COSEWIC
Assessment and Status Report

on the

Caribou
Rangifer tarandus

Dolphin and Union population

in Canada

ENDANGERED
2017

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report(s):

COSEWIC 2004. COSEWIC assessment and update status report on the Peary caribou *Rangifer tarandus pearyi* and the barren-ground caribou *Rangifer tarandus groenlandicus* (Dolphin and Union population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 91 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Gunn, A., F.L. Miller and D.C. Thomas. 1979. COSEWIC status report on the Peary caribou *Rangifer tarandus pearyi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 40 pp.

Miller, F.L. 1991. Update COSEWIC status report on the Peary caribou *Rangifer tarandus pearyi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 124 pp.

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Dolphin and Union Caribou. The bull, second from left, has shed his antlers. Photograph by Kim Poole, Aurora Wildlife Research.

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COSEWIC
Assessment Summary

Assessment Summary – November 2017

Common name
Caribou - Dolphin and Union population

Scientific name
Rangifer tarandus

Status
Endangered

Reason for designation
This Arctic caribou population is endemic to Canada, occurring in Nunavut and the Northwest Territories. Recognized for its unique migration pattern from Victoria Island across the sea ice to the mainland, observations have shown that its distribution has retracted and expanded since the beginning of the 20th century, in rough correspondence with population size. In the early 1900s, the herd was reported to be large, then a strong decline was likely precipitated by the introduction of firearms, combined with severe winters. A 50-60-year period of low densities and no sign of migration across the sea ice followed. The herd started to increase in the late 1970s, and resumed its migration to the mainland in the late 1980s, increasing in numbers until the 1990s. In 2015, the herd was estimated at about 18,000 animals. Three survey estimates over the last 18 years and Aboriginal Traditional Knowledge suggest a decline as high as 50-60%, which appears to have accelerated since 2010. The population is experiencing multiple threats, including reduced connectivity and disrupted migration between winter and summer range associated with commercial shipping in Dease Strait that is increasingly supported by ice-breakers. Climate change is linked with decreased periods of ice cover and irregularity of sea ice conditions, causing mortality through drowning and delays in migration with consequences for nutrition and parasite burdens. Overharvest has been involved in past declines and recent exploitation levels are unknown, although access opportunities from five additional communities have increased. The spread of insect pests and pathogens as a consequence of climate change is an additional concern. Natural fluctuations of the population remain a source of uncertainty.

Occurrence
Northern Territories, Nunavut

Status history
The original designation considered a single unit that included Peary Caribou, *Rangifer tarandus pearyi*, and what is now known as the Dolphin and Union population of Caribou, *Rangifer tarandus*. It was assigned a status of Threatened in April 1979. Split to allow designation of three separate populations in 1991: Banks Island (Endangered), High Arctic (Endangered) and Low Arctic (Threatened) populations. In May 2004 all three population designations were de-activated, and the Peary Caribou, *Rangifer tarandus pearyi*, was assessed separately from the Dolphin and Union population of Caribou, *Rangifer tarandus*. The Dolphin and Union population is comprised of a portion of the former "Low Arctic population", and it was designated Special Concern in May 2004. Status re-examined and designated Endangered in November 2017.

COSEWIC
Executive Summary

Caribou
Rangifer tarandus

Dolphin and Union population

Wildlife Species Description and Significance

Dolphin and Union Caribou are easily recognizable from Barren-ground and Peary Caribou. Intermediate in body size, they are morphologically and behaviourally distinct from both, and genetic analyses have consistently confirmed their uniqueness. A key distinguishing behavioural trait relative to other Caribou populations is the seasonal migrations that occur twice a year when members of this population cross the sea ice between Victoria Island and the mainland in a synchronous and coordinated way to reach their summer or winter ranges. They are integral components of Inuit and Inuvialuit culture, and have high spiritual, economic, and subsistence value.

Distribution

Endemic to Canada, the range of Dolphin and Union Caribou spans two jurisdictions: Northwest Territories and Nunavut. These Caribou summer as one population occupying most of Victoria Island. Having first been documented in the mid-1850s crossing the Dolphin and Union Strait, they now migrate across the Coronation Gulf, the Dease Strait and Queen Maud Gulf to winter on the mainland. Recorded observations show that the distribution of Dolphin and Union Caribou has retracted and expanded at various points in time since the beginning of the 20th century, in rough correspondence with population size.

Habitat

Calving areas on Victoria Island are not discrete and lie in the Northern Arctic Terrestrial Ecozone, while wintering areas on the mainland coast are in the Southern Arctic Ecozone. The annual range is composed of tundra habitats populated by prostrate dwarf-shrubs, forbs, sedges, mosses and lichens. Given their regular migrations between Victoria Island and the mainland, a key habitat requirement for Dolphin and Union Caribou is the seasonal sea ice connecting the Island and mainland.

Habitat changes brought about by climate change include changes to sea ice, shifts in vegetation community composition, and amount and timing of plant growth. Although there has been minimal natural resource development within the range to date, there are two operating mines and several proposed mining developments with accompanying

infrastructure, as well as plans for ships passing through ice-crossing areas, that are likely to compromise habitat quality and continuity in the future.

Biology

Similar to Barren-ground Caribou, Dolphin and Union Caribou follow an annual cycle, undertaking pre-calving and fall migrations between seasonal ranges. Although pre-calving migration is relatively gregarious, individuals disperse to calve over much of Victoria Island. The rut likely occurs during either migration or staging and Caribou males will often mate with more than one female. Dolphin and Union Caribou have a reproductive lifespan of about 12 years, usually first calving when they are 3 years old, or at 2 years when high-quality forage is available. Generation time is estimated at 7 to 9 years. These Caribou have a similar morphology to Peary Caribou, which appears to have arisen by convergent adaptation to a highly seasonable and cold climate. They share their annual range with four large mammalian predators, two other populations of Caribou (Barren-ground and Peary), Muskoxen, and several species of smaller-bodied mammalian herbivores and waterfowl, all of which have experienced population and distribution changes in recent years. Humans and Wolves are the main predators of Dolphin and Union Caribou.

Population Sizes and Trends

In the early 1900s, the Dolphin and Union Caribou population was thought to be about 100,000 individuals, but this was a best guess. Shortly afterwards, this population declined precipitously, a likely consequence of the introduction of firearms combined with severe winters. By the 1920s, its migration across the Dolphin and Union Strait ceased. Caribou were rarely seen on Victoria Island for the next five decades. In 1959, the resident, non-migratory population on Victoria Island was estimated at 671 individuals. Inuit from Cambridge Bay began seeing Caribou in the 1970s and 1980s and, by 1993, up to 7,000 were once again migrating annually across Coronation Gulf and Dease Strait.

Three surveys in 1997, 2007 and 2015 have deployed a consistent methodology, with comparable results, to allow for a quantitative trend estimate over three generations. The first two survey estimates were retroactively corrected: A 1997 survey that estimated 27,989 ± SE 3,367 total Caribou in the visual survey strata was later revised to 34,558 ± CI 6,801, extrapolated to include animals outside the survey area based on information from radio collars. In 2007, 21,753 ± SE 2,343 were estimated, later revised to 27,787 ± CI 7,537. In 2015, the population was estimated at 18,413 ± 6,795 (95% Cl, 11,664- 25,182). Using the original and revised estimates from the surveys as minima and maxima, there has been an overall exponential decline of over 50% since 1997. Inuit Qaujimajatuqagit (IQ), Aboriginal Traditional Knowledge and local knowledge have also noted a declining trend of about 80%, which accelerated after 2010. IQ collected in 2014 observed declines in numbers in the young age classes, a high proportion of animals with poor body condition, and increased observations of diseased animals.

Threats and Limiting Factors

Dolphin and Union Caribou are facing a large number of direct threats to population persistence, which have been assessed as High-Very High Impact, although there is much uncertainty. Reduced connectivity of sea ice is a primary concern, with ice-breaker-supported shipping in Dease Strait already showing signs of disrupting migration. Decreased periods of ice cover and/or irregularity of sea ice conditions has also been observed, associated with climate change, which causes mortality through drowning and delays migration with consequences for nutrition and parasite burdens. Overharvest has been involved in past declines and recent exploitation levels are unknown, although access opportunities from five additional communities have increased. Predation from Wolves and Grizzly Bears is an additional concern. The spread of insect pests and pathogens associated with climate change is a threat. An unknown mortality factor may be involved in Dolphin and Union Caribou population declines, possibly involving Muskox populations through multi-prey interactions with wolves and/or multi-host interactions with parasites and pathogens. Also uncertain is the future cumulative disturbance and habitat change if any, or all, of several proposed mining projects with associated infrastructure (roads and ports) are approved for construction.

Protection, Status and Ranks

Dolphin and Union Caribou are co-managed in Nunavut according to the Nunavut Land Claims Agreement, and are co-managed in the Northwest Territories according to the Inuvialuit Final Agreement. These agreements confer primary wildlife management authority on the respective management boards: the Nunavut Wildlife Management Board and, in the NWT, the Wildlife Management Advisory Council and the Inuvialuit Game Council.

Dolphin and Union Caribou are currently listed as Special Concern under both the federal *Species at Risk Act* (2003) (on Schedule 1) and the territorial *Species at Risk (NWT) Act* (2013). COSEWIC originally assessed Dolphin and Union Caribou as Special Concern in May 2004, and this population was reassessed as Endangered in November 2017.

Globally, Caribou is listed by the International Union for Conservation of Nature (IUCN) as Vulnerable; subspecies or ecotypes are not differentiated. NatureServe ranked Caribou as secure globally and Not Yet Ranked for Dolphin and Union Caribou, which is ranked imperiled-vulnerable at the national level (N2N3), imperiled-vulnerable (S2S3) in the NWT, and unranked (SNR) in Nunavut.

Tuktuk Nogait National Park includes coastline in the southwestern portion of Dolphin and Union Caribou range and the Queen Maud Gulf Bird Sanctuary offers a certain level of habitat protection to part of the wintering range.

TECHNICAL SUMMARY

Rangifer tarandus

Caribou - Dolphin and Union population (Designatable Unit 2)

Caribou - Population Dolphin-et-Union (Unité désignable 2)

Range of occurrence in Canada (province/territory/ocean): Northwest Territories and Nunavut (Victoria Island and adjacent parts of the mainland).

