all applicable laws and regulations;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil and shipboard pollution plans, spill contingency plan and hazardous waste management.

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- minimize disturbance to vegetation communities;
- infrastructure will avoid sensitive waterbirds habitats such as staging areas, where possible; and
- minimize the size of Project footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on waterbirds includes:

- construct and maintain equipment to minimize the production of noise – see Noise and Vibration (Volume 4, Section 3) and Hope Bay Project Noise Abatement Plan (Volume 8 Annex V8-8);
- monitor and adaptively manage noise – see Volume 8 Annex V8-8; and

- pilot education about the potential negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed (Volume 8, Annex V8-3).

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for waterbirds include:

- enforce speed limits on all Project roads;
- wildlife will be given the right-of-way on all roads;
- maintaining clean Project sites where any equipment or materials that could entangle or entrap wildlife are safely stored;.
- conducting ground clearing outside of sensitive nesting periods for waterbirds or conduct pre-clearing surveys for waterbirds if Construction cannot be scheduled outside of sensitive periods; and
- monitoring of wind turbines for waterbird mortality will be conducted for a period of two years of wind turbine operations during spring and fall migration, as per recommendations in Environment Canada (2007b). As a precautionary measure, adaptive management to reduce the potential effect will be triggered if the number of bird mortalities due to turbine strikes exceeds suggested guidelines (i.e., more than 14 birds/turbine/year at individual turbines or turbine groups; OMNR 2011) or if any waterbird species of conservation concern is recorded as experiencing mortality due to the turbines.

Mitigation for Increased Access and Harvest

Mitigation and management to reduce the potential for increased access and harvest of waterbirds include:

- no connection of all-weather roads to any communities;
- all Phase 2 Project roads closed to the public; and
- a policy prohibiting hunting by Project staff and contractors while on site.

Mitigation for Attraction

Mitigation and management to reduce the potential for waterbirds to be attracted to site infrastructure:

- all buildings will be wildlife-proof;
- a policy of no wildlife feeding;
- no sewage ponds created;
- monitoring of water quality and waterbird usage of Project ponds and exclusion of waterbirds if required; and
- lighting directed into facilities and toward the ground whenever possible.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of waterbirds to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, P4-3), and Hope Bay Project Hazardous Waste Management Plan (Volume 1, P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);
- fuels and chemicals are stored in wildlife-proof buildings;
- cyanide destruction inside the mill; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.18.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for waterbirds will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, waste management, vehicle-wildlife collisions, water quality and incidental observations.

Monitoring specific for waterbirds will include:

1. monitoring and reporting the size of the footprint;
2. local-area scans prior to blasting;
3. reporting of wildlife incidents;
4. reporting of wildlife observations;
5. population monitoring to determine if there is a zone of influence surrounding the Project where waterbirds avoid infrastructure;
6. monitoring of wind turbines and transmission line for waterbird mortality.

9.18.3 Characterization of Potential Project-related Effects

9.18.3.1 Habitat Loss

This assessment evaluates the potential effects of habitat loss on waterbirds which will occur where Phase 2 Project infrastructure overlaps suitable waterbird habitat. The proposed location of infrastructure takes wildlife habitat into consideration and is designed to minimize and avoid sensitive wildlife areas. However, some habitat loss and degradation may still occur.

The potential for degradation of vegetation near infrastructure due to dust generated from Phase 2 Project development was assessed in human health and environmental risk assessment (Volume 6, Section 5). This analysis did not predict any residual effects on vegetation due to dust and therefore no

effects on waterbird habitat due to dust are expected. Moreover, the use of PDAs will account for any edge effects that may extend beyond Phase 2 footprint.

Suitable waterbird habitat within the RSA was quantified based on mapped wetlands and water bodies identified in mapping from Northwest Territories Department of Resources, Wildlife, and Economic Development (RWED) Ecological Land Classification (ELC) for the Slave Geological Province (Matthews, Epp, and Smith 2001). Suitable habitat was considered to be all wetlands, waterbodies, and suitable terrestrial ecosystems within 100 m of waterbodies and wetlands. The use of a 100 m buffer reflects Environment Canada's avoidance guideline recommendation of 50 m for waterfowl nests plus a 50 m buffer to provide a conservative estimate (M.L. Mallory 2016). Assessment of the effect of habitat loss for waterbirds was based on:

1. Loss of suitable habitat contained within the PDA, as a proportion of that area in the LSA and RSA; and
2. Loss of high use areas (e.g., staging areas) identified in baseline studies and long term monitoring (WMMP) for the Doris Project.

A total of 1,873 ha of suitable waterbird habitat is located within the PDA, which is 4.7% of suitable habitat within the LSA and 0.5% within the RSA (Table 9.18-1). Assuming loss of the entire PDA, habitat losses include 30 ha of waterbodies, 576 ha of wetlands, and 1,873 ha of suitable terrestrial habitat. The amount of habitat available to waterbirds is also an over-estimate, since not all waterbodies and not all ecosystems surrounding waterbodies provide suitable habitat for waterbirds. Ecosystems within the wildlife LSA and RSA that were not considered suitable habitat for waterbirds include barren/disturbed, dry upland vegetation communities, shrubby tundra, and unclassified habitats.

The Exiting and Permitted development has resulted in loss of 184.6 ha of suitable waterbird habitat. The calculated habitat loss from Hope Bay Project combined will result in a total of 2,058 ha of suitable waterbird habitat loss within the RSA which is <1% of suitable habitat within the RSA (Table 9.18-1).

One high use area for waterbirds is situated within the PDA and is thus considered to be habitat loss. Roughly 60 Canada geese were observed during the 2011 brood surveys at this location which is situated along the shoreline of Aimaokatalok Lake approximately 221 m west of the Boston airstrip. Though it falls within the PDA, waterbird use at this site occurs primarily within the bay to the west of the airstrip rather than on terrestrial habitat within the PDA. Additionally, a 40 m buffer around lakes is required for aquatic habitats which will also act to mitigate effects on waterbirds. Characterization of this site as habitat lost is therefore a conservative measure as losses will likely be minimal to nil for this high use area. No other high-use areas used during the spring nesting period or spring or fall staging periods were identified in the PDA.

Summary of Potential Habitat Loss Effects

Whenever possible, reclamation activities will be undertaken to restore habitat for waterbirds upon Project Closure. The amount of habitat loss is reduced because Phase 2 will use Approved infrastructure such as Doris site, Doris airstrip, Roberts Bay offloading facility, and the Madrid North and South sites. This minimizes the footprint of new development and reduces the area of habitat affected. In addition, the PDA overestimates the amount of habitat that will be lost as a result of Phase 2 development because the footprint is only 30% of the size of the PDA. Clearing will only occur on a portion of the PDA determined once Phase 2 layout is finalized. Mitigation is anticipated to reduce but not completely eliminate the effect of habitat loss to waterbirds, and **thus a residual effect is predicted to occur for Phase 2**.

Table 9.18-1. Suitable Waterbird Habitat Lost in the Wildlife LSA and RSA due to the PDA

	Suitable Habitat		Suitable Habitat Lost[1] due to the Phase 2 PDA		Suitable Habitat Lost[1] due Hope Bay Project	
Area	**Amount (ha)**	**% Area**	**Area (ha)**	**% Suitable Habitat**	**Area (ha)**	**% Suitable Habitat**
Local Study Area						
Waterbodies	9,757	17.3	30	0.3	105	1.0
Wetlands	10,907	19.4	576	5.3	620	5.7
Terrestrial Habitat[2]	18,812	33.4	1,267	6.7	1,333	7.1
Total	39,476	70.1	1,873	4.7	2,058	4.9
Regional Study Area						
Waterbodies	99,612	20.3	30	<0.1	105	0.1
Wetlands	58,370	11.9	576	1.0	620	1.1
Terrestrial Habitat[2]	185,952	37.9	1,267	0.7	1,333	0.7
Total	**343,935**	**70.1**	1,873	**0.5**	2,058	**0.6**

[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.
[2]Terrestrial Habitat defined as suitable nesting habitat within an 100 m buffer of water bodies and wetlands.

The Hope Bay Project will result in the loss of 2,058 ha of suitable waterbird habitat. This loss of suitable habitat is 4.9% of the suitable habitat within the LSA and <1% within the RSA. The same mitigation proposed for Phase 2 has been carried out for the Permitted Project. Mitigation has and is anticipated to reduce but not completely eliminate the effect of habitat loss to waterbirds, and **thus a residual effect is predicted to occur for the Hope Bay Project.**

9.18.3.2 Disturbance

The potential for Phase 2 to result in disturbance to waterbirds through noise was evaluated particularly from blasting and aircraft, and vehicle movement. Some studies have reported that disturbance can cause behavioural changes and changes in spatial distribution of waterbirds (Bayne, Habib, and Boutin 2008).The degree to which birds perceive a disturbance as a threat dictates the intensity of behavioural responses (A. Frid and Lawrence M. Dill 2002). Studies have found lower bird densities within 1 km of infrastructure like roads, seismic lines, oil fields, and wind turbines (Benitez-Lopez, Alkemade, and Verweij 2010; Loesch et al. 2013; Niemuth et al. 2013). Disturbance of waterbirds was evaluated for the life of Phase 2.

Two methods were used to evaluate potential disturbance effects on waterbirds in the RSA.

1. Direct, observational data was used, based on the results of the long-term Doris Project monitoring program for waterbirds (WMMP).
2. A literature review was conducted of the distance at which waterbirds are reported to respond to disturbances.

Disturbance is described for Phase 2 Phase anticipated to result in the highest level of disturbance related effects (Operations); all other Phases are expected to result in less disturbance. The PDA is considered habitat loss and thus is not included in the disturbance analysis.

Long-Term Monitoring for the Doris Project

Long-term monitoring has been conducted for the Doris Project between 2006 and 2015. Statistical analyses were conducted as part of the Doris 2015 WMMP Report (ERM 2016a) to identify potential effect regions of the Doris Project on waterbirds. This analysis provides a rigorous assessment of potential effects of the Doris Project during potential effect years (2009 to 2011), and in the vicinity of the Doris Project (< 1,000 m from infrastructure). Potential differences over time within and outside the potential effect region were assessed via 1) the proportion of birds within 1,000 m of infrastructure and 2) using a generalized additive mixed model (GAMM) regression analysis. Potential disturbance effects of the Project are summarized based on the results of the long-term statistical analysis of Doris Project data.

Potential differences over time within and outside the potential Doris effect region assessed via 1) the proportion of birds within 1,000 m of infrastructure and 2) using a GAMM regression analysis, showed that neither analysis suggested evidence of a Project related effect during the potential effect years within the potential effect region. Additional sensitivity analyses confirmed that this result remained consistent upon testing different potential effect regions (300 m, 500 m, and 1,800 m) and potential effect years (2009 to 2011 and 2015), and excluding data from the Mid-Belt Block, a block that was deemed to be unique from the Doris and Roberts Bay blocks (ERM 2016a).

Results of the Doris Project statistical analyses support that Phase 2 will not have a disturbance effect on waterbirds. No statistical difference in waterbird abundance and diversity was detected between potential effect years even at a distance of 300 m from Doris Project infrastructure. Therefore, the most likely case is that the Project will exhibit similar trends and no disturbance effect will be generated by interactions between waterbirds and Project activities.

Flight Initiation Distance

Disturbance can be estimated through flight initiation distance (FID) which is the distance between a disturbance and an individual bird when it is flushed from a perched position (Ruddock and Whitfield 2007). Waterbirds may be disturbed by activities occurring beyond this distance, but FIDs are thought to represent the minimum distance birds require to feel relatively safe while at the nest site.

Disturbance effects of the Project were quantitatively assessed based on the number of high use areas which occur within a zone of influence for disturbance. A spatial buffer of 300 m on the PDA is used to estimate the distance from activities at which waterbirds may experience threat from disturbances that is severe enough to initiate flight. Studies indicate that FIDs are commonly within 300 m from the disturbance source (Rodgers Jr. and Schwikert 2002; Male and Nol 2005; A. C. Smith et al. 2005; Ruddock and Whitfield 2007; Whitfield, Ruddock, and Bullman 2008). There is an increasing body of evidence that wind farms generally do not affect waterbird distribution and Powlesland (2009) reported that recent studies in Britain have found no disturbance effects to birds.