Demographic Information

Generation time (usually average age of parents in the population; indicate if another method of estimating generation time indicated in the IUCN guidelines (2011) is being used)	7-9 yrs
Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?	Yes
Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]	33.8% decline since 2007
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. *Based on three survey points, with much uncertainty as to trend and pattern of decline.*	~52% (using GT of 7 yrs) – 61% (9 yrs)
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].	Unknown
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future.	May be >50%
Are the causes of the decline a. clearly reversible and b. understood, and c. ceased?	a. no b. no c. no
Are there extreme fluctuations in number of mature individuals?	Unlikely

Extent and Occupancy Information

Estimated extent of occurrence (EOO)	499,449 km²
Index of area of occupancy (IAO) (Always report 2x2 grid value).	391,292 km²

Is the population “severely fragmented” i.e., is >50% of its total area of occupancy in habitat patches that are (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. no b. no
Number of “locations”* (use plausible range to reflect uncertainty if appropriate)	1
Is there an [observed, inferred, or projected] decline in extent of occurrence?	Likely, but unquantified
Is there an [observed, inferred, or projected] decline in index of area of occupancy?	Unknown
Is there an [observed, inferred, or projected] decline in number of subpopulations?	N/A (one subpopulation)
Is there an [observed, inferred, or projected] decline in number of “locations”*?	N/A (one location)
Is there an [observed, inferred, or projected] decline in [area, extent and/or quality] of habitat?	Yes
Are there extreme fluctuations in number of subpopulations?	N/A
Are there extreme fluctuations in number of “locations”*?	N/A
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each subpopulation)

	N Mature Individuals
Total *This estimate includes an unknown number of immature animals*	18,413 ± 6,795 (2015)

Quantitative Analysis

Is the probability of extinction in the wild at least [20% within 20 years or 5 generations, or 10% within 100 years]?	Analysis not done

* See Definitions and Abbreviations on COSEWIC web site and IUCN (Feb 2014) for more information on this term

Threats (direct, from highest impact to least, as per IUCN Threats Calculator)

Was a threats calculator completed for this species? Yes
Total Impact: Very High-High

i. Shipping Lanes (IUCN Threat # 4.3) (High Impact)
ii. Problematic native species (IUCN Threat #8.2) (High-Low Impact)
iii. Hunting (IUCN Threat # 5.1) (Medium-Low Impact)
iv. Climate Change and Severe Weather (IUCN Threat #11) (Medium-Low Impact)
v. Parasites and Diseases (IUCN Threat # 8.1[Invasive non-native alien species]) (Medium-Low Impact)
vi. Storms and Flooding (11.4) (Medium-Low Impact)
vii. Energy Production and Mining (IUCN Threat #3) (Low Impact)

What additional limiting factors are relevant?

Rescue Effect (immigration from outside Canada)

Status of outside population(s) most likely to provide immigrants to Canada.	N/A (Endemic to Canada)
Is immigration known or possible?	N/A
Would immigrants be adapted to survive in Canada?	N/A
Is there sufficient habitat for immigrants in Canada?	N/A
Are conditions deteriorating in Canada?[+]	N/A
Are conditions for the source (i.e., outside) population deteriorating?[+]	N/A
Is the Canadian population considered to be a sink?[+]	N/A
Is rescue from outside populations likely?	No

Data Sensitive Species

Is this a data sensitive species?	No

Status History

COSEWIC: The original designation considered a single unit that included Peary Caribou, *Rangifer tarandus pearyi*, and what is now known as the Dolphin and Union population of Caribou, *Rangifer tarandus*. It was assigned a status of Threatened in April 1979. Split to allow designation of three separate populations in 1991: Banks Island (Endangered), High Arctic (Endangered) and Low Arctic (Threatened) populations. In May 2004 all three population designations were de-activated, and the Peary Caribou, *Rangifer tarandus pearyi*, was assessed separately from the Dolphin and Union population of Caribou, *Rangifer tarandus*. The Dolphin and Union population is comprised of a portion of the former "Low Arctic population", and it was designated Special Concern in May 2004. Status re-examined and designated Endangered in November 2017.

[+] See Table 3 (Guidelines for modifying status assessment based on rescue effect)

Status and Reasons for Designation:

Status: Endangered	**Alpha-numeric codes**: A2ad+4acd
Reasons for designation: This Arctic caribou population is endemic to Canada, occurring in Nunavut and the Northwest Territories. Recognized for its unique migration pattern from Victoria Island across the sea ice to the mainland, observations have shown that its distribution has retracted and expanded since the beginning of the 20th century, in rough correspondence with population size. In the early 1900s, the herd was reported to be large, then a strong decline was likely precipitated by the introduction of firearms, combined with severe winters. A 50-60-year period of low densities and no sign of migration across the sea ice followed. The herd started to increase in the late 1970s, and resumed its migration to the mainland in the late 1980s, increasing in numbers until the 1990s. In 2015, the herd was estimated at about 18,000 animals. Three survey estimates over the last 18 years and Aboriginal Traditional Knowledge suggest a decline as high as 50-60%, which appears to have accelerated since 2010. The population is experiencing multiple threats, including reduced connectivity and disrupted migration between winter and summer range associated with commercial shipping in Dease Strait that is increasingly supported by ice-breakers. Climate change is linked with decreased periods of ice cover and irregularity of sea ice conditions, causing mortality through drowning and delays in migration with consequences for nutrition and parasite burdens. Overharvest has been involved in past declines and recent exploitation levels are unknown, although access opportunities from five additional communities have increased. The spread of insect pests and pathogens as a consequence of climate change is an additional concern. Natural fluctuations of the population remain a source of uncertainty.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Meets Endangered A2ad, with 3-generation decline of 51-61% estimated, based on aerial surveys [a], with exploitation [d] also driving population decline. Also meets A4acd (past and future), because future decline is predicted based on ongoing threats.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Population): Not applicable.
Criterion E (Quantitative Analysis): Not applicable.

PREFACE

This updated report incorporates information that became available after the last COSEWIC Status Update (COSEWIC 2004) for Dolphin and Union Caribou. In 1991, prior to the enactment of the *Species at Risk Act* (SARA), Caribou throughout the Canadian Arctic Archipelago (except for Baffin Island) were considered by COSEWIC to be Peary Caribou (Miller 1991). Although recognized as a distinct entity, Dolphin and Union Caribou were assessed as part of the Low Arctic Islands population, which included Peary Caribou. In 2004, COSEWIC assessed two entities in one status report (COSEWIC 2004): 1) Peary Caribou, which included all Caribou in the Arctic Archipelago except for Baffin Island and central and southern Victoria Island, and 2) Dolphin and Union Caribou, a genetically distinct population that occupies the remainder of Victoria Island, and migrates to the mainland in winter.

COSEWIC undertook an analysis of designatable unit (DU) structure of Caribou in Canada as a special project (COSEWIC 2011) to define the units for future status assessments and reassessments of this species according to the latest guidelines. Recognition of Peary Caribou and Dolphin and Union Caribou as two of 12 DUs in Canada was affirmed by this analysis, and an updated status assessment of Peary Caribou was undertaken in 2015 (COSEWIC 2015).

This report incorporates information collected since the 2004 COSEWIC Status Update for the Dolphin and Union Caribou, including data from surveys conducted in 2007 (Dumond and Lee 2013) and 2015 (Leclerc *et al*. in prep.; 2016), which allow for the calculation of trend estimates over a three-generation time span.

The Government of the Northwest Territories completed a status assessment for Dolphin and Union Caribou (SARC 2013) under the *Species at Risk (NWT) Act*. A Management Plan under the federal *Species at Risk Act* is being prepared jointly by the Government of Nunavut and the Government of the Northwest Territories, in cooperation with the Government of Canada and co-management partners (GNU and GNWT 2017). This COSEWIC report has been able to include key maps and figures produced for both documents, and also benefited from ATK (including Inuit Qaujimajatuqangit [IQ; Inuit Knowledge]) gathered through this process. IQ and ATK are considered to be synonyms in this report.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2017)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment and Climate Change Canada
Canadian Wildlife Service
Environnement et Changement climatique Canada
Service canadien de la faune
Canada

The Canadian Wildlife Service, Environment and Climate Change Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Common names: Island Caribou (NWT and Nunavut; English), Arctic island Caribou (NWT and Nunavut; English), Mainland Caribou (Ulukhaktok, NWT; English), Dolphin and Union Caribou, Barren-ground Caribou (Dolphin and Union population) (English), Caribou du troupeau Dolphin-et-Union (French), Kiilliniq Caribou (Inuinnaqtun; Nunavut); Killinik (Inuktituk).

Caribou are members of the deer family (Order: Artiodactyla, Family: Cervidae, Subfamily: Capreolinae, Genus: *Rangifer*, Species: *tarandus*; Gilbert *et al.* 2006). Banfield (1961) classified *Rangifer* into sub-species and "inter-grades", based largely on Manning's (1960) morphometric measurements of skulls and leg bones, as well as pelage colouration and antler form. This taxonomy has not been updated, even though it was often based on few specimens and newer techniques, such as DNA analyses, are revealing different evolutionary relationships among Caribou populations.

Barren-ground Caribou of North America and Greenland (in which Dolphin and Union were likely included) were named *Cervus groenlandicus* by Borowski (1780) based on a specimen from Greenland, and later transferred to the genus *Rangifer* (Kellogg 1932). First singled out for their distinctiveness by Manning (1960), Dolphin and Union Caribou have been alternatively classified as *R. t. groenlandicus*, *R. t. pearyi* and *R. t. groenlandicus* × *pearyi*. In recognition of their uniqueness relative to neighbouring Peary and mainland Barren-ground Caribou, recent authors have referred to them as *R. t. groenlandicus* × *pearyi* (Poole *et al*. 2010; Nagy *et al*. 2011; SARC 2013; GNU and GNWT 2017). Despite some confusion over taxonomic classification, its genetic distinctiveness has been recently re-confirmed (McFarlane *et al*. 2016; see **Population Spatial Structure and Variability**). An overall revision of the genus is needed to clarify subspecies (Geist 2007, COSEWIC 2011).

Harvesters and elders interviewed in the Ulukhaktok area recognize two types of Caribou (Peary, and Dolphin and Union) on Victoria Island, and tend to differentiate Dolphin and Union Caribou from other Caribou by differences in size, colour, and taste (Elias 1993 in SARC 2013).

This Caribou population is named after the Dolphin and Union Strait, which they once crossed twice yearly on their northward spring migration and southward fall migration. Their current migration patterns, however, are concentrated in the Coronation Gulf and Dease Strait (see **Dispersal and Migration**).

Morphological Description

Dolphin and Union Caribou are highly recognizable and distinguishable from Barren-ground and Peary Caribou (GNU and GNWT 2017, SARC 2013). Individuals are smaller than Barren-ground Caribou, but larger than most Peary Caribou (SARC 2013). They have similar pelage patterning to that of Peary Caribou except that they are slightly darker, with gray down the front of their legs instead of white. The early winter coat is white with a pale brown back. Skeletal and antler differences further distinguish them from most Peary Caribou. Dolphin and Union and Peary Caribou share three characteristics that contrast them with those belonging to the Barren-ground Caribou: grey antler velvet, proportionally long molar tooth rows, and wider hooves (Manning 1960; Gunn and Fournier 1996; SARC 2013).

Mean body length has not been published, but Gunn and Fournier (1996) compared skull measurements of southern Victoria Island female Caribou with female Barren-ground Caribou from Pelly Bay: the mean condylobasal length was 297.83 ± SE 1.31 mm in the Victoria Island Caribou compared to 317.86 ± SE 3.21 mm in the Pelly Bay skulls.

Population Spatial Structure and Variability

Genetic Structure

North American Caribou have been divided into two lineages using genetic analysis of mitochondrial DNA (mtDNA) sequences. The Beringian-Eurasian Lineage and the North American Lineage refer to Pleistocene refugia that they originated from (COSEWIC 2011; Klütsch *et al*. 2012; Yannic *et al*. 2014). Barren-ground (COSEWIC in press), Peary (COSEWIC 2015), and Dolphin and Union Caribou are part of the Beringian-Eurasian Lineage. After the last ice age, as populations expanded and colonized (or re-colonized) northern lands, hybridization resulted in introgression of haplotypes from each lineage into the other at a low enough frequency to leave each lineage distinct and clearly separable (Klütsch *et al*. 2012). Phylogenetic data based on mitochondrial DNA (Eger *et al*., 2009) suggest that Dolphin and Union and the Bathurst subpopulation of Barren-ground Caribou (see Designatable Units) diverged from one other another approximately 1000 years ago (Eger *et al*., 2009; McFarlane *et al*., 2016). Estimates from microsatellite DNA suggest that the divergence time from other mainland subpopulations occurred around the same time, whereas divergence of Dolphin and Union Caribou from eastern arctic island subpopulations occurred earlier (about 3000 ybp) (McFarlane *et al*. 2016).

Genetic analyses based on nuclear (microsatellite) DNA have consistently confirmed the distinctiveness of Dolphin and Union Caribou from other designatable units (Eger *et al*. 2009; Zittlau *et al.* 2009; COSEWIC 2011; Serrouya *et al*. 2012; McFarlane *et al*. 2014, 2016). Despite this, low to moderate levels of gene flow have been detected between Dolphin and Union Caribou and mainland Barren-ground Caribou, particularly in historical times (*i.e.,* several hundred years ago; McFarlane *et al*. 2016).

Subpopulation Structure

All available evidence points to Dolphin and Union Caribou belonging to one demographic unit (subpopulation). Although calving is dispersed across a large part of Victoria Island, only one rutting area has been described from collared Caribou (Gunn and Fournier 2000, Nishi 2000) which supports the single subpopulation. When this herd was reduced to low numbers in the 1920s, the migration ended and did not become regular until several decades later (see **Population abundance and trends**). However, it was the same type of Caribou that had previously migrated between Victoria Island and the mainland, based on their skull measurements, pelage colour, and the migratory behaviour of Caribou on southern Victoria Island in the 1980s being similar to those previously described by Manning (1960) for the Dolphin and Union herd (Gunn and Fournier 1996).

Designatable Units

Dolphin and Union Caribou were first assessed by COSEWIC in 1979 as part of Peary Caribou (Gunn *et al*. 1979). In 1991, Dolphin and Union Caribou were recognized by COSEWIC (Miller 1991) as a separate 'population' from Peary, but were not assessed separately until COSEWIC (2004). COSEWIC (2011) confirmed the Dolphin and Union Caribou as one of 11 extant Caribou DUs.

Measures of genetic divergence between Dolphin and Union Caribou and both Peary and Barren-ground Caribou populations support their discrete nature. New genetic information since COSEWIC (2011) re-affirms the uniqueness of Dolphin and Union Caribou (McFarlane *et al*. 2014, 2016). Morphology (e.g., skull shape, antler velvet colour, hoof size, and breeding pelage pattern; Gunn & Fournier 1996; Manning 1960; see **Mophological Description**) provides additional evidence of discreteness. Dolphin and Union Caribou are geographically or temporally isolated from most other Caribou during calving and rutting (Gunn and Fournier 2000; Nishi and Gunn 2004, Poole *et al*. 2010; Nagy *et al*. 2011), although spatial overlap during winter with the Ahiak (Barren-ground) herd does occur (L. Leclerc, pers. comm., 2017).

In terms of evolutionary significance, while Dolphin and Union Caribou share haplotypes with members of adjacent DUs, the retention of some distinct genetic lineages (Eger *et al*. 2009) suggests possible local adaptations by these Caribou. They differ significantly from Barren-ground Caribou (DU3) because their regular twice-annual migratory pattern across sea ice is unique and reflects the unique ecological setting. The scale of this migration (thousands of individuals) is also distinct from the often dispersed uncoordinated individual-scale movements over sea ice observed in Peary Caribou (COSEWIC 2011). Although the Dolphin and Union Caribou have a strong migratory annual cycle that is similar to Barren-ground Caribou, they have a dispersed individualistic calving strategy similar to Peary Caribou (Nishi 2000; Poole *et al.* 2010). They are also isolated from other populations during the rut on Victoria Island (Poole *et al.* 2010; Nagy 2011).

Special Significance

Inuit and Inuvialuit peoples of the Canadian Arctic have harvested Caribou for > 4,000 years (Manseau *et al.* 2004). Dolphin and Union Caribou share cultural, historical, economic, and ecological importance with Peary Caribou (COSEWIC 2015). Ancient Caribou drive systems made of stone lines and cairns and communal Caribou kill sites found on southern Victoria Island span several millennia, covering the whole of modern Inuit occupation and, before them, the unrelated Dorset culture (Brink 2005; Friesen 2013). These records show that the Caribou on both Victoria Island and the mainland are a deeply integral component of Inuit and Inuvialuit culture, Arctic ecology and Canadian history. Humans harvested Caribou within the region for centuries (Manning 1960; Savelle and Dyke 2002; Brink 2005). Today, this Caribou population is the source of fresh meat for four Inuvialuit and Inuit communities and two outpost camps. In addition, Dolphin and Union Caribou have likely been an important factor in the distribution of the genetic signatures of wolves (*Canis lupus*) that follow them (Carmichael 2007).

DISTRIBUTION

Global Range

Dolphin and Union Caribou range is entirely within Canada.

Canadian Range

The range of Dolphin and Union Caribou spans two jurisdictions: Northwest Territories and Nunavut (Figure 1). These Caribou occupy most of Victoria Island (except for the northwest portion) as well as sections of the mainland coast. Their range includes Gateshead Island, Jenny Lind Island and Admiralty Island and islands in Coronation Gulf, Queen Maud Gulf and Dolphin and Union Strait, and the adjacent mainland coast (summarized by SARC 2013). Dolphin and Union Caribou are also known to travel to Read Island and Cambridge Bay (Elias 1993 in SARC 2013).

Recorded observations describe the distribution of Dolphin and Union Caribou retracting and expanding at various points in time since the beginning of the 20th century, in rough correspondence with population size (Table 2 in GNU and GNWT 2017). For example, population numbers were so low in the 1920s, that animals ceased to migrate across the Dolphin and Union Strait for several decades (see **Population Abundance and Trends**). In the 1960s to 90s, during a time of population increase, the winter range extended further south on Victoria Island than in the past (ATK and community knowledge sources cited in SARC 2013).

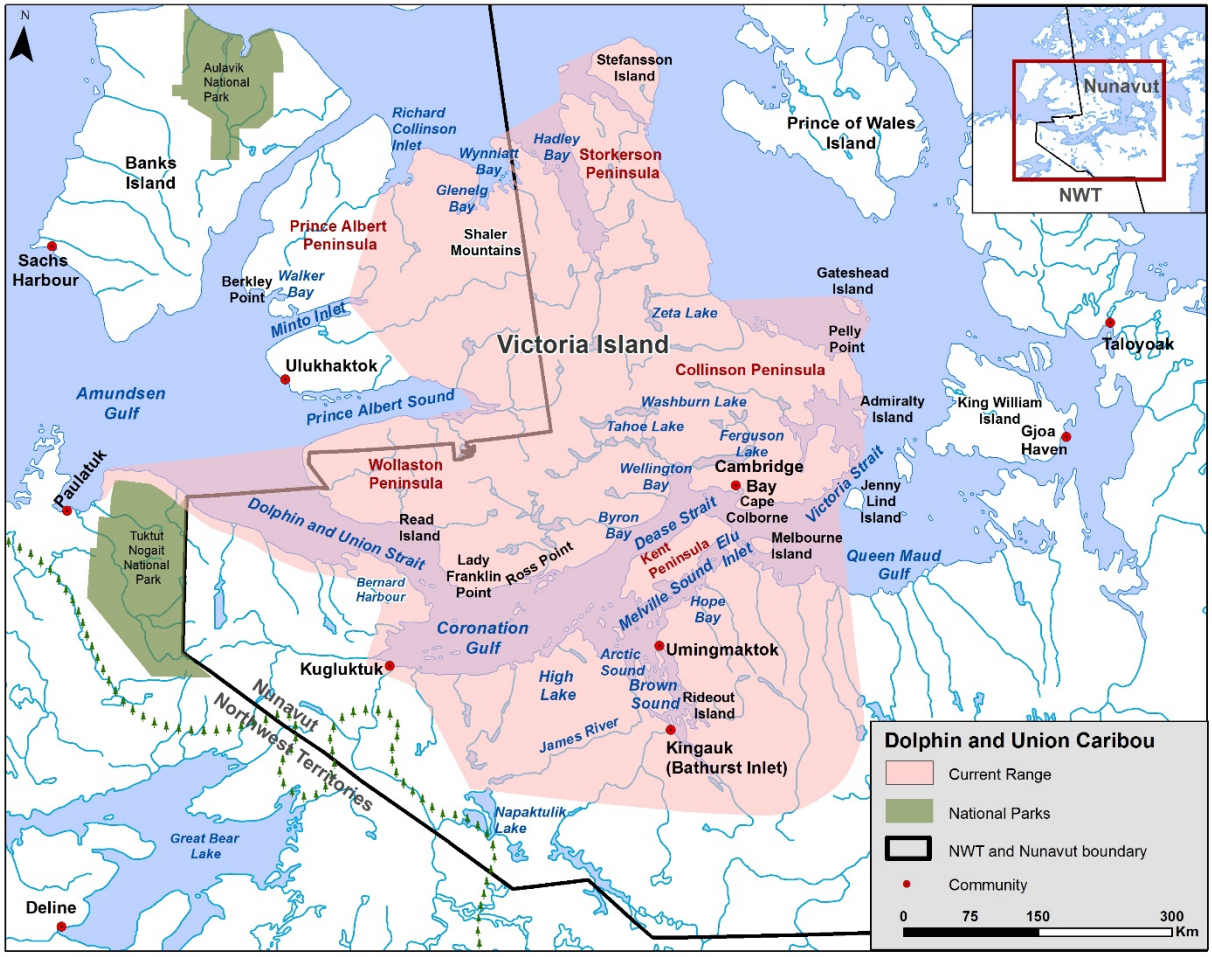

Figure 1. Current range of Dolphin and Union Caribou, including notable place names (NWT Environment and Natural Resources, range data developed for Species at Risk program 2016).