Three high use areas for waterbirds detected during staging and brooding surveys were identified within the 300 m disturbance ZOI from proposed Phase 2 infrastructure. The largest staging area observed occurred along the shore of Aimaokatalok Lake approximately 204 m from Boston camp infrastructure. During 2014 spring staging surveys approximately 900 individuals including primarily Canada geese with six additional species including American green-winged teal, glaucous gull, greater scaup, greater white-fronted goose, northern pintail, and tundra swan were observed (Table 9.18-2). Within the disturbance zone of influence, a high use staging area for Canada geese were also observed during brooding surveys along the Aimaokatalok Lake shoreline to the east of the airstrip. These staging areas are likely to experience an intermittent and minor impact of sensory disturbance during aircraft take-off and landing. The three high use areas were over 4.4 km from the nearest wind turbine infrastructure and noise generated by the two proposed wind turbines located near the Aimaokatalok Lake shoreline is expected to be minimal.

Table 9.18-2. High Use Areas for Waterbirds near Phase 2 Infrastructure

Waterbody	Nearest Component	Distance to Nearest Component (m)	Occupation Status	Survey Type
Unnamed Pond N of Boston	Quarry T	16	2014 - Group of 140 Canada Geese	Spring Staging
Aimaokatalok Lake	Contact Water Pond (Boston camp)	204	2014 - Group of 300 Canada Geese 2014 - Group of 300 Canada Geese 2014 - Group of 100 Greater White-fronted Geese	Spring Staging Spring Staging Spring Staging
Aimaokatalok Lake	Airstrip	378	2011 - Group of 50 Canada Geese	Brood

An additional high use staging area was observed during 2014 staging surveys at an unnamed pond along the Madrid-Boston road just north of Boston camp. During spring staging, 140 Canada geese were present at this pond which is situated approximately 16 m from the proposed Quarry T and 7.0 km from the nearest wind turbine. Blasting and Construction activities at Quarry T would result in intermittent sensory disturbance when the pond is occupied. All other high use staging areas were located more than 1 km from Phase 2 infrastructure and thus are unlikely to experience disturbance effects associated with Project activities.

No additional high use areas for waterbirds are situated within 300 m of Permitted development. The combined impacts of Doris and Phase 2 on high use staging and brooding areas for waterbirds are the same as those for Phase 2 alone.

Summary of Potential Disturbance Effects

Mitigation to reduce potential effects of disturbance on waterbirds will include designing and purchasing equipment to minimize noise, maintaining appropriate flight elevations, and situating infrastructure, including wind turbines, away from significant waterbird staging and breeding areas. Mitigation is expected to reduce but not completely eliminate the effect of disturbance caused by Phase 2 on waterbirds. Long term monitoring of the Doris Project indicated that mitigation measures have largely been successful and no effects of disturbance were observed on waterbird abundance or diversity. However, as staging areas were observed within the potential disturbance zone of influence, **a residual effect of disturbance on waterbirds is predicted to occur for Phase 2 and the Hope Bay Project.**

9.18.3.3 Disruption of Movement

Disruption to movement may occur where waterbirds alter their local flight path or migration route to avoid wind turbines. Energetic costs are more of a concern when birds have to fly further to avoid a large array of turbines (Powlesland 2009). A study of the effect of large offshore wind farms (> 50 turbines) on migrating waterbird species, eiders, has shown the effect of disruption to movement to be negligible based on the trivial increase in energetic cost associated with flying around the turbines (Masden et al. 2009). Post-construction monitoring of a turbine located at the edge of a river valley in the Yukon reported migrating waterbirds avoided flying close to the turbine, and exhibited an ability to navigate a series of abrupt course changes (Mossop 1998).

During migratory standwatch surveys, several waterbirds were observed at turbine height (i.e., between 50 and 200 metres above ground level) but far fewer waterbirds were observed within the potential zone of interaction with wind turbines (i.e., flying between 50 and 200 metres above ground level and on a flight trajectory towards the wind turbines), where diversion around infrastructure would be necessary to avoid collision with wind turbines (Section 9.2.10.2). Eighteen percent (n=179) of the 973 waterbirds observed flying at turbine height during spring migration surveys in the Doris area, and 29% of the 2,644 of waterbirds flying at turbine height in the Doris and Boston area in fall, were recorded in the potential zone of interaction with wind turbines (EDI 2017). Because only two wind turbines proposed for each of the three sites that are situated several kilometres apart, and migration through the area is broad front (i.e., with concentrated movement "corridor"), diversion distances are anticipated to be minimal. Thus, **no residual effects of disruption of movement are predicted for waterbirds due to Phase 2 or Hope Bay Project.**

9.18.3.4 Attraction to the Project

This section evaluates the potential for waterbirds to be attracted to structures which provide habitat or artificial waterbodies that tend to be warmer than surrounding natural ponds and lakes. Many species of waterbird use sewage treatment ponds and other man-made waterbodies during migration or poor weather conditions (R. W. Campbell et al. 1990). Other studies document waterbird use of artificial waterbodies associated with mines, such as sewage and tailings ponds (Read 1999 and citations therein).

Migrating waterbirds use waterbodies which open relatively early in the Arctic, therefore waterbirds may be attracted to Project ponds. Contact water ponds will be maintained at a dry state and residence time of water will be minimized therefore the ponds are unlikely to act as a waterbird attractant. Additionally all site surface and underground mine water that does not meet discharge criteria will be redirected to the Doris TIA. Therefore no effects related to use of the TIA will occur.

There will be no sewage ponds generated for the Project; instead sewage will be transported to Doris for treatment and disposal. If water quality in Phase 2 ponds does not meet water quality guidelines for wildlife, appropriate management will be conducted to exclude birds from these areas (e.g., air cannons). The effectiveness of deterrent systems will be monitored and adaptively managed if they are not successful.

Waterbirds are unlikely to be attracted to Project water storage areas. Long-term monitoring at Doris have not detected waterbird attraction to Doris infrastructure and these trends are expected to continue. With mitigation and management outlined in the WMMP, **no residual effects of attraction are predicted for waterbirds due to Phase 2 or Hope Bay Project.**

9.18.3.5 Direct Mortality

The potential for direct mortality and injury of waterbirds due to 1) ground clearing and construction, 2) vehicle strikes, 3) aircraft strikes, and 4) collisions with infrastructure (wind turbines, transmission line, towers and guy-wires). Mitigation measures for Phase 2 are expected to eliminate the effect of mortality and injury due to vegetation clearing. These measures include preferential ground clearing outside of the sensitive nesting periods and pre-clearing nest surveys prior to clearing during the nesting periods. Thus, mortality and injury of waterbirds is not expected to occur as a result of ground clearing.

No waterbird-vehicle collisions have been recorded in years of monitoring for the Doris Project (2006 - 2016) and thus waterbird collisions with ground vehicles are not expected to occur. Other operating Arctic mines such as Snap Lake, Diavik, Jericho, and Meadowbank have reported no vehicle-related mortality of waterbirds in recent years (Golder 2008b; Gebauer 2010; Golder 2014, 2015).

Due to the large body size of many waterbirds, collisions between aircraft and waterbirds is a danger to the aircraft. As such, pilots and crews actively manage aircraft flights to limit the potential for waterbird strikes. Doris as well as several operating mines in the region (e.g., Ekati, Snap Lake, Diavik) have recorded zero instances of a waterbird-aircraft collision (ERM Rescan 2014c; Golder 2014; ERM 2015c; Golder 2015). The monitoring for birds conducted prior to take-off and landing for the safety of personnel will also mitigate potential effects on waterbirds. In flight waterbird-aircraft collisions are expected to be very rare, as all aircraft associated with the Project will avoid waterbirds (and other birds) and maintain minimum flight altitude where the majority of collisions are known to occur (DeVault et al. 2011).

Waterbirds collisions with tall structures such as wind turbines, transmission lines, towers and guy-wires can occur under certain circumstances, typically when towers are tall, the area is prone to fog, causing poor visibility and lower altitude flight by migrating birds, night time migration pathways intersect infrastructure, and towers are located such that red flashing aviation warning lights are required, that can temporarily blind waterbirds (Kingsley and Whittam 2005; Powlesland 2009; National Wind Coordinating Collaborative (NWCC) 2010). When combined with high bird abundance, these conditions can increase the collision risk for waterbirds. Waterbird fatalities with wind turbines is mostly due to collisions with rotating blades (American Wind Wildlife Institute (AWWI) 2017). In poor weather conditions, waterbird collisions with wind turbines typically involved single birds, and fatalities were recorded infrequently at land-based wind facilities similar to those proposed in Phase 2 (Kingsley and Whittam 2005; Powlesland 2009; National Wind Coordinating Collaborative (NWCC) 2010). During the migration period, poor weather events are expected to occur infrequently during periods of darkness at the Hope Bay Project; only occurring in fall. Based on the TMAC daily runway weather report (TMAC 2017), there are only two days in each of the months of August to October in which the ceiling was less than 640 feet (200 meters), which would only marginally increase the potential for waterbird collisions with the wind turbines during migration. Studies indicate that at night, migrating flocks of geese and

seaducks were more prone to enter wind farm areas but counteracted the higher risk of collision in the dark by increasing their distance from individual turbines and flying around or in the corridors between turbines (Desholm and Kahlert 2005; Kingsley and Whittam 2005). During spring migration, daylight occurs all day, so collisions are not expected.

At the Hope Bay Project, the effects of direct mortality due to interactions with wind turbines are expected to be higher during the migration period compared to the breeding period because no high use breeding or brooding areas for waterbirds were identified within 4.0 km of the proposed wind turbines based on monitoring data from the Doris Project. Baseline standwatch surveys indicated that while several waterbirds migrated through the area, individuals were not necessarily observed flying within the physical space of the proposed turbines. Eighteen percent of the 973 waterbirds observed flying at turbine height in the Doris area during spring and 29% of the 2,644 waterbirds recorded at turbine height in fall at Doris and Boston areas were observed flying within the potential zone of interaction with wind turbines (i.e., between 50 and 200 metres above ground level and flying at a trajectory towards the wind turbines). Canada geese comprised the majority of the birds observed in spring with approximately 171 (18%) of individuals observed flying within the potential zone of interaction with wind turbines. In fall, several tundra swans were observed gathering at the lake northwest of the Boston site, likely preparing to migrate south. Annual mortality events due to due wind turbines were low for both of these wide-ranging species, based on Canada-wide mortality rates across 83 wind power projects operating between 2006 and 2016; the Canada goose account for 0.13% of 2,955 bird carcasses and no mortality event have been reported for tundra swan (Bird Studies Canada 2017).

Mortality of waterbirds due to collisions with turbine infrastructure has not been reported at a windfarm in the Arctic (Diavik Project; D. Wells, RioTinto, personal comm), and has rarely been reported across 2,570 turbines installed at 83 wind energy projects in Alberta, Ontario, and Atlantic Canada, accounting for 257 fatalities over a nine year period (2007-2016) (Bird Studies Canada 2017). Mortality of species of conservation concern also appears to be rare, as reported by Bird Studies Canada (2017). Mortalities of brant, the species of conservation concern recorded during the migration periods at the Project, have not been reported among the fatalities at wind farms in Canada (Bird Studies Canada 2017). Based on the observation of waterbird movement within the potential zone of interaction with wind turbines during migration, and the relatively low numbers of waterbird mortality events recorded at wind farms across Canada, there is a potential of increased mortality risk for waterbirds migrating through the Project area due to collision with turbine blades.