In the 1980s, harvesters' reports corroborated biologists' surveys showing a shift in winter distribution of the Dolphin and Union Caribou from the south and east of Victoria Island (Gunn *et al.* 1997). In the 1990s and 2000s, the Dolphin and Union population extended its winter range on the coast of the mainland and individuals were seen north of Great Bear Lake in the range of mainland Barren-ground Caribou (elder Phillip Kadlun of Kugluktuk, cited in Golder Associates Ltd. 2003; Tomaselli *et al*. 2018; Figure 2). They have also been seen west as far as Tuktut Nogait National Park (Gau pers. comm. 2011 cited in SARC 2013).

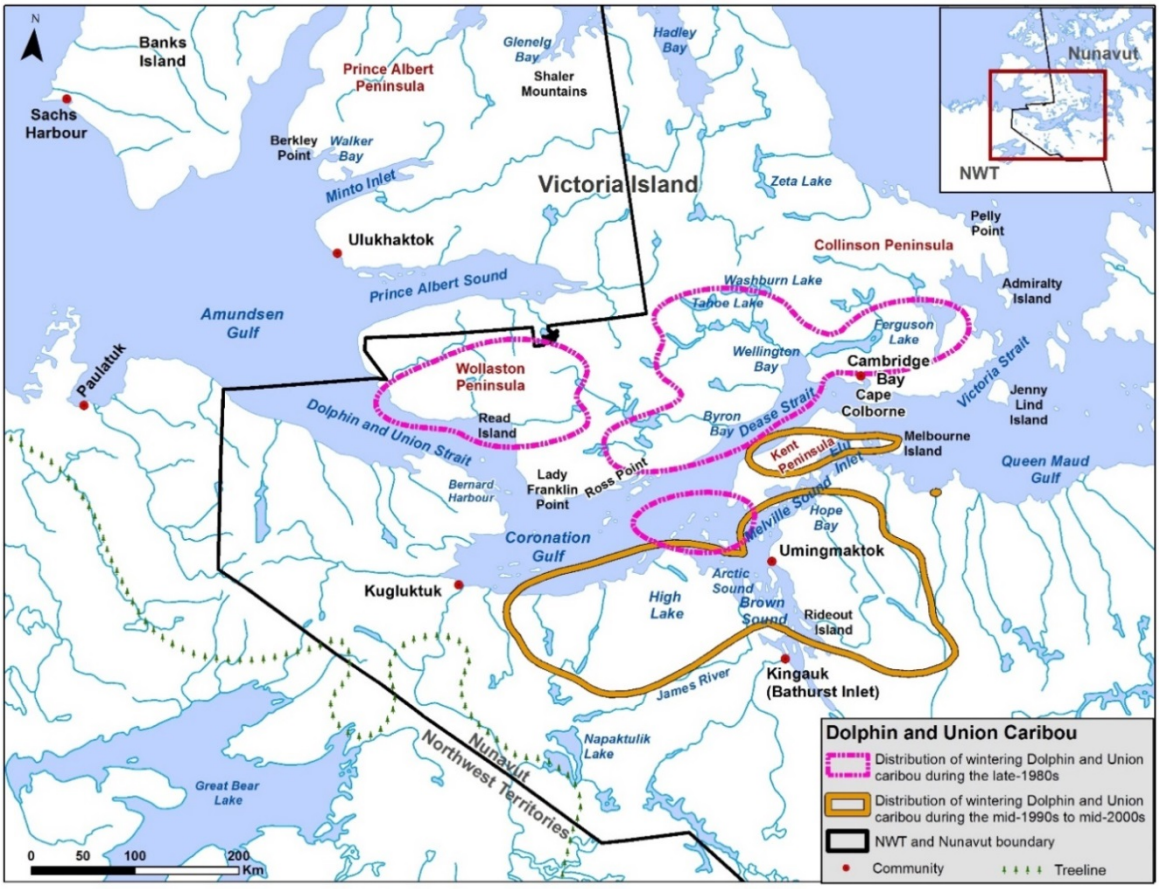

Figure 2. Approximate distribution of wintering Dolphin and Union Caribou during the late 1980s (pink line), and the mid-1990s to mid-2000s (gold line), based on satellite-collared Caribou. Data from Poole *et al*. (2010); figure reproduced from the SARC (2013) by B. Fournier, GNWT-ENR 2016.

Extent of Occurrence and Area of Occupancy

The extent of occurrence (EOO) for Dolphin and Union Caribou was estimated as 499,449 km^2 for the population, encompassing areas where these Caribou have been recorded since 1980. The index of area of occupancy (IAO) was estimated as the surface area of 2 x 2 km grid cells that intersect the area of occupancy and totalled 391,292 km^2 (SARC 2013). In light of IUCN guidance that the “smallest area essential at any stage to the survival of existing populations of a taxon” might be a more relevant measure of area of occupancy (IUCN Standards and Petitions Subcommittee 2017:49), the area of the fall staging area on the southern shore of Victoria Island might qualify, but has not been consistently mapped and is variable in location and size. Dolphin and Union Caribou follow a dispersed calving strategy scattered over a large proportion of Victoria Island.

Search Effort

Inuvialuit and Inuit from the communities, including Ulukhaktok and Paulatuk (NWT) and those from Cambridge Bay, Kugluktuk, Umingmaktok and Kingauk (formerly Bathurst Inlet) in Nunavut, regularly hunt throughout the range of the Dolphin and Union Caribou.

They also trap and conduct other traditional activities in these areas, and are always alert to the presence or unexpected absence of Caribou (SARC 2013). Experienced hunters can visually distinguish Dolphin and Union Caribou from other Barren-ground Caribou and from Peary Caribou. Their observations have been reported (e.g., Nishi 2000) and collected by focused interviews (e.g., Thorpe *et al*. 2001; SARC 2013, Tomaselli *et al*. 2016; 2018; GNU and GNWT 2017).

The widespread adoption of snow machines in the 1970s effectively increased search effort because hunters could cover greater distances searching for Caribou or Muskoxen or travelling cross-country for other reasons (Condon 1996 cited in SARC 2013). Due to the amount of time spent on the land and the experience and skills required to continue their cultural traditions the Inuvialuit and Inuit have a high level of awareness of Caribou and other wildlife distribution, density and condition (c.f. Dumond 2007; SARC 2012; 2013).

Information particular to wildlife management is also shared in meetings of local Hunters and Trappers Organizations (Nunavut) and Committees (Inuvialuit), and between them and regional wildlife management boards. In this way, knowledge of status, movements and condition of wildlife is accumulated and spreads among communities. The search effort entailed in the wildlife management aerial surveys varied prior to 1997 but typically was low coverage and/or only parts of the island were surveyed (Jakimchuk and Carruthers 1980; Gunn and Fournier 2000; Nishi and Buckland 2000), partly because Victoria Island is so large. The large area was a leading reason since 1986 for switching to VHF, satellite and GPS collars to locate Caribou, although the low number of collars (<25/year) reduces precision of analyses. Collar locations are used to map Caribou in the fall to allocate aerial survey effort (Nishi and Gunn 2000, Dumond and Lee 2013).

HABITAT

Habitat Requirements

Dolphin and Union Caribou require high-quality forage while reducing their risk of exposure to mosquitos and warble flies (*Hypoderma* sp.), parasites and predators (ATK summarized in SARC 2013). They may use eskers for fly-free travel and for the Moss Campion (*Silene acaulis*), a preferred food, as noted in the Olokhaktomiut Community Conservation Plan (2008). Information on forage habitat requirements specific to Dolphin and Union Caribou is limited, due to incomplete or few descriptions of their diet, and the wide distribution of forage by vegetation types and feeding sites relative to plant phenology or snow conditions (SARC 2013). The energetic costs of foraging when snow and ice restrict forage access are also unknown.

A key habitat requirement for Dolphin and Union Caribou is the seasonal connectivity of the sea ice between Victoria Island and the mainland. Poole *et al*. (2010) reported that these Caribou require >90% ice coverage in the fall. While the Caribou may cross on recently formed new ice (<10 cm thickness), they generally cross when most of the surface is young ice (e.g., grey coloured, 10–30 cm thick), which is in the transition stage from new ice to first-year ice.

The climate is strongly seasonal and continental, with short, dry, summers and long cold winters. Mean annual daily temperature was -13.9 ^{0}C (1981-2000) with a mean July temperature of 8.9 ^{0}C at Cambridge Bay on Victoria Island (http://climate.weather.gc.ca/climate_normals/). Mean annual precipitation is 138.8 mm at Cambridge Bay (59% as snow) (http://climate.weather.gc.ca/climate_normals/).

West and southern Victoria Island lies within the 7-9 ^{o}C mean July temperature while central and eastern Victoria are cooler being within 5-7 ^{o}C (Gould *et al*. 2003). The annual range of Dolphin and Union Caribou is within the Northern and Southern Arctic Ecozones. Calving areas on Victoria Island lie in the Northern Arctic Terrestrial Ecozone, while wintering areas on the mainland coast are in the Southern Arctic Ecozone (Gunn *et al*. 2011; Rankin *et al*. 2011).

The low summer rainfall means that the drought index is high, especially in August compared to mainland herds (CARMA unpubl. data). The cooler summers reduce the warble fly index to about half that recorded for the mainland Caribou ranges. Cumulative snow depth averages 80 cm on the winter range, which is relatively deep and the snow density is relatively high compared to Barren-ground Caribou winter ranges.

The vegetation is mostly prostrate dwarf shrubs and mosses, with dwarf shrubs and non-tussock grasses and shrubs (Gould *et al*. 2002). The calving, summer, and fall ranges on Victoria Island are characterized by discontinuous upland vegetative cover, varying between 5-80% coverage and dominated by prostrate dwarf shrubs including Purple Saxifrage (*Saxifraga oppositifolia*), Dryas spp., and Arctic Willow (*Salix arctica*), along with Alpine Foxtail (*Alopecurus alpinus*), Wood Rush (*Luzula nivalis*), and other saxifrages (Gould *et al*. 2003). The vegetation is relatively sparse as most of the island has 5-50% plant cover and less than 500 g/m^2, which contrasts to the nearby mainland where above-ground biomass and plant productivity is higher (Gould *et al*. 2003, Hughes 2006). The variety of dwarf shrubs, grasses and forbs provides sufficient high quality forage despite the relatively low cover of lichens.

Diet

The diet of Dolphin and Union Caribou is high in protein-rich vascular plants (sedges, grass, and willows) and in flowers in summer. Unusually dry summers tend to yield relatively poor forage quality, which can lead to population-level impacts the following year (Dumond 2007).

Winter diet on Victoria Island in the late 1980s and in May 2004 was dominated by dwarf shrubs (Mountain Avens [*Dryas octopetala*], willow) and sedges but, on the nearby mainland, Arctic Heather (*Cassiope tetragona*) and lichens dominated the diet (Hughes 2006, SARC 2013; GNU and GNWT 2017). The mainland has quite different topography and geology compared to Victoria Island but these influences on forage selection are unmeasured.

Dolphin and Union Caribou must adjust their foraging to changing snow conditions, which are affected by terrain (slope and aspect) and the timing of snowmelt (Larter and Nagy 2001; SARC 2013). Snow cover can also affect energy costs, e.g., access forage through digging for food and travel (Thorpe *et al*. 2001).

Habitat Trends

A lack of information hampers assessing habitat trends, except for the general satellite-derived mapping of arctic vegetation which can be related to underlying trends in summer warmth and reduced sea ice cover (for example, Bhatt *et al.* 2017). Climate trends for Victoria Island are described in **Threats and Limiting Factors**.

Other possible habitat trends are the effects of anthropogenic development and activities on habitat, but there have been no scientific assessments within Dolphin and Union Caribou calving and summer ranges. One mine (TMAC Resources' Hope Bay project) began operating in 2017, and there are mineral exploration camps and proposed mining projects in the mainland part of the winter range that could influence habitat use for these animals in the future (see **Energy Production and Mining**).

Inuit and Inuivialuit living in the summer range of Dolphin and Union Caribou reported an increase in plant growth, and consequently better forage, over the last three decades of the 20th century, which they attributed to climate change (Thorpe *et al.* 2001). Informants also said that acceptable forage is appearing in new areas and existing forage is increasing in quality and this trend sustained the population increase (SARC 2013). Hunters from Kugluktuk, however, thought that the “grass was quite sparse on Dolphin and Union summer range” (ENR 1998, cited in SARC 2013), possibly due to heavy grazing by Caribou associated with a peak in population about 1997.

After members of the Dolphin and Union Caribou population migrate through an area, the vegetation is so decimated that it takes two years to grow back (Phillip Kadlun of Kugluktuk cited by Golder Associates Ltd. 2003). The concentration of Caribou on southern Victoria Island during the rut and along the coast in preparation for fall migration has resulted in visible, but unquantified, effects on forage over the years (Nishi and Gunn 2004).

BIOLOGY

Life Cycle and Reproduction

Similar to Barren-ground Caribou, Dolphin and Union Caribou follow an annual cycle, undertaking pre-calving and fall migrations between seasonal ranges. In the spring, they migrate northward to where they calve in early to mid-June (Gunn and Fournier 2000, Nishi 2000) and then spend the summer gaining weight. In the fall, they move to the south coast of Victoria Island where they stage waiting for freeze-up, after which they migrate to the over-wintering grounds (Poole *et al*. 2010; SARC 2013) (see **Dispersal and Migration**). Although pre-calving migration is relatively gregarious (groups of dozens of females), individuals disperse to calve over much of Victoria Island east to the eastern coast (Gunn and Fournier 2000; Nishi 2000; Nishi and Buckland 2000). The rut likely occurs during either migration or staging and the mating system is polygynous (c.f. Holand *et al*. 2007), with bulls tending small groups of females which are relatively synchronized in their oestrus (Mysterud *et al*. 2003).

Dolphin and Union Caribou have a reproductive lifespan of about 12 years (SARC 2013), and assuming they are similar to Peary Caribou (Thomas 1982), usually first calve when they are 3 years old, or at 2 years old when there is high-quality forage available. SARC (2013) presented data on pregnancy rates for the Dolphin and Union Caribou from 1987 to 1997 that varied from 43% to 100% over this time period. Hughes (2006) found the age of harvested Dolphin and Union Caribou females ranged from 1.8 to 13.8 years, with a mean age of 6.5 years.

Information regarding generation time is lacking for Dolphin and Union Caribou. Moreover, age structure and sex ratio changes with each severe winter that is followed by reduced survival and fecundity. For the Dolphin and Union population, COSEWIC (2004) and the SARC (2013 citing Boulanger pers. comm. 2011) estimated the intergeneration time as 7 to 9 years, based on unpublished data on adult survival and fecundity.

Physiology and Adaptability

Special adaptations of Dolphin and Union Caribou are undescribed. Their migration pattern is broadly similar to Barren-ground Caribou populations, except that they undertake long ice crossings and their winter and summer ranges are farther north. Their morphological similarity to Peary Caribou (relatively large hooves, molariform tooth row, and smaller body size) suggests adaptation to similar selection pressures, which include the highly seasonal and cold climate and relatively sparse forage (Miller *et al*. 2007; Zittlau *et al*. 2009).

Dispersal and Migration

Before about 1920, when numbers were still high, Caribou crossed the Dolphin and Union Strait at various points as far west as Cape Bexley and Coronation Gulf east to Queen Maud Gulf in the spring (summarized in SARC 2013). They moved rapidly

northwards to the north coast and spread out over most of Victoria island. Some individuals remained on the Wollaston Peninsula during the summer, while the main herd continued north past Prince Albert Sound. In the fall, after the rut, they returned to the mainland south of Coronation Gulf and west at least to Cape Dalhousie (Nishi 2000; Poole *et al.* 2010). Scientific observations and hunters' reports indicate that, during the 1980s, Caribou shifted their fall aggregation areas to the south and east on Victoria Island (Gunn *et al.* 1997).

Currently, most of the central-southern-eastern Victoria Island Caribou migrate to the mainland in winter. Some of those Caribou crossed to Read Island, while others went east to Cambridge Bay. A few individuals remain on Victoria Island all year (Thorpe *et al*. 2001). Elias (1993 in SARC 2013) summarized Inuvialuit traditional knowledge and found that the resident Victoria Island Caribou migrated north of Prince Albert Sound to calve in the spring; they wintered around there or on islands to the east or south of the coast. Those that migrate across the sea ice to winter on the mainland in November return in April to southeast Victoria Island.

Archaeological studies on southeast Victoria Island reveal a high likelihood of the persistence of the fall staging and migration of Dolphin and Union Caribou. Pre-Dorset 11th-13th century CE) and Thule people (16-18th century CE) depended on the Caribou and fish (Howse 2008, Howse and Friesen 2016). Wolverine (*Gulo gulo*) bones were associated with Pre-Dorset and Wolf bones with Thule (Howse and Friesen 2016). Examination of the bones suggests the Caribou were killed during fall and spring. Rae (1852, cited in Manning 1960) was the first European explorer to describe the migration across to southwest Victoria in 1851.

Major migration routes follow a consistent pattern (ATK in SARC 2013, Poole et 2010). In fall, Caribou in the Victoria Island's Cape Colbourne area cross Dease Strait south to the Kent Peninsula, reaching Umingmaktok (Bathurst Inlet) by mid-November; those in the Read Island area cross Dolphin and Union Strait to the mainland, although this occurs much more rarely than it did in the early 2000s. In spring, Caribou move from the mainland to Melbourne Island and across Queen Maud Gulf or Dease Strait to Victoria Island. Those starting in the Browne Sound area cross to Arctic Sound and Rideout Island towards Elu Inlet (on the south side of the Kent Peninsula), then across Dease Strait to Cambridge Bay, while those further west cross Coronation Gulf west of Bathurst Inlet to Ross Point on Victoria Island.

Scientific evidence regarding the migration across the Dolphin and Union Strait is congruent with ATK (Figure 3). Satellite tracking records of 46 individuals from 1987–2006 demonstrated that Caribou crossed throughout the western Queen Maud Gulf-Dease Strait-Coronation Gulf area and that only two individuals crossed the Dolphin and Union Strait (Poole *et al.* 2010), as they did historically.

The Dolphin and Union Caribou begin moving southward in October to staging areas along the southern coast of Victoria Island while waiting for freeze-up; Caribou that summer farther north on Victoria Island arrive later, shortening their time spent on the staging area. They begin migrating south in fall as soon as the sea ice is formed and most depart from just a few locations, which they tend to use consistently for year to year (Poole *et al.* 2010). In winter, ATK has suggested increasing overlap of Dolphin and Union and Barren-ground Caribou herds on the mainland (summarized by SARC 2013).

The Ekaluktuktiak Hunters and Trappers Association in Cambridge Bay reported that Melbourne Island is an important area for the Dolphin and Union Caribou in the spring (cited by Gunn *et al.* 1997). They also stage and feed intensively on the Kent Peninsula and other areas along the mainland coast. It is believed that island-hopping routes are chosen to maximize foraging before crossing the sea ice to Victoria Island (Gunn *et al.* 1997).

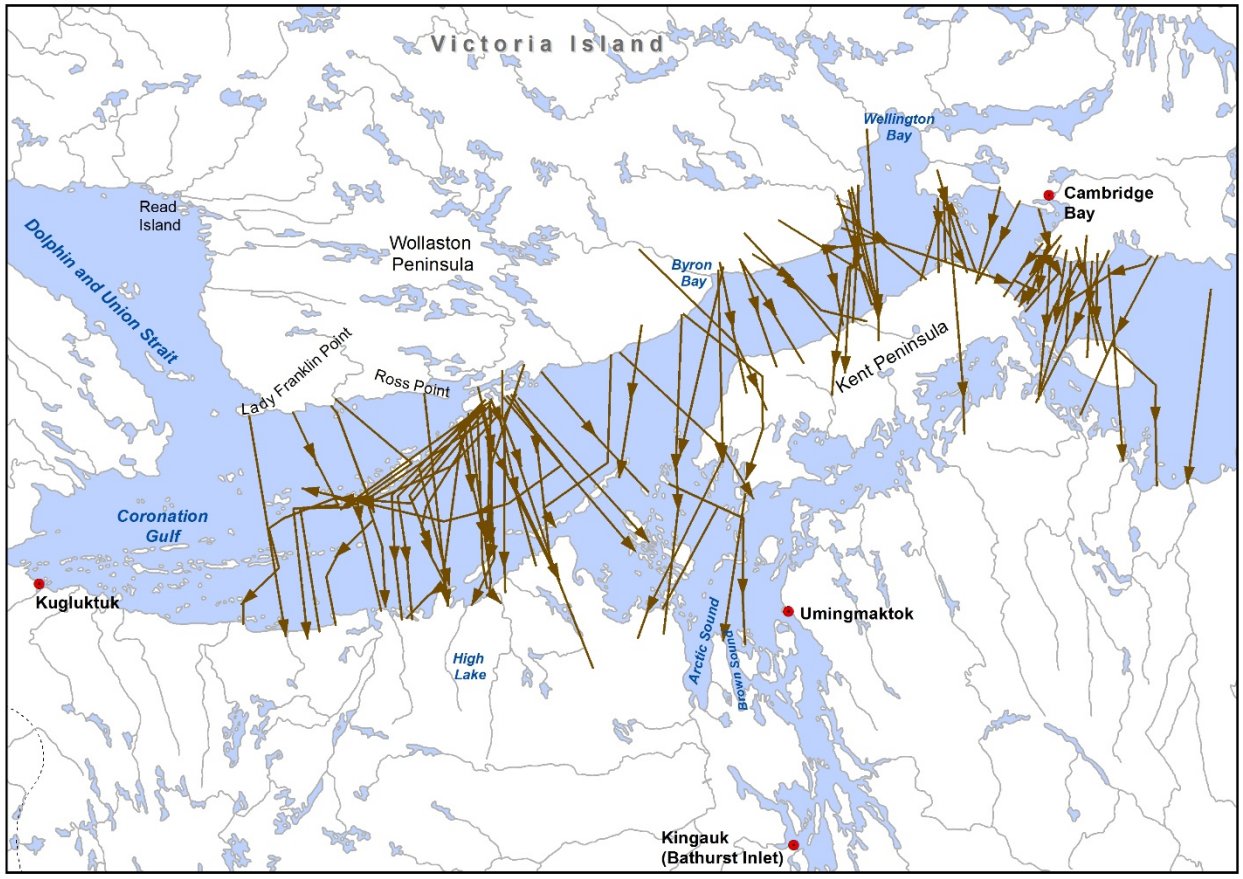

Figure 3. Dolphin and Union Caribou fall migration between Victoria Island and the mainland since 1986 (modified from Poole *et al*. 2010, by B. Fournier, GNWT-ENR 2016). Note: although not depicted here, some movements are still known to occur across the Dolphin and Union Strait (SARC 2013).