Waterbirds can collide with transmission lines because of their poor manoeuvrability and large wingspans (Bevanger 1998; Cooper and Day 1998; Moritzi, Spaar, and Biber 2001; Erickson, Johnson, and Young Jr 2005; Barrett and Weseloh 2008; Rioux, Savard, and Gerick 2013). The majority of bird collisions with transmission lines occur in specific habitats, including next to wetlands (Bevanger 1998), between resting and foraging areas (Savereno et al. 1996), near and parallel to shores (Cooper and Day 1998), valleys and river valleys (Bevanger 1998; Moritzi, Spaar, and Biber 2001), and along ridge lines where soaring birds congregate on thermal updrafts (Barrios and Rodriguez 2004). Any transmission lines constructed during Phase 2 will be constructed using best management guidelines presented by the Avian Power Line Interaction Committee (APLIC 2006) to minimize any effects on bird populations. Monitoring at other Arctic mines has not reported any waterbird mortalities due to strikes on towers or guy-wires, and mitigation is expected to be successful at further reducing the chances of collisions with towers and guy-wires (APLIC 2006).

Summary of Potential Direct Mortality Effects

At the Hope Bay Project, the conditions that increase collision risk with tall structures are either not met by Phase 2, or are predicted to occur infrequently during waterbird breeding or migration.

Migration through the Project area is broad-front with no apparent barriers to, or concentrated areas of movement. Proposed wind turbines are situated away from breeding habitat and high use areas for waterbirds, reducing waterbird collision risk. Mortality risk associated with potential collisions with the transmission line will be mitigated for using recommendations from the Avian Power Line Interaction Committee Mitigation (2012). Mitigation is expected to lower but not completely eliminate the effect of direct mortality to waterbirds due to potential collisions with wind turbines. Thus, a **residual effect of direct mortality is predicted** for waterbirds due to Phase 2 and the Hope Bay Project.

9.18.3.6 Increased Access and Harvest

This section evaluates the potential for mortality of waterbirds resulting from increased hunting facilitated by easier access. Road access will be restricted to Project employees, who will not be permitted to hunt. Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Project area (Volume 6, Section 3). Waterbirds are common in the Kitikmeot region and it is unlikely that a harvester would travel to the Project site when there is easier access and greater densities of waterbirds in areas closer to permanent communities. Therefore, increased hunting pressure on waterbirds is unlikely to occur, **no residual effects of direct mortality are predicted due to either the Phase 2 or Hope Bay Project**.

9.18.3.7 Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to activities prior to any development in the Hope Bay belt, due to the Approved Projects and due to the Hope Bay Project as a whole on ecological receptors (e.g., waterbirds). The assessment determined that Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in waterbirds due to Project activities. Therefore, the potential effect of changes in environmental media quality is not considered as a residual effect on waterbirds for either Phase 2 or the Hope Bay Project.

9.18.4 Significance of Project-related Residual Effects for Waterbirds

This section evaluates the significance of the three predicted residual effects for waterbirds which are rated as residual effects; habitat loss, disturbance, and direct mortality, which are summarized in Table 9.18-3.

9.18.4.1 Habitat Loss

The loss of habitat will be a negative effect on waterbirds. The effect is rated as low magnitude, given the area expected to be affected by the Project and the sensitivity and resilience of the local waterbird community. Overall, the Project will remove less than 1% of the suitable waterbird habitat in the RSA, and one high-use area was found within the PDA, although this area is not likely to be lost as waterbird use at this site occurs primarily in aquatic rather than on terrestrial habitat within the PDA. The local waterbird community is expected to have a low sensitivity to habitat changes, as none of the species that have been recorded to date as local breeders and migrants through the area are considered to be of federal conservation concern. The local population is also expected to have some resilience to adapt to habitat changes for the same reasons, as no federal species of conservation concern have occurred in the region to date. Habitat loss for waterbirds will occur during Construction of Phase 2 Project and continue through post-Closure and so will be of long-duration. The habitat loss will occur infrequently during Construction as the Project is built and will be limited to the PDA. Closure and Reclamation of the site will reverse the effect of habitat loss in some areas, but not in areas where no reclamation is planned or possible. The residual effect of direct habitat loss is therefore assessed as **Not Significant** for the Phase 2 and Hope Bay Project. Confidence is this assessment is high, as waterbird activity is well documented for this area.

Table 9.18-3. Summary of Residual Effects and Overall Significance Rating for Waterbirds

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2 Project									
Habitat Loss	Negative	Low	Long	Infrequent	PDA	Reversible with effort	Likely	Not significant	High
Disturbance	Negative	Low	Medium	Intermittent	LSA	Reversible	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not significant	Medium
Hope Bay Project									
Habitat Loss	Negative	Low	Long	Infrequent	PDA	Reversible with effort	Likely	Not significant	High
Disturbance	Negative	Negligible	Medium	Intermittent	LSA	Reversible	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not significant	Medium

Long-term effects monitoring of waterbirds for the Doris Project identified no effects of disturbance with no differences in waterbird diversity and abundance near the Project as compared to outside the region of possible effects. However, this potential effect was rated as a residual effect as a conservative measure.

9.18.4.2 Disturbance

The effect of disturbance on waterbirds was rated as negative with low magnitude based on the results of the Doris Project monitoring and the sensitivity and resilience of the local waterbird community (Section 9.18.4.1). The duration was rated as medium term as disturbances will last the life of Phase 2. The effects are characterized as intermittent, occurring only during the passing of an aircraft or vehicle and during blasting. The geographic extent is limited to the LSA as disturbance effects may extend 300 m from the source. Disturbance effects are reversible upon Project Closure. The residual effect of disturbance is therefore assessed as **Not Significant** for the Phase 2 and Hope Bay Project. Confidence is this assessment is high, as long-term monitoring has shown that there have been no disturbance effects on waterbirds to date due to the Doris Project.

9.18.4.3 Direct Mortality

The effect of direct mortality on waterbirds due to Phase 2 was rated as a negative residual effect with low magnitude because migration through the area is broad-front, with no barriers to waterbird movement, and zero avian strikes reported for other wind turbines operating in the Arctic. The sensitivity of waterbirds to the effect is expected to be low because fatalities of waterbirds are recorded infrequently at land-based wind facilities (Kingsley and Whittam 2005; Powlesland 2009; American Wind Wildlife Institute (AWWI) 2017; Bird Studies Canada 2017). The local population is also expected to have good resiliency to the effect, as no federal species of conservation concern have occurred in the region to date and populations of species' groups vulnerable to collisions with man-made structures are increasing across Canada, indicating that current levels of collision mortality are not limiting population growth, with the possible exception of species at risk. The duration was rated as medium, occurring while the wind turbines are operational, during the life of the Project. The frequency will be continuous, and the geographic extent of the effect is confined to the turbine locations. The residual effect is fully reversible because when the turbines are decommissioned during Project Closure, the added mortality risk is eliminated. Post-construction monitoring will allow for adaptive management of turbines if fatalities are reported. The probability is moderate and the residual effect is not significant. The confidence is medium as post-construction monitoring indicates that waterbird fatalities at wind farms in the Arctic are unlikely. Very few waterbirds are anticipated to be affected, so population-level effects are unlikely.

The residual effect of direct mortality on waterbirds due to the Hope Bay Project was given the same ratings as that of Phase 2. The Hope Bay Project will not result in any additional direct mortality for waterbirds beyond that indicated for Phase 2. The magnitude of the potential effect was rated as low due to the reasons provided for Phase 2. Overall, the residual effect of direct mortality on waterbirds due to the Hope Bay Project was rated as **Not Significant**. The confidence was rated as medium for the same reasons provided above for Phase 2.

9.19 WATERBIRDS – CUMULATIVE EFFECTS ASSESSMENT

Three potential effects were rated as residual effects for waterbirds; habitat loss, disturbance, and direct mortality. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.19.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of waterbirds are described in Section 9.5.7.

9.19.1.1 Spatial Boundary

The cumulative effects assessment for waterbirds considers the RSA as the spatial boundary. The RSA is large enough to encompass entire summer home ranges of waterbirds and a representative set of the regional population.

9.19.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.19.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Section 9.18.3 and 9.18.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for waterbirds and cumulative effects for this VEC are not considered further.

9.20 UPLAND BIRDS – EFFECTS ASSESSMENT

9.20.1 Introduction

The upland bird VEC includes two species, the red knot and buff-breasted sandpiper, which are listed as a species of conservation concern under the federal *Species at Risk Act* (SARA; 2002) with the red knot subspecies *rufa* listed on Schedule 1 of SARA as Endangered and buff-breasted sandpiper listed as Special Concern under Schedule 1. COSEWIC has assessed the red-necked phalarope as a species of Special Concern (Table 9.2-48; COSEWIC 2014a). All three species have the potential to occur in the RSA (although the red knot would be considered rare) but only red-necked phalarope were observed during baseline studies. The CESCC designations for Nunavut include ten upland bird species regularly occurring in the RSA which are listed as Vulnerable or Apparently Secure (CESCC 2016; Table 9.2-48).

Potential effects on upland birds were included based on Inuit TK, community concerns expressed at meetings, professional judgement, experience at other similar projects in Nunavut, and scientific literature (Section 9.6). Potential Phase 2 and Hope Bay Project effects were evaluated, making reference to season and to mine phase (i.e., Construction, Operation and Reclamation/Closure Phases) for upland birds. Interactions of upland birds with Phase 2 Project components were evaluated to determine which of the following potential effects may occur (Table 9.6-9):

- habitat loss;
- disturbance;
- attraction to the Project;
- disruption to movement;
- direct mortality;
- increased access and harvest; and

- changes in environmental media quality.

Habitat loss will occur in all areas where new infrastructure overlaps with suitable habitat, which may include the expansion of the Roberts Bay, Doris site and TIA facilities and the Construction of the new Boston road and Boston facility. This potential effect will begin during Construction and last through to Post-closure of Phase 2.

Noise and the presence of personnel, vehicles, aircraft, wind turbines, and other activities near upland bird habitat may cause disturbances, which may alter their regular behaviour or cause avoidance of the site. This potential effect will begin with Construction and continue through the Operations and Closure, and cease in Post-closure.

Tall structures with lights such as communications towers, transmission lines, and wind turbines can alter the movements of birds (Erickson, Johnson, and Young Jr 2005). This potential effect is evaluated as beginning in Construction and ending in Closure when wind turbine infrastructure and the transmission line are decommissioned and removed.

Direct mortality and injury from vehicle and aircraft strikes, and collisions with turbine infrastructure and powerlines was evaluated for upland birds. This potential effect is evaluated as beginning in Construction and ending at Closure when vehicles will stop traveling on Phase 2 roads, aircraft are no longer required, and wind turbines and the transmission line will cease operations.

Increased access and harvesting was identified by the Government of Nunavut as a potential concern for wildlife when hunters are attracted to the Project site for logistical reasons and to use the proposed Project road to Boston as a travel route. However, TK indicates that there is little to no harvest of upland birds except for ptarmigan and there is no reason to believe that harvesters would travel to the Project site to harvest when ptarmigan are abundant everywhere on the tundra.

There is potential for upland birds to be attracted to physical structures which may provide habitat or artificial lighting which attracts migratory birds. This potential effect is would begin during Construction and end at Closure when lights and structures will no longer be used.

The potential for dust or contaminants to be deposited in the environment and alter the quality of environmental media such as water, soil or vegetation was identified by the KIA and the NIRB. This potential effect was evaluated as part of the human health and ecological risk assessment (Volume 6, Section 5) as beginning during Construction and extending into Post-closure.

Each potential effect is described in the following sections, and then evaluated as to whether or not it will occur. When potential effects are likely to occur, they are further evaluated to determine if a residual effect will remain after mitigation actions are implemented.

9.20.2 Identification of Mitigation and Management Measures for Upland Birds

9.20.2.1 Mitigation by Project Design

Mitigation by Phase 2 Project design that is applicable to all wildlife includes:

- minimizing the Phase 2 footprint;
- avoiding sensitive areas for wildlife;
- ensuring that waste management facilities and Project buildings are wildlife-proof; and

- maintaining equipment to minimize noise that may disturb wildlife.

9.20.2.2 Best Management Practices

Best management practices that apply to all wildlife are discussed in Section 9.7 and include:

- employee education on their responsibilities to reduce potential effects on wildlife;
- policies that prohibit hunting on site, littering, and feeding wildlife;
- open water shipping will conform to all applicable laws and regulations;
- avoiding disturbance to wildlife by aircraft;
- speed limits, giving wildlife the right of way, and dust control on roads;
- camp management, waste management; and
- oil and shipboard pollution plans, spill contingency plan and hazardous waste management.

Mitigation for Habitat Loss and Alteration

Mitigation and management to reduce the potential effect of habitat loss includes:

- minimize disturbance to vegetation communities;
- infrastructure will avoid sensitive habitats for upland birds, where possible; and
- minimize the size of the Project footprint.

Mitigation for Disturbance

Mitigation and management to reduce the potential effect of disturbance on upland birds includes:

- construct and maintain equipment to minimize noise – see Noise and Vibration (Volume 4, Section 3) and Hope Bay Noise Abatement Plan (Volume 8 Annex V8-8);
- monitor and adaptively manage noise – see Noise Abatement Plan (Volume 8 Annex V8-8); and
- pilot education about the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife are observed (Volume 8, Annex V8-3).

Mitigation for Direct Mortality and Injury

Mitigation and management to reduce the potential for direct mortality and injury for upland birds include:

- set and enforce speed limits on all Project roads;
- wildlife will be given the right-of-way on all roads;
- maintaining clean Project sites where any equipment or materials that could entangle or entrap wildlife are safely stored;
- conducting ground clearing outside of sensitive nesting periods for upland birds or conduct pre-clearing surveys for upland breeding birds if Construction cannot be scheduled outside of sensitive periods; and

- monitoring of wind turbines for upland bird mortality will be conducted for a period of two years of wind turbine operations during spring and fall migration, as per recommendations in Environment Canada (2007b). As a precautionary measure, adaptive management to reduce the potential effect will be triggered if the number of bird mortalities due to turbine strikes exceeds suggested guidelines (i.e., more than 14 birds/turbine/year at individual turbines or turbine groups; OMNR 2011) or if any upland bird species of conservation concern is recorded as experiencing mortality due to the turbines.

Mitigation for Increased Access and Harvest

Mitigation and management to reduce the potential for increased access and harvest of upland birds include:

- no connection of all-weather roads to any communities;
- all Project roads closed to the public; and
- a policy prohibiting hunting by Project staff and contractors while on site.

Mitigation for Attraction

Mitigation and management to reduce the potential for upland birds to be attracted to site infrastructure:

- all buildings will be wildlife-proof;
- a policy of no wildlife feeding; and
- lighting directed into facilities and toward the ground whenever possible.

Mitigation for Altered Environmental Media Quality

Mitigation and management to reduce the potential for exposure of upland birds to altered environmental media include:

- managing the use of fuels and hazardous chemicals, as described in the Oil Pollution Prevention/Oil Pollution Emergency Plan (Volume 8, Annex V8-1), Hope Bay Spill Contingency Plan (Volume 1, Package P4-3), and Hope Bay Project Hazardous Waste Management Plan (P4-15);
- water quality is managed through the Water Management Plans, Hope Bay Project Doris-Madrid Water Management Plan (P4-7) and Hope Bay Project Boston Water Management Plan (P4-8), and monitored through the Hope Bay Project Aquatic Effects Monitoring Plan (Package P4-18);
- dust and air quality is managed through the Air Quality Management Plan (Annex V8-2);
- fuels and chemicals are stored in wildlife-proof buildings;
- cyanide destruction inside the mill; and
- appropriate measures taken to exclude or deter wildlife from areas where water or waste could pose a risk to wildlife.

9.20.2.3 Proposed Monitoring Plans and Adaptive Management

Monitoring programs for upland birds will include the standard monitoring activities used to ensure that mitigation is effective, including monitoring for the size of the footprint, noise, dust, hunters, waste management, vehicle-wildlife collisions, water quality and incidental observations.

Monitoring specific for upland birds will include:

1. monitoring and reporting the size of the footprint;
2. local-area scans prior to blasting;
3. reporting of wildlife incidents;
4. reporting of wildlife observations;
5. regional monitoring to determine if upland birds are avoiding Phase 2 using PRISM and variable radius point count surveys;
6. monitoring of wind turbines and transmission line for upland bird mortality.

9.20.3 Characterization of Potential Project-related Effects

9.20.3.1 Habitat Loss

This assessment evaluates the effects of habitat loss on upland birds. Potential effects associated with habitat loss will likely occur in areas where Phase 2 infrastructure overlaps suitable upland bird habitat. The proposed location of infrastructure takes wildlife habitat into consideration and is designed to minimize and avoid wildlife sensitive areas. However, some habitat loss may still occur.

The potential for degradation of vegetation near infrastructure due to dust generated from Phase 2 Project development was assessed in the Human Health and Environmental Risk Assessment (Volume 6, Section 5). This analysis did not predict any residual effects on vegetation due to dust and therefore no effects on upland bird habitat due to dust are expected. Moreover, the use of a Project Development Area (PDA) will account for any edge effects that may extend beyond Phase 2 footprint.

Loss of suitable habitat was quantified based on the amount of suitable upland bird habitat present within the PDA. Suitable habitat for upland birds was considered to be dry and moist to wet vegetation communities using the TEM for the LSA and the Northwest Territories Department of Resources, Wildlife, and Economic Development (RWED) Ecological Land Classification (ELC) for the Slave Geological Province for the RSA (Matthews, Epp, and Smith 2001). As the bird community varies across this moisture gradient, areas of each of the two vegetation communities were calculated separately. Assessment of the effect of habitat loss for upland birds was based on loss of suitable habitat contained within the PDA as a proportion of that area in the LSA and RSA.

Based on ecosystem mapping, 1,794 ha of suitable dry upland bird habitat and 2,226 ha of moist to wet suitable habitat will be removed within the PDA (Table 9.20-1). This represents 9.0% of the dry habitat within the LSA and 0.6% within the RSA and 8.4% of the moist to wet lowland habitat in the LSA and 1.2% in the RSA.

The Hope Bay Project will result in a total of 4,177 ha of suitable upland bird habitat loss within the RSA which is 0.9% of the RSA. This includes 1,848 ha of suitable dry habitat and 2,329 ha of suitable moist to wet lowland habitat.

Table 9.20-1. Suitable Upland Bird Habitat Lost in the Wildlife LSA and RSA due to the PDA

Area	Suitable Habitat		Suitable Habitat Lost[1] due to Phase 2 PDA		Suitable Habitat Lost[1] due to Hope Bay Project	
	Amount (ha)	% Area	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat
Local Study Area						
Dry Upland[2]	19,901	35.3	1,794	9.0	1,848	9.3
Moist to Wet Lowland[3]	26,524	47.1	2,226	8.4	2,329	8.8
Total	**46,425**	**82.4**	**4,019**	8.7	**4,177**	9.0
Regional Study Area						
Dry Upland[2]	280,133	57.1	1,794	0.6	1,848	0.7
Moist to Wet Lowland[3]	183,326	37.4	2,226	1.2	2,329	1.3
Total	**463,459**	**94.5**	**4,019**	0.9	**4,177**	0.9

[1] *Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.*

Summary of Potential Habitat Loss Effects

Whenever possible, reclamation activities will be undertaken to restore habitat for upland birds upon Phase 2 Project Closure. The amount of habitat loss is reduced because Phase 2 will use existing Doris infrastructure such as Doris site, Doris airstrip, Roberts Bay offloading facility, and the Madrid North and South sites. This minimizes the footprint of new development and reduces the area of habitat affected. In addition, approximately 30% of the PDA will be developed and thus only a portion actual displacement is anticipated. Clearing will only occur on a portion of the PDA determined once Phase 2 layout is finalized. Mitigation is expected to reduce but not completely eliminate the effect of habitat loss to upland birds, and **thus a residual effect is predicted to occur for Phase 2 and Hope Bay Project**.

9.20.3.2 Disturbance

The potential for Phase 2 to result in disturbance to upland birds through noise from blasting and aircraft, vehicle movement, wind turbines, and humans in close proximity to nest sites is assessed in this section. Some studies have reported that disturbance can cause behavioural changes and changes in spatial distribution if preferred habitats are avoided following disturbance (Bayne, Habib, and Boutin 2008). The presence and noise of wind turbines may deter birds from using an area close to these structures. The degree to which birds perceive a disturbance as a threat dictates the intensity of behavioural responses (A. Frid and L.M. Dill 2002).

Studies have found lower bird densities within 1 km of infrastructure like roads, seismic lines, and oil fields (Benitez-Lopez, Alkemade, and Verweij 2010). Lower density of territorial males, reduced total annual output of males, and reduced overall population size have also been reported near roads (Clark and Karr 1979; Van Der Zande et al. 1984; Foppen and Reijnen 1994; R. Reijnen and Foppen 1994; M. J. S. M. Reijnen 1995; M. J. S. M. Reijnen, Veenbaas, and Foppen 1995; R. Reijnen, Foppen, and Meeuwsen 1996). However, these observed reductions reflect vehicle strikes as well as disturbance. Effects may range from 600 m to 1,800 m depending on highway vehicle frequency (R. Reijnen, Foppen, and Meeuwsen 1996). According to a review of impact on birds from wind farms in the UK, there is an increasing body of evidence that wind farms generally do not affect bird distribution or abundance (Powlesland 2009; Douglas, Bellamy, and Pearce-Higgins 2011; Minderman et al. 2012), however some studies indicated varied responses by shorebirds to wind turbines, with some avoiding up to 500 m away and others showing no effect (Kingsley and Whittam 2005).

Two methods were used to evaluate potential disturbance effects on upland birds in the RSA:

1. Direct, observational data was used, based on the results of the long-term Doris Project monitoring program for upland birds; and
2. A literature review was conducted of the distance at which upland birds are reported to respond to disturbances.

Disturbance is described for the Project phase anticipated to result in highest level of disturbance related effects (Operations); all other Project phases are expected to result in less. The PDA is considered habitat loss and thus is not included in the disturbance analysis.

Long-Term Monitoring for the Doris Project

Long-term monitoring for upland birds at the Doris Project has been conducted between 2006 and 2016 using a combination of linear arrays of variable radius point count (VRPC) stations, a rapid monitoring technique for birds, and Program for International Shorebirds Monitoring (PRISM) plots, where surveyors search a large plot for birds.

As part of the monitoring program for the Doris Project, an analysis was conducted to determine if the relative abundance of upland birds changed with increasing distance from the Doris footprint, and between years when there was more activity (construction during 2007 through 2012 and 2015) and less or no activity (2006 and care and maintenance 2013 to 2014). A generalized additive mixed regression model (Zuur et al. 2010; Zuur 2013) was used to determine if fewer birds or bird species were observed near the footprint during years with more activity compared to distal areas and years with less activity (ERM 2016c).

Overall, the relative abundance data was variability in space and time. The analysis did not support the hypothesized predictions – there was no evidence of fewer birds near the footprint during years with more construction or mining activity (non-effect years) based on point count data collected on surveys within 7 km of the Project and north of northing 7,550,000 (roughly the terminus of the Doris-Windy AWR) and PRISM data collected on surveys within 60 km of the Project. Upland bird relative abundance appeared to be lower in potential effect years as compared to non-effect years, but confidence intervals around predictions overlapped in all cases, which indicated that relative abundance in potential effect years was not significantly lower than that recorded in non-effect years.

Regression analyses of species diversity could only be conducted using the PRISM data; results using all PRISM data collected on surveys located within 60 km of the Project indicated that there was a significant increase in species diversity with increasing distance to infrastructure in potential effect years and not in non-effect years. A similar result was obtained in the sensitivity analysis of the subset of PRISM data collected on surveys located within 20 km of the Project. Due to the overlapping confidence intervals, it was concluded that out to 20 km and 60 km, there is no evidence of upland bird diversity declining as a function of distance to infrastructure in either potential effect years or non-effect years. There were no strong indications of a potential ZOI for species diversity using either data within 20 or 60 km of the Project. Together, these results indicate that disturbance from the Doris Project does not have a measurable effect on relative abundance or diversity of upland bird populations.

A power analysis conducted retroactively indicated the potential effect of a Project-related disturbance on relative abundance data was small relative to the natural variability observed. For a complete description of the analyses and results, see (ERM 2017a). It is therefore the most likely case is that Phase 2 will exhibit similar trends and no disturbance effect will be generated by interactions between upland birds and Phase 2 Project activities.