Interspecific Interactions

Dolphin and Union Caribou share their annual range with four mammalian predators (Wolf, Grizzly Bear [*Ursus horribilis*], Wolverine, and Polar Bear [*U. maritimus*]), two other populations (designatable units) of Caribou (Barren-ground and Peary), Muskoxen, and four species of smaller-bodied herbivores: Arctic Hare (*Lepus arcticus*), ptarmigan (*Lagopus* spp.), and lemming (*Dicrostonyx groenlandicus*, *Lemmus trimucronatus*). Wolves are the primary predators of Dolphin and Union Caribou, although Grizzly Bears are also known to take Caribou, especially calves.

Over the past decade, there have been documented changes to populations of some sympatric species. For example, Wolf numbers are increasing, as judged by more frequent sightings of wolves during aerial surveys for Caribou and Muskoxen (SARC 2013). Grizzly Bears have recently expanded their range onto Victoria Island (COSEWIC 2012). There is no direct information on predation rates.

Muskox abundance increased on Victoria Island in the 1980s and 1990s (Gunn and Patterson 2012), but showed a decline by 2013-2014 (L. Leclerc, pers. comm. 2016). Numbers of smaller herbivores normally fluctuate on the Arctic Islands. (Schaefer *et al*. (1996) documented the tendency for Hares, ptarmigan and Muskoxen to have distinct patterns of habitat use from Caribou during one study on southeast Victoria Island during winter in the mid-1990s).

Geese populations (e.g., Snow Goose (*Chen caerulescens*) and Ross's Goose (*C. rossi*)) on the east side of the Dolphin and Union Caribou wintering range (Queen Maud Gulf) have increased so substantially that they were recently designated as overabundant (CWS Waterfowl Committee 2014; 2015).

POPULATION SIZES AND TRENDS

Sampling Effort and Methods

Documenting population trends of arctic-dwelling Caribou within narrow limits of statistical confidence is difficult because of the irregularity of surveys and the relative inconsistency of survey coverage and methods until 1997. Surveys are expensive because of the vast area involved, and weather conditions can prevent completion of planned surveys. The first informal estimates for Dolphin and Union Caribou were conducted by estimating the number of animals that crossed the Dolphin and Union Strait (Anderson 1917). Count estimates of this population were largely from sightings documented during unsystematic flight surveys in summer by Macpherson (1961), who compiled Caribou observations during an airborne geological survey of the western Arctic Islands in the summers of 1958–59. In recent decades, abundance estimates for Dolphin and Union Caribou have been based on animal counts from strip transects during systematic aerial surveys.

Jakimchuk and Carruthers (1980) conducted the first systematic aerial survey of the entire Victoria Island in summer to determine distribution and abundance of Caribou and Muskoxen as part of an environmental assessment for the proposed Polar Gas Project. The next systematic aerial surveys in the early 1990s were during the calving period and covered the western portion of the island, followed by a larger survey of western and central Victoria Island in June 1994 (Nishi and Buckland 2000). Subsequent systematic aerial surveys were restricted to northwest Victoria Island in 1998, 2001, 2005 and 2010 (see SARC 2013) but were targeted for Peary Caribou and Muskoxen.

In the late 1990s, biologists recognized that aerial surveys used to estimate abundance of Dolphin and Union Caribou would be most efficient and effective if conducted in the fall (October) when individuals stage along the south coast of Victoria Island waiting for the sea-ice to freeze. The trade-off is the poor flying weather at this time of year. Nishi and Gunn (2004) developed the strip transect design, orienting flight lines mainly perpendicular to the coast, with some inland lines to identify any gradient of distribution. The formal survey would be preceded by an aerial reconnaissance survey and radio-tracking VHF collars to stratify the survey according to observed densities observed.

Surveys using this methodology were conducted in 1997 (Nishi and Gunn 2004), 2007 (Dumond and Lee 2013), and 2015 (Leclerc *et al*., in prep.; 2016). Dumond and Lee (2013) corrected the 1997 and 2007 fall survey results to account for those individuals that had not yet reached the coastal staging area. However, the use of satellite collar data from animals for 2000-2002 to estimate the probability of Caribou being close to the coast in 2007 to derive correction factors was challenged by SARC (2013). Dumond and Lee (2013) used the 1997 VHF collars as a correction factor even though they had been all located on the coast in 1997, and Leclerc *et al*. (in prep.; 2016) used 2015 collars to derive the extrapolated 2015 survey estimates. In this report, because of the uncertainty whether all Caribou aggregate on the south coast at the same time and the applicability of correction factors, we present the corrected and uncorrected estimates (Figure 4) for 1997, 2007 and 2015 surveys as minimum and maximum estimates, respectively. Numbers of mature individuals cannot be estimated, as non-mature adults and calves were included in the counts.

The population estimates obtained in 1997, 2007 and 2015 are comparable with one another and provide a time period near three generations (assuming a 7-9 year generation time from 2017) over which to estimate population trend. However, there are considerable uncertainties associated with the calculation of this trend, including corrections applied to the individual population estimates, lack of data on generation time, and lack of understanding of patterns of decline and the extent to which natural fluctuations are at play.

Abundance

Anderson (1917) guessed the number of Caribou crossing the Dolphin and Union Strait to be between 100,000 and 200,000 animals. Manning (1960) gave a detailed account of the historic migration. He suggested that these and other early observations indicated a migratory and a resident population of Caribou on Victoria Island and referred to

the former as the Dolphin and Union Strait herd. He used the lower of Anderson's range, 100,000 Caribou that summered on Victoria Island before the 1920s, as the most realistic estimate. However, SARC (2013:86) suggested this estimate is likely "unrealistically high" as the overall density at 100,000 Caribou would be 0.4 Caribou/km^2. In comparison, the peak density of Peary Caribou on Banks Island in the 1970s (12,000 Caribou; Urquhart 1973) was 0.2 Caribou/km^2.

Caribou numbers sharply declined and by the early 1920s had ceased migrating across the Dolphin and Union Strait. This decline coincided with the opening of trading posts along the coast, which led to changes in hunting practices (Manning, 1960; Freeman, 1975). At the same time, Inuit elders noted that severe icing storms caused Caribou deaths (Gunn, 1990). The herd was assumed to be extinct (Macpherson 1961), and these Caribou were rarely seen on Victoria Island for the next five decades (Poole *et al*. 2010).

Macpherson (1961) compiled observations of geologists, who recorded Caribou observations in summer 1959, yielding an estimate of 670 animals. Inuit from Cambridge Bay began seeing Caribou in the 1970s and 1980s. Jackimchuk and Carruthers (1980) surveyed Victoria Island in summer and estimated 7,936 ± SE 1100 Caribou (Miller 2004), just under 3,500 of which were likely Dolphin & Union Caribou (SARC 2013). By 1993, up to 7,000 Caribou were migrating annually across Coronation Gulf and Dease Strait (Gunn *et al*. 1997; Gunn and Nishi 1998).

In June 1994, Nishi and Buckland (2000) flew transects across the western 63% of Victoria Island, estimating 14,539 ± SE 1015 adult Dolphin and Union Caribou. The surveys included the range of Peary Caribou on northwestern Victoria Island, but only 4 Caribou were seen there, an insignificant proportion of the total. Unsystematic aerial searches and VHF radio-tracking, however, documented Caribou throughout the eastern 37% of the island. Dumond and Lee (2013) revised the Nishi and Buckland (2000) estimate to 22,368 individuals (no variance calculated), using the proportion of VHF radio-collars. However, factors such as the variability in the densities across survey strata and differences in group sizes between systematic surveys in the west and reconnaissance surveys in the east suggest that it may be problematic to extrapolate mean densities from the west to the eastern part of the island.

Nishi and Gunn (2004) flew transects in October 1997, just before freeze-up when male and female Caribou were massing along the south shore of Victoria Island prior to crossing the straits, under the assumption that most of the population would be in the pre-migration aggregation. Their estimate was 27,989 ± SE 3,367 total Caribou. Dumond (2007) estimated 21,753 ± SE 2,343 Caribou in the survey area on the south of Victoria Island in 2007 and Dumond and Lee (2013) later revised this upward to 27,787 ± CI 7,537 by extrapolating to areas not covered that had been assumed to be unoccupied, but were later found by satellite telemetry to be populated (see **Sampling Efforts and Methods**). Dumond and Lee (2013) retroactively applied this same probability of VHF collared Caribou as a correction factor to the 1997 estimate (which had used the same methods and covered the same area), resulting in a revised estimate of 34,558 ± CI 6,801 for 1997.

The Government of Nunavut completed an aerial population assessment in fall 2015, estimating 14,730 Dolphin and Union Caribou, and extrapolated this to 18,413 ± 6,795 (95% CI, 11,664- 25,182) by using information for Caribou collared in the same year (Leclerc *et al*. in prep.; Leclerc 2016; GNU and GNWT 2017). Changes in distribution were also documented, with no animals observed in the eastern one-third of the survey area, east of Wellington Bay (Leclerc 2016).

Fluctuations and Trends

An overall trend estimate for the Dolphin and Union Caribou population can be derived from the only three relatively comparable surveys undertaken in 1997, 2007, and 2015, covering a period of 18 years, or not quite three generations (21-27 years). Uncertainty around these population estimates, all of which involve extrapolation and/or correction factors, is a further complicating factor. Prior to 1997, aerial surveys did not include the southeastern portion of Victoria Island where animals aggregate prior to migrating to the mainland. The change in survey design and area suggest that it is inappropriate to compare estimates and resulting population trends from the 1995 survey with the 1997, 2007, and 2015 surveys (Figure 4).