Flight Initiation Distance

Disturbance can be estimated through flight initiation distance (FID) which is the distance between a disturbance and an individual bird when it is flushed from a perched position (Ruddock and Whitfield 2007). Upland birds may be disturbed by activities which occur beyond this distance, but FIDs are thought to represent the minimum distance birds require to feel relatively safe while at the nest site.

Disturbance effects of the Project were quantitatively assessed based on numbers of upland birds expected to occur within 300 m of proposed Project infrastructure. A spatial buffer of 300 m on the PDA is used to estimate the distance from activities at which upland birds may experience threat from disturbances that is severe enough to initiate flight. Studies indicate that FIDs are commonly within 300 m from the disturbance source (Rodgers Jr. and Schwikert 2002; Ruddock and Whitfield 2007; Whitfield, Ruddock, and Bullman 2008). According to literature, the upland bird responses to wind turbines is varied; some studies indicate no disturbance effects of wind turbines on upland birds (Douglas, Bellamy, and Pearce-Higgins 2011; Minderman et al. 2012), while others suggest shorebird species avoid turbines up to 500 m away in cases where suitable habitat is readily available away from

wind turbines (Kingley and Whittam 2005). The 300-m buffer was considered to be a conservative FID for wind turbines given disturbance has not been reported for most upland bird species groups.

Disturbance effects are likely to occur primarily within the PDA for upland birds with potential disturbance effects decreasing with distance from infrastructure. The PDA has already been evaluated as lost in the habitat lost section and thus does not contribute to disturbance residual effects. However, residual effects are predicted to occur outside the Phase 2 PDA. Approximately 5,089 ha of suitable habitat was within the 300 m FID (Table 9.20-2). This includes 1,953 ha of suitable dry habitat (0.7% of suitable dry habitat in the RSA) and 3,137 ha of suitable wet to moist habitat (1.7% of the wet to moist habitat in the RSA). Disturbance effects in this suitable habitat, however, will likely be minimal as disturbance effects decrease with distance from the source.

An additional 672 ha of suitable upland bird habitat may experience disturbance effects associated with the Doris Permitted Project. Therefore, the total amount of habitat which may experience disturbance effects for the Hope Bay Project outside the PDA is 5,761 ha, which is 1.2% of the suitable upland bird habitat within the RSA.

Summary of Potential Disturbance Effects

Mitigation to reduce potential effects of disturbance on upland birds will include designing and purchasing equipment to minimize noise and maintaining appropriate flight elevations. Mitigation is expected to reduce but not completely eliminate the effect of disturbance caused by Phase 2 on upland birds. Long-term monitoring of the Doris Project indicated that mitigation measures have largely been successful as no effects of disturbance were observed on upland bird relative abundance. However, in order to be conservative, literature values of FID were used to calculate a potential area where some habitat outside the PDA may be exposed to disturbance. If this FID-based analysis is used, **a residual effect is predicted to occur for Phase 2.**

Similarly, the Hope Bay Project (the Permitted Project plus Phase 2) will likely produce similar results as those recorded by long-term monitoring of the Doris Project; no observed effects of disturbance on the relative abundance of upland bird populations. However, given the predicted disturbance effects for Phase 2, **a residual effect of disturbance on waterbirds is predicted to occur for the Hope Bay Project**.

9.20.3.3 Attraction to the Project

This section evaluates the potential for upland birds to be attracted to structures which provide habitat or artificial lighting which attracts migratory birds or if meso-predators may be attracted to Phase 2 site that may prey on upland birds.

The densities of some upland birds species have been found to be higher near Arctic infrastructure than undisturbed sites (e.g., horned larks, semipalmated plover, white-crowned sparrows; Staniforth 2002; Male and Nol 2005; A. C. Smith et al. 2005). A small portion of the upland bird community may therefore be attracted to Phase 2 to establish breeding territories. Attracted birds may use Phase 2 infrastructure as habitat, for example use of elevated sites for perching and singing. Some forms of lighting also attract migratory birds, which can lead to collisions (Kerlinger 2000; Erickson, Johnson, and Young Jr 2005; Manville II 2008; T. Longcore et al. 2013).

Table 9.20-2. Suitable Upland Bird Habitat within 300 m FID

	Suitable Habitat		Suitable Habitat in Phase 2 Disturbance Buffer (300 m)		Suitable Habitat in Hope Bay Project Disturbance Buffer (300 m)	
Area	**Amount (ha)**	**% Area**	**Area (ha)**	**% Suitable Habitat**	**Area (ha)**	**% Suitable Habitat**
Local Study Area						
Dry Upland	19,901	35.3	1,953	9.8	2,327	11.7
Moist to Wet Lowland	26,524	47.1	3,137	11.8	3,434	12.9
Total	**46,425**	**82.4**	**5,089**	**11.0**	**5,761**	**12.4**
Regional Study Area						
Dry Upland	280,133	57.1	1,953	0.7	2,327	0.8
Moist to Wet Lowland	183,326	37.4	3,137	1.7	3,434	1.9
Total	**463,459**	**94.5**	**5,089**	**1.1**	**5,761**	**1.2**

It is anticipated that some degree of attraction of upland birds to Phase 2 infrastructure may occur. Over the years that monitoring has been conducted for the Doris Project (2006 – 2016),there have been seven incidents of upland birds being attracted to infrastructure at the Doris Project for nesting purposes; all nests were monitored to completion by ESR, and the majority fledged successfully (Golder 2007, 2008a, 2009; Rescan 2010, 2011c, 2011f, 2013d; ERM Rescan 2014a; ERM 2015b, 2016a).Hence, it is likely that very small numbers of upland birds may be attracted to Phase 2 Project infrastructure, similar to that observed during monitoring for the Doris Project. It appears that breeding pairs selecting for infrastructure for nesting purposes may not suffer lower productivity, since the majority of nests built on Doris Project infrastructure still successfully fledged young.

External lighting is unlikely to have effects on migratory birds. Long photoperiod during the summer and consequent little use of external lighting during the summer eliminates this effect. The majority of interaction between upland birds with external lighting during periods of darkness is expected to occur during fall migration. Tall structures (e.g., wind turbines and towers) will be affixed with red strobe, red flashing, or white strobe lights as per Transport Canada guidelines (Canadian Aviation Regulations (CARs) 2017-2); these lighting options showed less risk of disorienting and attracting migrating birds compared to steady burning lights (T. Longcore, Rich, and Gauthreaux Jr. 2008). Lighting, therefore, is not expected to cause a residual effect of attraction on upland birds to the Project nor to the Project combined with Doris.

Indirect mortality can also occur through increased rates of nest predation. Research indicates that upland bird nest predation by predators such as the Arctic and red fox, gulls, and the common raven may be enhanced near industrial projects. Infrastructure and human waste may provide food and structures for nesting, denning, and refuge (reviewed in Liebezeit et al. 2009). Higher predation rates on songbird nests were found close to infrastructures in Prudhoe Bay, Alaska (Liebezeit et al. 2009).

To assess whether Doris infrastructure may have resulted in increased predation pressure on upland birds, detection rates of nest predators common to industrial sites (common raven, glaucous gull, jaegers, Arctic and red fox) were calculated from Treatment (within 300 m of Doris Project infrastructure) and Control (at least 2 km from Doris Project infrastructure) areas from the 2015 point counts and PRISM surveys (ERM 2016a). To calculate detection rates of nest predators, observations of nest predators recorded during point count or PRISM plot surveys were standardized by survey time by dividing the number of nest predators recorded per hour spent conducting point count and PRISM plot surveys in Treatment and Control areas.

Upland bird nest predator detection rates were minimal during 2015 (ERM 2016a). Based on combined observations from point count and PRISM plot surveys, nest predator detection rates were 0.49 predators/ha in the Control area and 0.72 predators/ha in the Treatment area (ERM 2016a). Additionally, data collected from the wildlife camera monitoring program indicated that both wolf and fox species (Arctic and red) are present in the Treatment Area and in the Control areas. Although qualitative, these results do not suggest that nest predators are favouring the habitat on or near the Doris Project site nor do there appear to be any absolute increase in the presence of mammalian nest predators near mine infrastructure. This suggests that predators may not be attracted to the infrastructure and therefore may not be affecting nesting productivity of upland birds at the existing infrastructure. Such trends are anticipated to continue for Phase 2 development.

Mitigation to reduce the bird nest predation will include proper waste management, and additional measures to prevent bird nesting and mammalian denning on Project infrastructure. Based on the nest predator detection findings from the 2015 Doris WMMP (ERM 2016a), no increase in nest predation due to Project infrastructure is anticipated.

With mitigation, it is not expected that significant numbers of upland birds will be attracted to Phase 2 site, and it is unlikely that any population-level response will occur, either locally or regionally. Therefore, **no residual effect is predicted on upland birds** as a result of their attraction for Phase 2 or for the Hope Bay Project.

9.20.3.4 Direct Mortality

This section evaluates the potential for direct mortality and injury of upland birds due to 1) ground vehicle strikes, 2) aircraft strikes, 3) collisions with infrastructure (wind turbines, transmission line, towers and guy-wires), 4) entrapment in infrastructure, and 5) nest destruction during vegetation clearing.

Small birds such as passerines and other upland birds comprise the majority of birds that strike vehicles globally (Erritzoe, Mazgajski, and Rejt 2003; Erickson, Johnson, and Young Jr 2005). Bird mortality rates as a result of vehicle strikes increase with traffic volume and speed (Erritzoe, Mazgajski, and Rejt 2003). Vehicle strikes of upland birds are expected to occur very rarely for Phase 2. From 2006 to 2016, there have been three instances of upland bird mortality from vehicle collisions at Doris (Rescan 2011e, 2013d). To minimize the potential for interactions between vehicles and upland birds, speeds will be limited to a maximum of 50 km/h. The Doris Project has experienced very low mortality of upland birds and therefore with the addition of Phase 2 the effect of mortality will likely continue to be minimal.

The potential for collisions between aircraft and upland birds is a risk to aircraft and so is managed and reported. Other Arctic projects have not reported aircraft strikes on upland birds and in-flight strikes are expected to be very rare because aircraft will maintain 610 m except when landing and taking off.

Over the years that monitoring has been conducted for the Doris Project (2006 – 2016),there have only been three instances of mortality from birds becoming trapped in infrastructure at Doris (Rescan 2011c, 2011f, 2013d). Mitigation measures such use of mesh screening and phase out of megabags for tailings storage have successfully prevented further incidences.

Mitigation measures for Phase 2 are expected to eliminate the effect of mortality and injury due to vegetation clearing. These measures include preferential ground clearing outside of the sensitive nesting periods and pre-clearing nest surveys prior to clearing during the nesting periods. Thus, mortality and injury of upland birds is not expected to occur as a result of ground clearing.

Upland birds collisions with transmission lines, towers and guy-wires are rare for upland birds. These types of collisions can be an issue for species with large wingspans such as raptors or high wing loadings such as waterbirds, but with the exception of one upland bird species group, shorebirds, are rarely an issue for upland birds. Any transmission lines constructed during Phase 2 will be constructed using best management guidelines presented by the Avian Power Line Interaction Committee (APLIC 2006). Monitoring at other Arctic mines has not reported any waterbird mortalities due to strikes on towers or guy-wires, and mitigation is expected to be successful at further reducing the chances of collisions with towers and guy-wires (APLIC 2006). Interactions with transmission lines, towers and guy-wires are not considered further (Rioux et al. 2013).

Small passerines such as upland birds, typically account for the majority of bird fatalities at wind turbines relative to raptors and waterbirds, in part because this species group is comprised of more than 90% of all landbirds (National Wind Coordinating Collaborative (NWCC) 2010) (Bird Studies Canada 2017). Long-distance and nocturnal migrants are more likely to be killed by collisions with manmade structures, including wind turbines, as compared to resident birds or diurnal migrants (Kingsley and Whittam 2005; Powlesland 2009; Arnold and Zink 2011). Collision risk increases during poor weather conditions that force birds to fly at lower heights (National Wind Coordinating Collaborative (NWCC) 2010), and in cases where wind turbine sites are situated near migratory stopover sites (National Wind Coordinating Collaborative (NWCC) 2010), or high use/high species diversity areas, or landscape

features that promote flight in the vicinity of the wind turbines (Powlesland 2009). Studies suggest that in favourable weather conditions, most upland bird species fly above turbine heights, reducing their risk of mortality due to collisions with wind turbines as compared to resident birds or diurnal migrants (Powlesland 2009; National Wind Coordinating Collaborative (NWCC) 2010; Arnold and Zink 2011; American Wind Wildlife Institute (AWWI) 2017).

At the Hope Bay Project, all upland bird species are migratory except ptarmigan, and most species migrate at night. With the extended Arctic photoperiod during the spring and summer period, nocturnal migrants moving through the Hope Bay Project area are only likely to encounter a combination of poor weather, blinking aviation warning lights on towers, and darkness during the fall migration period. Weather logs for the Hope Bay Project from the Doris Gravel Strip, with weather data for most of 2017 (TMAC, unpublished data), show only two days in each of the months of August, September and October in which the ceiling was less than 640 feet (200 metres), marginally increasing the potential for upland bird conflict with the wind turbines due to poor weather. In addition, studies in the United States have shown that Federal Aviation Administration (FAA) recommended lighting for wind turbines does not increase migrating songbird collision risk (Kerlinger et al. 2010; American Wind Wildlife Institute (AWWI) 2017). Powlesland (2009) found that even in poor weather conditions most collisions at wind farms were with single birds. Standwatch surveys conducted at the turbine sites noted that during fall migration, upland birds appeared to wait for favourable wind conditions to move south.

Avian mortality rates in relation to collisions with turbine infrastructure are variable. Mortality of upland birds due to collisions with turbine infrastructure has not been reported at a windfarm in the Arctic (Diavik Project; (D. Wells, RioTinto, personal comm), but has been reported at other wind farm projects in southern Canada (Bird Studies Canada 2017). In Alberta, Ontario, and Atlantic Canada, the average mortality of non-raptor birds (which were predominately passerines) was 2.34 ± 0.40 birds/turbine, 5.70 ± 0.01 birds/turbine, and 1.81 ± 0.47 birds/turbine, respectively (Bird Studies Canada 2017). Based on mortality estimates for collisions with manmade structures in North America, and with wind turbines in Canada specifically, population level effects on birds from collision mortality are unlikely (Arnold and Zink 2011; Zimmerling et al. 2013). Evidence from other wind energy projects in Canada suggest a negligible number of mortalities recorded for species at risk (Bird Studies Canada 2017). There have been no mortality events reported in Canada to date of the three potentially occurring species of conservation concern (red-necked phalarope, buff-breasted sandpiper, and red knot; Bird Studies Canada 2017). Hence, it is expected that no mortality of upland bird species of conservation concern will occur at the Project as a result of collisions with wind turbine infrastructure.

Summary of Potential Direct Mortality Effects

Given the low rates of upland bird mortality observed for the Doris Project and the application of mitigation and management measures, mortality of upland birds is anticipated to be low for the majority of Project interactions assessed (ground vehicle strikes, aircraft strikes, collisions with transmission line, towers and guy-wires, entrapment in infrastructure, and vegetation clearing).

The most likely cause of direct mortality of upland birds due to the Project is due to collisions with wind turbines. Fatality rates can be site-specific but are expected to be relatively low at the Project because there are a small number of wind turbines, low numbers of upland birds were observed within the potential zone of interaction with wind turbines (i.e., between 50 and 200 metres above ground level and flying at a trajectory towards the wind turbines), and migration through the Project area is broad-front with no apparent barriers to or concentrated areas of movement. Monitoring will be conducted for two years as per recommendations in Environment Canada (2007b), and to ensure the predictions of no mortality of species of conservation concern. Should the number of mortalities recorded exceed the 14 birds/turbine/year threshold (OMNR 2011), or if mortality of species of conservation concern is recorded, adaptive management will be triggered to reduce the potential

effect. Despite mitigation, a residual effect of mortality on upland birds is predicted to occur, as the effect cannot be fully mitigated and some mortality is expected to occur. Thus, **a residual effect of direct mortality of upland birds is expected for the Phase 2 Project and the Hope bay Project**

9.20.3.5 Environmental Media Quality

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to activities prior to any development in the Hope Bay belt, due to the Approved Projects and due to the Hope Bay Project as a whole on ecological receptors (e.g., upland birds). The assessment determined that Phase 2 Project effects on environmental media quality were negligible, thus there is no potential increase in risk of adverse health effects in upland birds due to Phase 2 Project activities. Therefore, the potential effects of changes in environmental media quality are not considered as a residual effect on upland birds for either Phase 2 or the Hope Bay Project.

9.20.4 Significance of Project-related Residual Effects for Upland Birds

This section evaluates the significance of the three potential residual effects for upland birds which are rated as residual effects; habitat loss, disturbance, and direct mortality, which are summarized in Table 9.20-2.

9.20.4.1 Habitat Loss

Direct habitat loss is anticipated for approximately 5.3% of the LSA and 0.5% of the RSA. As a result of Construction and Operation of Phase 2, the effect of habitat loss on upland birds, will be negative with magnitude is rated as low. The magnitude rating of low reflects the estimation that only 0.5% of available habitat in the RSA will be affected and also the sensitivity and resilience of the local upland bird community. The local upland bird community is expected to have a low sensitivity to habitat changes, as only one of the species recorded to date is considered to be a species of federal conservation concern, red-necked phalarope, listed as Special Concern by COSEWIC (COSEWIC 2014a). Breeding habitat loss and alteration as a result of climate change, contaminants, and industrial activities is considered to be one of the threats to the Canadian population of red-necked phalaropes (COSEWIC 2014a). The local upland bird population is expected to have some resilience to adapt to habitat changes because the community is generally composed of species that are not currently at risk and thus can be considered to have stable or increasing populations. The current population of red-necked phalarope across Nunavut and Canada is not known (COSEWIC 2014a). Data from regional monitoring in the Arctic (Alaska and Canada) through PRISM surveys suggest that red-necked phalarope are a commonly recorded species with an estimated population of 927,000 individuals across surveyed areas which include areas of coastal Alaska, the Yukon North Slope, the Mackenzie Delta, and Queen Maud Gulf Migratory Bird Sanctuary (Bart and Smith 2012 in COSEWIC 2014a).

Habitat loss will occur over the long term, into Post-Closure. The geographic scope is within the PDA. Habitat loss will occur intermittently over time, with the majority of habitat loss occurring during Construction and additional portions of habitat lost during expansions of laydowns and infrastructure during Operations. Lost habitat will be reclaimed at Closure, but habitat will not return to baseline conditions for upland birds and so the effect is rated as irreversible. The likelihood of this effect is high, because the footprint is planned to be constructed and birds are known to nest in the habitats where Construction will occur. The residual effect of habitat loss for upland birds is considered to be **Not Significant** due to the minimal area affected for birds. Confidence in this characterization is high, because the area of the footprint and the bird community in this area is well understood. Residual effect of habitat loss due to the Hope Bay Project was given the same ratings as that of Phase 2, resulting in a determination of **Not Significant**.

Table 9.20-2. Summary of Residual Effects and Overall Significance Rating for Upland Birds - Phase 2

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Phase 2									
Habitat Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not significant	High
Disturbance	Negative	Negligible	Medium	Intermittent	LSA	Reversible	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not significant	Medium
Hope Bay Project									
Habitat Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not significant	High
Disturbance	Negative	Negligible	Medium	Intermittent	LSA	Reversible with effort	Moderate	Not significant	High
Direct Mortality	Negative	Low	Medium	Continuous	PDA	Reversible	Moderate	Not signficant	Medium

9.20.4.2 Disturbance

Long-term effects monitoring of upland birds for the Doris Project identified no effects of disturbance with no differences in the relative abundance of upland breeding populations near the Doris Project as compared to outside the region of possible effects. However, this potential effect was rated as a residual effect as a conservative measure. For upland birds, the residual effect of disturbance was rated as negative with negligible magnitude based on the results of long-term monitoring at the Doris Project and the expected sensitivity and resilience of the local upland bird community population (Section 9.20.4.1). The duration of disturbance effects was rated as medium term because disturbances are anticipated to last the life of Phase 2. Effects occur primarily during the passing of an aircraft or vehicle and during blasting and thus are characterized as intermittent. Disturbance effects are limited to the LSA as effects may extend 300 m from the source. Disturbance effects are associated with specific activities and thus are reversible upon Project Closure. Therefore, the residual effect of disturbance on upland breeding birds is assessed as **Not Significant**. Confidence in this assessment is high, as long-term monitoring has shown that there have been no disturbance effects to upland birds to due to the Doris Project.

The residual effect of disturbance due to the Hope Bay Project was given the same ratings as that of Phase 2. The magnitude of the potential effect was rated as negligible because the results of long-term monitoring at the Doris Project indicated that there have been no effects of disturbance on upland birds. Likewise, the analysis using the literature value of 300 m for FID indicated that there would be few effects on upland birds. Overall the residual effect of disturbance on upland due to the Hope Bay Project was rated as **Not Significant**. The confidence was rated as high for the same reasons provided above for Phase 2.

9.20.4.3 Direct Mortality

Post-construction monitoring conducted at wind turbines in the Arctic (Diavik Diamond Mine) has reported zero avian strikes (D. Wells, RioTinto, personal comm). However, bird interactions with wind turbines can be site-specific, and as a conservative approach, this potential effect was rated as a residual effect.

The potential for direct mortality due to Phase 2 is a negative residual effect with low magnitude because migration through the area is broad-front, low numbers of birds have been observed at turbine sites, zero avian strikes reported for other wind turbines operating in the Arctic, and also the sensitivity and resilience of the local upland bird community. The local upland bird community is expected to have moderate sensitivity to the effects of direct mortality because a small number of upland birds may suffer mortality. However, the upland bird community is generally composed of species that are not currently at risk and thus can be considered to have stable or increasing populations.

Collisions with wind turbines is identified by COSEWIC as a potential future threat to one of the three populations of species of conservation concern that could occur in the Project area; buff-breasted sandpiper (COSEWIC 2012b). The species has not been recorded to date in the Project area and no fatalities of this species have been reported at operating wind farms in Alberta, Ontario, and Atlantic Canada (Bird Studies Canada 2017). Population level effects on birds from collision mortality are unlikely based on mortality estimates for collisions with wind turbines in Canada (Arnold and Zink 2011; Zimmerling et al. 2013), suggesting the local upland bird population will be resilient to this effect. The duration is medium, occurring while the turbines are operational, during the life of the Project. The frequency will be continuous, and the geographic extent of the effect is confined to the turbine locations. The residual effect is fully reversible because when the turbines are decommissioned, the added mortality risk is eliminated. Post-construction monitoring will allow for adaptive management of turbines if fatalities are reported. The probability is moderate and the residual effect is not significant.

The confidence is medium as post-construction monitoring has indicated that upland bird fatalities at wind farms in the Arctic have not been observed. No or very few upland birds are anticipated to be affected, so there is low risk and it is unlikely that population-level effects on upland birds will be observed.

The residual effect of direct mortality on upland birds due to the Hope Bay Project was given the same ratings as that of Phase 2. The Hope Bay Project will not result in any additional direct mortality for upland birds beyond that indicated for Phase 2. The magnitude of the potential effect was rated as low due to the reasons provided for Phase 2. Overall, the residual effect of direct mortality on raptors due to the Hope Bay Project was rated as **Not Significant**. The confidence was rated as medium for the same reasons provided above for Phase 2.

9.21 UPLAND BIRDS – CUMULATIVE EFFECTS ASSESSMENT

Two potential effects were rated as residual effects for upland birds; habitat loss and disturbance. This section evaluates potential interactions between the Hope Bay Project and other projects within a cumulative effects assessment boundary.

9.21.1 Methodology Overview of Cumulative Effects

The methods for the cumulative effects assessment of upland birds are described in Section 9.5.7.

9.21.1.1 Spatial Boundary

The cumulative effects assessment for upland birds considers the RSA as the spatial boundary. The RSA is large enough to encompass entire summer home ranges of upland birds and a representative set of the regional population.

9.21.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 2, Section 4.