Dumond and Lee (2013) reported that the apparent decline between 1997 and 2007 was not statistically significant (2-tailed z = 1.51, P =0.13), concluding that the population was, at best, statistically stable. However, information from local hunters and conservation officers (SARC 2013), as well as low adult survival rates from 1999-2006 (Poole *et al*. 2010), were more indicative of a population decline during this period. The most recent (2015) survey confirmed a decline relative to the 2007 survey estimates (z-test, Z=-2.19, p=0.036). Leclerc *et al*. (in prep.) concluded the population declined by 33.8% from 2007 to 2015.

The most recent survey estimates from 2015 (Leclerc *et al*. in prep; Leclerc 2016; GNU and GNWT 2017) provide some basis by which to derive an approximate three-generation trend estimate from uncorrected (minimum) and corrected (maximum) survey estimates (Figure 4). Assuming a 7-year generation time, a population trend was extrapolated over three generations (beginning in 2017) by fitting a model based on an exponential rate of decline, using the IUCN Red List Assessment Tool for Criterion A (see IUCN Standards & Petitions Subcommittee 2017). This yielded a three-generation trend estimate of -52% and -52.6% for corrected and uncorrected estimates, respectively. A 9-year generation time suggested higher decline rates (-61.1% and -61.7%) for both estimates.

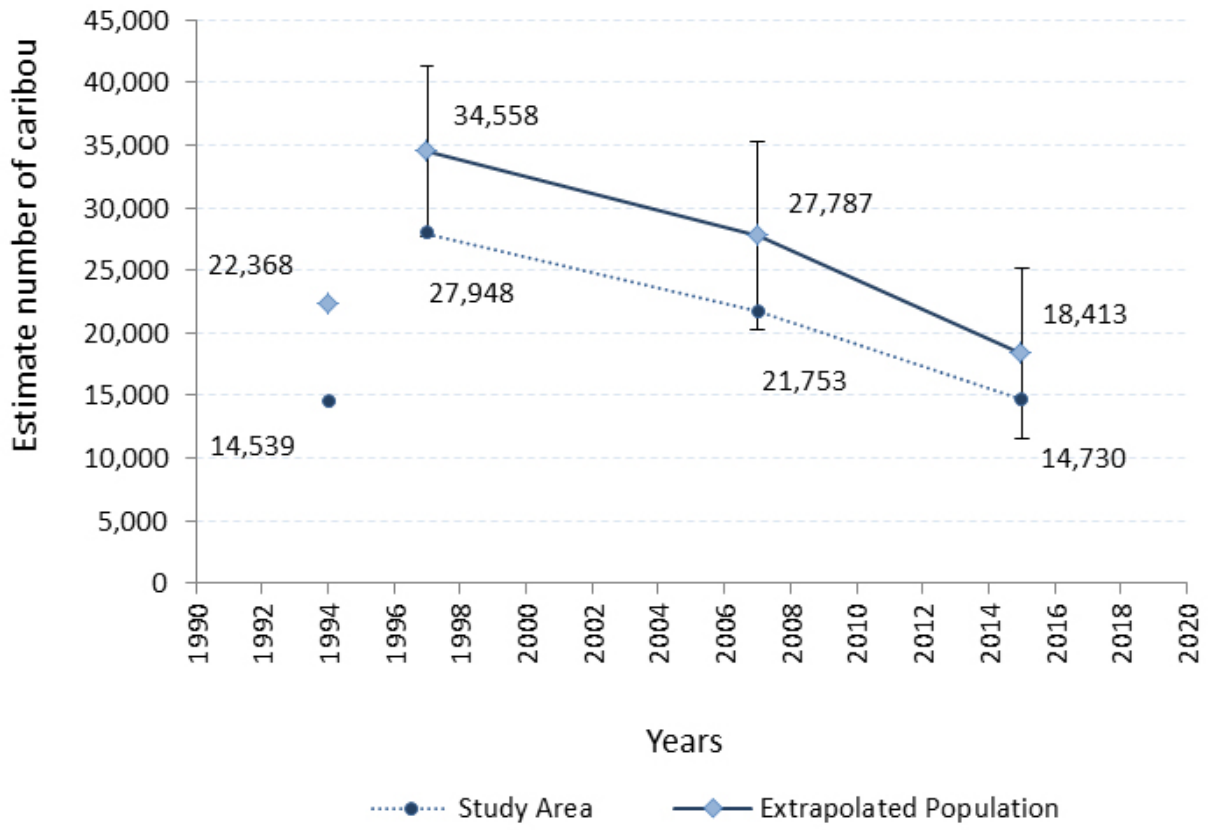

Figure 4. Population estimates (±SE) from 1997 to 2015, and minimum (Nishi and Buckland 2000) and extrapolated (Dumond and Lee 2013) estimates from 1994. Reproduced from GNU and GNWT (2017).

A declining trend since the 1990s is also reported by IQ (ATK) and local knowledge collected in a 2014 study conducted in the community of Ikaluktutiak (Cambridge Bay) on Victoria Island, Kitikmeot Region, Nunavut. Community members observed 80% (75-90%) fewer Dolphin and Union Caribou in the Cambridge Bay area compared to what they used to see in the 1990s, reporting that such declines began around 2005, with a major decline after 2010 (Tomaselli *et al*. 2018). Participants also observed an overall decrease of the young age classes, smaller group sizes, a higher proportion of those in poor body condition and increased observations of diseased animals, thus providing some explanatory factors for the decline (Tomaselli *et al*. 2018).

To place the estimated decline rate over the past three generations into a broader context (Figure 5), the Dolphin and Union Caribou population abruptly declined and experienced a recovery once before over the past century. In the early 1900s, the herd was documented in high numbers, followed by a 50-60-year period of very low densities with no sign of migration across the sea ice. The herd started to increase in the late 1970s, and resumed its migration in the late 1980s (Gunn and Nishi, 1998; Gunn and Fournier, 2000). Numbers increased until the late 1990s and began a decline sometime thereafter, with ATK and survey evidence both pointing to a significant shift in the mid-2000s and accelerated decline since about 2010. Evidence suggests that the severe bottleneck of 100 years ago was caused by the introduction of firearms, possibly interacting with winter icing, and recovery took place over seven decades. Hence the degree to which this population undergoes natural fluctuations similar to other Caribou populations (e.g., COSEWIC 2016) is uncertain (SARC 2013).

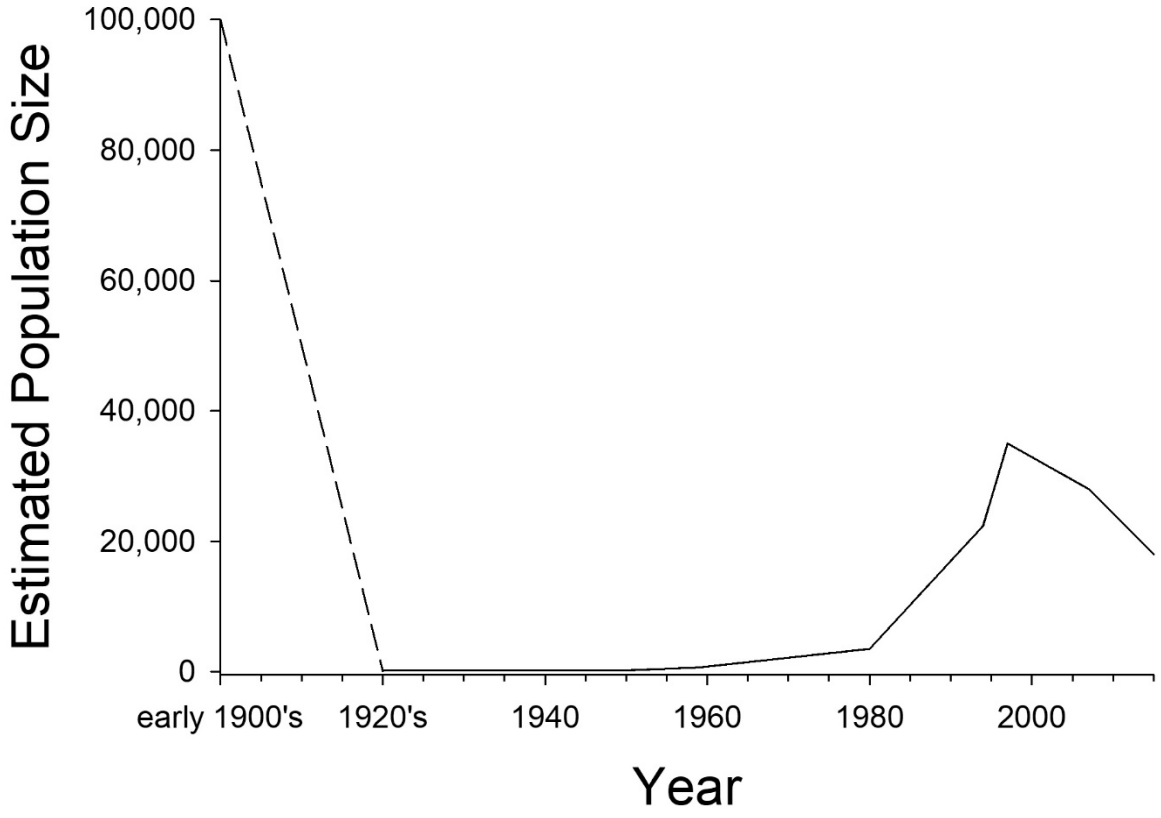

Figure 5. Depiction of approximate population trajectory of Dolphin and Union Caribou since the early 1900s (Anderson 1922, Manning 1960, Banfield 1950, MacPherson 1961, Jackimchuck and Carruthers 1980, Nishi and Buckland 2000, Nishi and Gunn 2004, Dumond and Lee 2013, Leclerc 2016).

Rescue Effect

For the endemic Dolphin and Union Caribou population, there is no possibility of immigration from outside of Canada.

THREATS AND LIMITING FACTORS

Direct threats facing Dolphin and Union Caribou assessed in this report were organized and individually evaluated based on the IUCN-CMP (World Conservation Union-Conservation Measures Partnership) unified threats classification system (Master *et al*. 2009). Threats are defined as the proximate activities or processes that directly and negatively affect each population.

The threat classification table for Dolphin and Union Caribou (Appendix 1) was completed by a panel of IQ, TK and scientific experts on Dolphin and Union Caribou in December 2014 and updated in February 2016. Each threat was assessed separately in relation to its impact, scope, severity and timing.

Narrative descriptions of the threats are provided below in the general order of highest to lowest overall impact threats. For many threats, there was significant uncertainty as to impact. For example, shipping lanes and predation will be high impact under certain future scenarios and how threats interact and potentially compound one another is difficult to discern or predict. Several additional low and medium-impact threats act in tandem, resulting in an overall High-Very High calculated and assigned threat impact.