9.21.2 Potential Interactions of Residual Effects with Other Projects

The Project-related effects assessment (Section 9.20.3 and 9.20.4) evaluated the effects of Madrid-Boston Project as well as the effects of the existing and approved project which includes the Doris Project, the Hope Bay Regional Exploration Project, the Madrid Advanced Exploration Program, and the Boston Advanced Exploration Project. No other substantial past, present or reasonably foreseeable projects occur within the cumulative effects assessment spatial boundary for upland birds and cumulative effects for this VEC are not considered further.

9.22 IMPACT STATEMENT

9.22.1 Caribou

This section provides the concluding statements about significance of the Madrid-Boston (Phase 2) Project's potential impacts to caribou populations. The assessment of the Madrid-Boston Project potential impacts on caribou was based on a precautionary approach and considered any sound and credible case that a risk of serious or irreversible harm to caribou may exist. The risk was based on conditions observed from impact monitoring from the existing Doris operation, Inuit TK provided by the KIA and a Project-specific commissioned report, and especially through engagement with expert Elders and land users in three risk assessment and management workshops looking specifically at the potential

impacts of the Madrid-Boston Project on caribou and other wildlife. The assessment of the identified risks included incorporation of observations from other northern mines and information in the published literature, direction from herd management plans, and analysis of habitat and disturbance effects that included energetics and population structure to evaluate the risk to caribou individuals and herds that interact with the Madrid-Boston Project.

During the course of the Project, individual caribou may encounter Project infrastructure or activities such as helicopter flights, traffic and general site noise. To determine whether these individual encounters could have effects on caribou populations, TMAC used both Inuit TK, western science, and experience from the operating site to assess the risk to caribou. TMAC discussed whether these encounters could have impacts on caribou herds with Elders and land users as part of the caribou workshops. TMAC also conducted energetics-protein and population modeling to project long-term impact risk to caribou from Project and cumulative effects.

Inuit TK and western science indicate that caribou encountering the Project would not result in herd-level impacts to the populations of the Dolphin and Union, Beverly or Ahiak herds. The potential risk of the Project on caribou is negligible

The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on caribou, outlined in the WMMP (Volume 8, Annex V8-3). Habitat loss was evaluated by comparing the Madrid-Boston location to known calving, post-calving, summering and wintering areas identified by TK, satellite collars and aerial surveys. The Project does not overlap any calving or post-calving areas, and occupies a small proportion of habitat in the Dolphin and Union winter range (0.07%), Beverly winter range (0.03%), and Ahiak winter range (0.03%). With mitigation to minimize the Project footprint, habitat loss was rated as a residual effect.

Monitoring of caribou using aerial surveys at the Windy exploration camp (1996-2005) indicated that caribou did not avoid the camp, while camera monitoring of the Doris Project (2012-2016) indicates that there are similar densities of caribou neat the Doris camp as in control areas further away. A 4 km zone of influence was reported by a literature review. Modeling indicated that noise and dust would reach applicable standards within that distance. Hence, a 4 km zone of influence was predicted, which for Phase 2 would affect 0.07% of the Dolphin and Union winter range, 0.06% of the Beverly herd winter range, and 0.03% of the Ahiak winter range.

Population modeling conducted by two separate caribou biologists using different methodologies and models. Despite taking different modeling approaches, the two models produced the same results:

- The Hope Bay Project alone will not affect the population size of the Beverly, Ahiak or Dolphin and Union herds.
- The addition of the Hope Bay Project to the current conditions, with disturbance effects from communities and industrial projects does not affect the population size for any of the three herds.
- The addition of the Hope Bay Project to future conditions, with disturbance from communities and all reasonably foreseeable future projects does not affect the population size for any of the three herds.

With mitigation to purchase and maintain equipment to reduce noise, maintain setback distances and elevations when using helicopters, maintain minimum elevations when using fixed-wing aircraft, set speed limits for vehicles, manage dust, and restrict blasting when groups of caribou are near quarries, this effect will be reduced, but was still rated as a residual effect.

Disruption of movement was considered to be residual effect, but is mitigated because the migratory movements of Dolphin and Union caribou are parallel to the Boston road. In addition, road design, and enhanced monitoring during migration and vehicle management giving caribou the right-of-way on all Project roads will allow caribou to cross the road.

Direct mortality due to vehicle accidents was not rated as a residual effect because the Project will set and enforce speed limits and will give all wildlife the right of way on roads. Increased access and harvest was not rated as a residual effect because the Project will have a no hunting policy and few hunters have been observed during the last 10 years of the Doris Project. The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect. The potential for caribou to be attracted to the TIA as a source of salt was not rated as a residual effect because water quality and caribou usage will be monitored and caribou will be excluded if necessary using methods suggested by Inuit Elders.

The three residual effects of habitat loss and disturbance are restricted to the LSA and RSA, respectively, and cover a relatively small area of the RSA, seasonal and annual caribou ranges, yielding a negligible magnitude for habitat loss and low magnitude for disturbance and disruption of movement. The overall effect of Phase 2 and the Hope Bay Project on the VEC caribou is considered **Not Significant**.

Monitoring is planned to evaluate whether mitigation is working and trigger management, including: local-area scans prior to blasting, increased vigilance and hilltop surveys during migration, reporting wildlife incidents and observations. Monitoring is also conducted to test impact predictions, including: monitoring the size of the Project footprint (habitat loss) and monitoring zone of influence monitoring using motion-triggered cameras (disturbance).

A cumulative effects assessment was conducted because residual effects were predicted due to the Project and other industrial projects occur within the annual ranges of the Dolphin and Union, Beverly and Ahiak caribou herds. Three potential cumulative effects were evaluated: habitat loss, disturbance and disruption of movement. Key indicators were calculated for those where data was available and residual cumulative effects were predicted for both potential effects. The magnitude of effects were rated as low because of the relatively small proportional area affected for each herd compared to their seasonal and annual ranges.

It is anticipated that all projects within the CEA boundary will have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on caribou in the CEA boundaries.

9.22.2 Grizzly Bear

Grizzly bear was included as a wildlife VEC based on the NIRB guidelines and because TK identifies grizzly bear as a species spiritually and culturally important to the Inuit. A review of potential Phase 2 iterations with grizzly bear identified seven potential effects: habitat loss, disturbance, disruption of movement, attraction to the Project, direct mortality, increased access and harvest, and changes to environmental media quality.

The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on grizzly bear, outlined in the WMMP (Volume 8, Annex V8-3). The good quality habitat identified by habitat suitability modeling in the existing Project footprint and Phase 2 Project Development Area, is 1.5% of that in the regional study area and 0.4% and 1.5% of the estimated good

quality from a male and female grizzly bear home range, respectively. With mitigation to minimize the Project footprint, habitat loss was rated as a residual effect.

Scientific studies report that grizzly bears do not avoid mining projects, and DNA capture-recapture studies report that grizzly bear populations surrounding the Ekati and Diavik mines in NWT are stable or increasing. Grizzly bears are known to occupy areas of elevated noise and approach camps and active mines. Therefore, disturbance was not rated as a residual effect for grizzly bears. Disruption of movement was considered a residual effect because traffic on the section of road between Doris and Madrid (15% of the haul road between Boston and Doris) will be above traffic levels reported to cause grizzly bear to avoid crossing roads and below for the remaining sections of road (the existing road between Roberts Bay and Doris and the to be constructed road between Madrid and Boston). No movement corridors were identified by TK across the road for grizzly bear.

Grizzly bear are frequently attracted to exploration camps and active mines in the Arctic and are predicted to be attracted to the Project site. Bears were frequent visitors to the closed Windy camp in 2009 and have been observed near the Doris site in subsequent years. Buildings and waste management facilities will be constructed to be grizzly bear-proof so bears cannot get any food rewards or endanger Project personnel. Management will include waste management, camp cleanliness and a no feeding wildlife policy to reduce the attractiveness of the Project site. Cameras will be used to monitor infrastructure to see if bears are attracted. Attraction of grizzly bears to the Project was rated as a residual effect.

Direct mortality due to vehicle accidents was not rated as a residual effect because the Project will set and enforce speed limits and will give all wildlife the right of way on roads. Increased access and harvest was not rated as a residual effect because the Project will have a no hunting policy and few hunters have been observed during the last 10 years of the Doris Project. The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

The three residual effects of habitat loss and attraction to the Project site are restricted to the LSA. The area removed is very small compared to a grizzly bear's home range, yielding a negligible magnitude effect. Traffic volumes are predicted to be above thresholds for only a short section of the roads to that will be used for the Project, and as such the magnitude of the effect is considered low. Good management has been shown to be effective at limiting the number of bears that are attracted to industrial projects, yielding a low magnitude effect in each case. The overall effect of Phase 2 and the Hope Bay Project on the VEC grizzly bear is considered **Not Significant**.

A cumulative effects assessment was initiated because residual effects were predicted due to the Project, but there are no other large industrial projects in the grizzly bear cumulative effects assessment area, defined as the area that a female grizzly bear with an average home range might travel from the Project site. Therefore, the cumulative effects assessment was not considered further for grizzly bear.

9.22.3 Muskox

Muskox was included as a wildlife VEC because it was listed in the NIRB guidelines and muskox are hunted by Inuit. A review of potential Phase 2 iterations with muskox identified seven potential effects: habitat loss, disturbance, disruption of movement, attraction to the Project, direct mortality, increased access and harvest, and changes to environmental media quality.

The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on muskox, outlined in the WMMP (Volume 8, Annex V8-3). The good quality habitat identified by habitat suitability modeling in the Permitted Project footprint and Phase 2 PDA, is 2.0% of that area in the Regional Study Area and the total habitat loss is equivalent to 0.02% of MU MX-11. Phase 2 does not overlap areas identified by TK as having higher densities of muskox; the Kent Peninsula and the areas surrounding Bathurst Inlet. With mitigation to minimize the Phase 2 footprint, habitat loss was rated as a residual effect.

Monitoring of muskox 1996-2010 using aerial surveys reported a relatively low number of muskox; too few to evaluate whether muskox are avoiding the Windy exploration camp or the Doris Project. There are few scientific studies examining muskox avoidance of industrial projects. To be conservative and estimate a potential zone of influence for muskox, by using the predicted zone of influence of 4 km surrounding the mine site and 1.5 km surrounding roads that was used for caribou. Following this assumption, the Hope Bay Project would affect 9-15% of the good quality muskox habitat in the RSA which is ~0.1 to 0.2% of MU MX-11. With mitigation to purchase and maintain equipment to reduce noise, avoid muskox with helicopters, maintain minimum flight elevations with fixed-wing aircraft, and restrict blasting when groups of muskox are nearby, this effect will be reduced, but was still rated as a residual effect.

Disruption of movement was considered a residual effect because of concern regarding this potential effect, although the traffic rates for the Project will be variable over the life of the Project and along sections of road, with the highest rates along a relatively short section of road (Doris-Madrid) and there is little evidence for muskox and the responses to traffic. The road will be built with crossing structures for caribou and muskox. No movement corridors or crossing locations were identified by TK for muskox.

Muskox are not expected to be attracted to the Phase 2 site. Direct mortality due to vehicle accidents was not rated as a residual effect because the Phase 2 will set and enforce speed limits and will give all wildlife the right of way on roads. Increased access and harvest was not rated as a residual effect because the Phase 2 will have a no hunting policy and few hunters have been observed during the last 10 years of the Doris Project. The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

The two residual effects of habitat loss and disturbance are restricted to the LSA and RSA, respectively, and cover a relatively small area of the RSA and area of the muskox management unit MX-11 that overlaps the Project, yielding a low magnitude effect in each case. The magnitude of the effect of disruption of movement is considered low because of the varying levels of traffic by road section, with only a small section between Doris and Madrid carrying traffic over 100 vehicles per day. The overall effect of Phase 2 and the Hope Bay Project on the VEC muskox is considered **Not Significant**.

A cumulative effects assessment was initiated because residual effects were predicted due to the Project, but there are no other large industrial projects in the muskox cumulative effects assessment area, which was defined as the regional study area. Therefore, the cumulative effects assessment was not considered further for muskox.

9.22.4 Furbearers

Wolverine (furbearers) was included as a wildlife VEC because it was listed in the NIRB guidelines and TK identifies wolverine as an important fur and trapping species for the Inuit. A review of potential Phase 2 iterations with wolverine identified seven potential effects: habitat loss, disturbance,

disruption of movement, attraction to the Project, direct mortality, increased access and harvest, and changes to environmental media quality. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on wolverine, outlined in the WMMP (Volume 8, Annex V8-3).

The effect of habitat loss was assessed through habitat suitability modeling in the Permitted Project footprint and Phase 2 PDA. For both Phase 2 and for the Hope Bay Project, approximately 0.5% of suitable denning habitat in the RSA is anticipated to be lost. Project design included locating the Phase 2 PDA so to avoid wolverine dens and the closest den is over 4 km away. With mitigation to minimize the Phase 2 footprint, habitat loss was rated as a residual effect.

Wolverine are known to occupy areas of elevated noise and to approach camps and active mines in the Arctic, displaying some degree of habituation. Sensory disturbance was therefore not considered as a residual effect.

Disruption of movement was considered a residual effect for wolverine because traffic on the section of road between Doris and Madrid (15% of the haul road between Boston and Doris) will be above traffic levels that may cause wolverine to avoid crossing (based on the threshold developed for grizzly bear) and below for the remaining sections of road (the existing road between Roberts Bay and Doris and the to be constructed road between Madrid and Boston).

Wolverine are occasionally attracted to exploration camps and active mines in the Arctic and are predicted to be attracted to the Project site. Wolverine were visitors to the closed Windy camp in 2009 and have been observed near the Doris site and Roberts Bay in subsequent years. Mitigation will include waste management, camp cleanliness and a no feeding wildlife policy to reduce the attractiveness of the Project site. Attraction of wolverine to the Project was rated as a residual effect.

Direct mortality due to vehicle accidents was not rated as a residual effect because the Project will set and enforce speed limits and will give all wildlife the right of way on roads. Increased access and harvest was not rated as a residual effect because the Project will have a no hunting policy and few hunters have been observed during the last 10 years of the Doris Project. The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

The residual effects of habitat loss and attraction are restricted to the LSA and cover a relatively small area of the RSA, yielding a negligible and low magnitude effect, respectively. Traffic volumes are predicted to be above thresholds for only a short section of the roads to that will be used for the Project, and as such the magnitude of the effect is considered low. The overall effect of Phase 2 and the Hope Bay Project on the VEC wolverine is considered **Not Significant**.

A cumulative effects assessment was initiated because a residual effect was predicted for the Project, but there are no other large industrial projects in the wolverine cumulative effects assessment area, defined as the average home range size of a male wolverine. Therefore, the cumulative effects assessment was not considered further for wolverine.

9.22.5 Raptors

Raptors were identified as a wildlife VEC because migratory birds were listed in the NIRB guidelines, raptors are identified as culturally important to the Inuit and there are best management practices and regulations under the *Nunavut Wildlife Act* concerning raptor nests. A review of Phase 2 activities

identified six potential effects for raptors: habitat loss, disturbance, disruption of movement, attraction to the Project, direct mortality, and changes to environmental media quality.

The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on raptors, outlined in the WMMP (Volume 8, Annex V8-3). The assessment for habitat loss evaluated the loss of cliff-nesting sites in the PDA. Five nests occur in the PDA, but only one nest (of a rough-legged hawk) occurs in the planned footprint area. This nest site is the only nest site for the territory and was confirmed occupied in 2013 and in no other year since 2004. This nest site was located in marginal nesting habitat and is likely infrequently occupied. Loss of lowland nesting and brood rearing habitat for short-eared owl will account for approximately 1.7-1.8% of the good quality habitat in the RSA for both Phase 2 and for the Hope Bay Project. Mitigation includes minimizing the size of the footprint and planning the footprint to avoid raptor nests. This mitigation will reduce but not completely eliminate the effect of habitat loss to raptors, and thus a residual effect was predicted.

Monitoring of raptors from 2004 to 2015 using aerial surveys for the Doris Project recorded occupancy of territories and productivity (the proportion of occupied territories that fledged young). An analysis of this data indicated that there is no effect of the existing Doris Project on nearby nesting raptors in terms of occupancy, but there was some indication of a localized effect (<1.5 km) on breeding activity. There were insufficient data to assess raptor productivity. A literature review reported that there may be an effect of disturbance on raptors, and disturbance was therefore rated as a residual effect for raptors. Mitigation will include purchasing and maintaining equipment to minimize noise disturbance.

Arctic mining projects report that raptors can be attracted to the rock walls of quarries and open pits. Phase 2 will have quarries, but no open pits. The RSA contains many nesting sites for raptors, where each raptor pair maintains a territory that typically includes multiple nesting sites, most unused. In addition, the quarry walls were rated as relatively low-quality nesting habitat because they are not as high as naturally-occurring rock faces with nest sites. Monitoring for raptors during the breeding season and management to exclude raptors prior to egg laying will remove potential effects of attraction to quarries. As a result, attraction was not identified as a residual effect for raptors. Disruption of movement was not anticipated to result from the interaction of raptors with wind turbines or other Project infrastructure, and was not identified as a residual effect.

Direct mortality of raptor eggs or chicks due to Construction was evaluated. Clearing outside of the breeding season, where possible, pre-Construction surveys in suitable cliff and short-eared owl habitat and the use of appropriate setbacks will mitigate for this potential effect. Based on a literature review, fatality rates are expected to be low due to raptor interactions with wind turbines and other tall structures; however, direct mortality due to collisions with turbine blades cannot be completely mitigated, and was therefore rated as a residual effect for raptors..

The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

Three residual effects were identified, habitat loss, disturbance, and direct mortality that are restricted to the LSA and cover a relatively small area of the RSA, yielding a low magnitude effect in each case. The overall effect of Phase 2 and the Hope Bay Project on the VEC raptors is considered **Not Significant**.

A cumulative effects assessment was initiated because residual effects were predicted due to the Project, but there are no other large industrial projects in the raptor cumulative effects assessment

area, which was defined as the regional study area. Therefore, the cumulative effects assessment was not considered further for raptors.

9.22.6 Waterbirds

Waterbirds (ducks, geese and loons) were identified as a wildlife VEC because migratory birds were identified in the NIRB guidelines and TK identified waterbirds as an important group of species for Inuit, who hunt birds and traditionally collected eggs as food. A review of the Phase 2 activities identified seven potential effects for waterbirds; habitat loss, disturbance, disruption of movement, attraction to the Project, direct mortality, increased access and harvest and changes to environmental media quality.

The assessment for habitat loss evaluated the loss of suitable water habitat and terrestrial nesting habitat and the loss of high use areas based on monitoring of waterbirds from 2006 to 2015 using aerial surveys for the Doris Project. Only one high-use area, used during the brood rearing season, occurs in the PDA, but is outside of the Boston footprint area. No other high-use areas used during the nesting or staging periods for waterbirds occur in the Project development area. Loss of suitable habitat for waterbirds will account for approximately 0.5% of the suitable habitat in the RSA for Phase 2 and 0.6% for the Hope Bay Project. Mitigation to minimize the Phase 2 footprint will reduce but not completely eliminate the effect of habitat loss to waterbirds, and thus a residual effect was predicted.

A literature review reported that there may be an effect of disturbance on waterbirds that was not observed in the ongoing Doris Project monitoring, and disturbance was therefore rated as a residual effect for waterbirds. Mitigation will include purchasing and maintaining equipment to minimize noise disturbance.

Some studies report that waterbirds can be attracted to tailings ponds during the spring when these ponds melt earlier than surrounding ponds. Monitoring of water quality and the presence of birds in the TIA and management to exclude birds if water does not meet wildlife guidelines will effectively mitigate this potential effect. Therefore, no residual effect of attraction to Phase 2 was predicted. Disruption of movement was not anticipated to result from the interactions of waterbirds with wind turbines or other Project infrastructure, and was not identified as a residual effect.

Direct mortality of waterbirds due to interactions with vehicles, aircraft traffic, and to eggs or chicks due to Construction was evaluated. Pre-Construction surveys in lakeshore habitat and the use of appropriate setbacks will mitigate for this potential effect, which was not rated as a residual effect. Vehicle strikes of birds have historically been low for Permitted Project and any effects are anticipated to be mitigated through enforcement of speed limits. Conditions that increase the likelihood of waterbird fatalities due to collisions with wind turbines and other tall structures are expected to occur infrequently at the Hope Bay Project. Mitigation to minimize direct mortality (i.e., line markers) will reduce but not completely eliminate the effect of direct mortality on waterbirds and thus a residual effect was predicted.

The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

Three residual effects were identified, habitat loss, disturbance, and direct mortality that are restricted to the LSA and cover a relatively small area of the RSA, yielding a low magnitude effect in each case. The overall effect of Phase 2 and the Hope Bay Project on the VEC waterbirds is considered **Not Significant**.

A cumulative effects assessment was initiated because residual effects were predicted due to the Project, but there are no other large industrial projects in the waterbird cumulative effects assessment area, which was defined as the regional study area. Therefore, the cumulative effects assessment was not considered further for waterbirds.

9.22.7 Upland Birds

Upland birds were identified as a wildlife VEC because migratory birds were identified in the NIRB guidelines and TK identified upland birds as an important group of species for Inuit, who hunt ptarmigan and traditionally collected eggs as food. A review of the Phase 2 activities identified seven potential effects for upland birds; habitat loss, disturbance, disruption of movement, attraction to the Project, direct mortality, increased access and harvest and changes to environmental media quality.

The assessment for habitat loss evaluated the habitat loss based on habitat suitability modelling. Loss of suitable habitat for upland birds will account for approximately 0.5% of the suitable habitat in the RSA for Phase 2 and 0.6% of suitable habitat for the Hope Bay Project. Mitigation to minimize the Phase 2 footprint will reduce but not completely eliminate the effect of habitat loss to upland birds, and thus a residual effect was predicted.

A literature review reported that there may be an effect of disturbance on upland birds that was not observed in the ongoing Doris Project monitoring, and disturbance was therefore rated as a residual effect for upland breeding birds. Mitigation will include purchasing and maintaining equipment to minimize noise disturbance.

Effects on upland birds can occur if birds are attracted to structures which provide habitat or artificial lighting which attracts migratory birds or if meso-predators are attracted to Phase 2 site that may prey on upland birds. Though some degree of attraction to infrastructure may occur, mitigation and management measures are anticipated to eliminate potential residual effects on upland birds. No difference in detection rates of nest predators were observed between the Doris Project and control sites and thus no increase in nest predation is anticipated to occur for Phase 2. Therefore, no residual effect of attraction to the Project was predicted.

Direct mortality of upland bird due to interactions with vehicles, aircraft traffic, and wind turbines, and to eggs or chicks due to Construction was evaluated. Preferential clearing outside breeding seasons and pre-clearing surveys will mitigate potential mortality effects due to Construction-related clearing. Vehicle strikes of birds have historically been low for Permitted Project and any effects are anticipated to be mitigated through enforcement of speed limits. A literature review reported that small passerines including upland bird species typically account for the majority of bird fatalities at wind turbines, although the majority of migrating upland birds were not observed at heights that interaction with wind turbines during spring and fall surveys at the Project. Mitigation is anticipated to reduce the effect of direct mortality to upland birds; however, fatality rates can be site-specific and variable and a residual effect of direct mortality on upland breeding birds was therefore predicted.

The human health risk assessment predicted negligible changes in environmental media quality – dust and water quality – and therefore toxicological effects on vegetation quality and wildlife were not considered a residual effect.

Three residual effects were identified, habitat loss, disturbance, and direct mortality that are restricted to the LSA and cover a relatively small area of the RSA, yielding a low magnitude effect in each case. The overall effect of Phase 2 and the Hope Bay Project on the VEC upland birds is considered **Not Significant**.

A cumulative effects assessment was initiated because residual effects were predicted due to the Project, but there are no other large industrial projects in the upland bird cumulative effects assessment area, which was defined as the regional study area. Therefore, the cumulative effects assessment was not considered further for upland breeding birds.

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