Shipping lanes (IUCN Threat # 4.3) (High Impact)

Declining sea ice within Canadian Arctic waters (see Sea Ice Loss) offers enhanced opportunities for the Northwest Passage through the Canadian Arctic Archipelago to become a seasonally viable alternative shipping route (Pizzolato *et al*. 2016). Given the Caribou migration across sea ice, increased shipping in the Queen Maud Gulf, Dease Strait, and Dolphin and Union Strait (where the majority of the ships travel) could seriously hinder or delay Dolphin and Union Caribou movements, depending on timing and frequency. The increasingly shorter sea ice season enables increased marine traffic access over an extended time period (Poole *et al*. 2010). Increased icebreaker-supported shipping would exacerbate the climate-induced effect of thinner ice and more lengthy ice-free periods (Poole *et al.* 2010; Gunn *et al.* 2011).

Shipping activity significantly increased from 1990 to 2015 in this southern route of the Northwest Passage (Pizzolato *et al*. 2016). Passages of cruise ships increased more than threefold between 1993 and 2007, although the total number is still low (Judson, 2010, cited in Gunn *et al.* 2011). For the shipping season of 2016, eleven cruise vessels declared itineraries that include voyages within the Canadian Arctic, but these were all during summer months (Marine Security Operations Centre East 2016).

In 2007, Dumond *et al*. (2013) photographed approximately 1,000 Dolphin and Union Caribou trying to migrate across Dease Strait in the fall and being impeded for at least 6 days by an open-water channel that was being maintained by an ice-breaking tug near Cambridge Bay. Local harvesters have noted an increase in the number of Caribou drownings in recent years, sometimes in the hundreds (Thorpe *et al*. 2001; GNU and GNWT 2017; Miller *et al*. 2005; First Joint Meeting 2015; Leclerc 2016; Second Joint Meeting 2016). A ship was recently observed to break through about 30 cm of ice during the third week of October (fall migration) (Ekaluktutiak HTO 2016). With at least 10 cm of ice required to allow Caribou to cross, concerns have been raised that a further increase in shipping traffic will mean there will be inadequate time for the ice to re-freeze (First Joint Meeting 2015). Miller *et al*. (2005) suggested that year-round marine traffic and ice breaking activities could ultimately prevent the Dolphin and Union Caribou's fall and spring migrations altogether and fragment the Dolphin and Union range.

Any population-level impact to Dolphin and Union Caribou from shipping would have to occur through ice-breaking vessels during the time of the sea-ice migration; open water shipping occurring during the ice-free season would not be a direct threat. However, with Dolphin and Union Caribou beginning their crossing as early as October 15 and into December, even 2-3 boats coming through at that time of year could halt or delay the migration and increase Caribou drownings. This threat would depend on when the ice has an opportunity to re-freeze and whether the Caribou die trying to cross the re-freezing ice or become trapped in leads, or open water that develops when sea ice pulls apart. Shipping in late fall, such as early October-end of September, could delay ice formation and impact ice condition (due to leads by ship wakes) (ENR 2015; 2016). The survival rate of satellite-collared adult Dolphin and Union Caribou females during 1999-2006 was lowest during fall and early winter crossing period and then mid- to late winter on the mainland coast (Patterson unpubl. data 2002 in Poole *et al*. 2010). The nature of the risk to Caribou is considerably less on the return migration in late winter-spring from the wintering range on the mainland to calving areas on Victoria Island, given the higher predictability of ice conditions during that time, lack of staging, and relative speed of the migration (Poole *et al*. 2010).

The implications of a delayed or halted migration are uncertain and likely include reduced body condition as the Caribou would be foraging in areas of lower plant productivity and harder wind-packed snow compared to the mainland. If migration was delayed, the Caribou would be staging along the south coast where forage quality is already likely reduced (Nishi and Gunn 2004).

Globally, access to and exploration of Arctic resources (including fisheries, minerals, and tourism) are the chief factors determining the extent of Arctic shipping (Eguíluz *et al*. 2016). For example, among other projects (see **Energy Production and Mining** below) the Nunavut Impact Review Board (NIRB 2017) has been considering a new deepwater port and a road connecting the port to several proposed mines, which will stimulate shipping traffic.

Problematic native species (IUCN Threat #8.2) (High-Low Impact)

Possible multi-prey and predator interactions were noted earlier (see **Interspecific Interactions**). This is a subject of much speculation and a paucity of hard data, such that future population-level impacts remain highly uncertain. Although the impact of Wolf predation on arctic Caribou population dynamics is unknown, many authors consider it likely to become a major threat to recovery when population sizes are low (Nagy *et al*. 1996; Gunn *et al*. 2000b; SARC 2012).

During the meetings to inform the development of the joint management plan for Dolphin and Union Caribou (GNU and GNWT 2017), Inuit and Inuvialuit repeatedly expressed serious concerns over increases in Wolf numbers and potential impacts (Ulukhaktok TK interviews 2011-2013; First Joint Meeting 2015; Ekaluktutiak HTO 2016; Kugluktuk HTO 2016; Second Joint Meeting 2016). SARC (2013) suggested that sympatric Muskoxen populations may support more Wolves, thereby increasing the vulnerability of individual Dolphin and Union Caribou to predation (SARC 2013). However, Muskoxen on Victoria Island are declining more rapidly than Caribou at present (Kutz *et al*., 2016).

Increasing goose populations may be affecting the vegetation, potentially affecting habitat quality of fragile arctic ecosystems (Batt 1997). Potential impacts include vegetation removal through the alteration or elimination of plant communities, and changes to soil salinity, nitrogen dynamics and moisture levels, which may compromise Dolphin and Union Caribou winter habitats and forage (CWS Waterfowl Committee 2014; 2015).

Hunting (IUCN Threat # 5.1) (Medium-Low Impact)

Modern Inuit and the cultures that preceded them, including the Thule from whom Inuit are descended, and the unrelated Dorset and pre-Dorset cultures, have been harvesting Caribou in the region for at least 4,000 years (Manseau *et al.* 2005; Howse 2008; Friesen 2013).

Beneficiaries (i.e., Inuit) of the Nunavut Land Claim Agreement (NLCA) and Inuvialuit Final Agreement are not restricted through legislation from hunting Caribou, unless a conservation issue arises that results in establishing a Total Allowable Harvest (TAH); without a TAH, there is only voluntary report of the Caribou harvested (NLCA, s. 5.6.1; IFA, s.14. (36) (a,b,c,d)). Harvest records in the absence of a TAH and mandatory reporting are not kept consistently, which prevents quantitative analysis or enumeration of trends. The absence of the harvest information becomes a serious threat if a population is declining as the effects of harvesting are known to increase during a decline.

The distribution of the population and movements of individual Caribou relative to human settlements dictate harvesting opportunities and potential population-level impacts. Generally, residents of Cambridge Bay and Ulukhaktok (formerly Holman) harvest Dolphin and Union Caribou in the spring and fall as Caribou migrate between Victoria Island and the mainland. Kugluktuk, Umingmaktok and Kingauk community members harvest during winter and spring. There is also a limited non-resident sport hunt for Dolphin and Union Caribou operated out of Cambridge Bay in the fall (GNU and GNWT 2017).

Subsistence harvesting levels are unknown, given lack of mandatory reporting (SARC 2013). Harvest studies that have relied on voluntary participation (e.g., Inuvialuit Harvest Study 2003, NWMB 2004) are subject to several sources of error and significant inter-annual variability (GNU and GNWT 2017). Unpublished records and estimates compiled by Dumond (2007) and summarized by the SARC (2013) suggested that the total number of all Caribou harvested by Kugluktuk hunters was similar between periods 1997-2001 and 2004-2007 at about 1,000–2,000 animals; however, the Dolphin and Union Caribou proportion of the harvest was estimated to have shifted from about 20%–30% of all Caribou harvested during 1997–2001 to about 75% in 2006–2007. From 1991 through 2010, the hunters in the Prince Albert Sound area of Victoria Island annually harvested 40–400 Dolphin and Union Caribou (SARC 2013).

The number of hunters targeting Dolphin and Union Caribou may be increasing, likely in response to declines in access or availability of other Caribou populations (Second Joint Meeting 2016), yet the overall number of hunters is declining (First Joint Meeting 2015). However, SARC (2013) suggested that the annual harvest may be between 2,000 and 3,000 animals from Nunavut communities and < 200 from NWT, or about 11% of the 2007 corrected population estimate of ca. 27,000 individuals (see **Population Size and Trend**). SARC (2013) commented further that this harvest rate would not be sustainable unless the herd is increasing and has strong calf recruitment. Given the current declining trend, harvesting may become an increasingly important threat, especially if mortality rates from predation or drowning increase.

Changes in hunting technology may have been a cause of the past decline for Dolphin and Union Caribou. The disappearance of the Dolphin and Union Caribou by around 1920 was thought to be due at least in part to hunting following the introduction of firearms (Anderson 1934; Manning 1960). Elias (1993 in COSEWIC 2004) reported from ATK the widespread availability of rifles at this time, and snow machines after the 1960s, which affected hunting efficiency. Several elders reported wastage of meat after high-powered rifles were available and Caribou were killed only for their skins.

Climate change and severe weather (IUCN Threat #11) (Medium-Low Impact)

Climate change is already affecting the Arctic. Inuit of the Kitikmeot region reported for the mainland (Golder Associates Ltd. 2003 and sources therein) a variety of effects including longer summers, unusual freeze-thaw cycles in the spring, earlier spring break-up and open sea-ice, later fall freeze-up, thinner ice (both lakes and sea-ice), lower water levels, less snow, shifts in Caribou migration, and changes in animal distribution

(COSEWIC 2015; GNU and GNWT 2017). Although severe weather events are predicted to increase in frequency and severity, there is considerable uncertainty with respect to location and timing of such events, and the effects on population dynamics within the next three generations.

Habitat Shifting and Alteration (#11.1)

Long-term arctic warming trends are continuing at unprecedented rates. The average surface air temperature for the year ending in September 2016 was the highest recorded since 1900, (Richter-Menge *et al*. 2016), and since 2005 has been higher than for any five-year period since first measured in the 1880s (AMAP 2012). Evidence from lake sediments, tree rings, and ice cores suggest that recent summer temperatures have been higher than at any time in the past 2,000 years (AMAP 2012). Minimum sea ice extent in 2016 was the second lowest since records began in 1979, and spring snow cover extent was the lowest recorded (since 1967) (Richter-Menge *et al*. 2016). Sea-ice thickness is also decreasing and sea-ice cover is increasingly dominated by younger, thinner ice (AMAP 2012).

Future temperatures in the Arctic are difficult to model because of uncertainties regarding extent of snow cover and retreat of sea ice, which are accelerating much faster than previously predicted (see below). Nevertheless, experts agree that by 2100, mean projections for Arctic winter air temperatures under various CO^2 concentration scenarios will be an increase of 2–9 °C above the 1986–2005 average; the highest projections range up to about 15 °C above the 1986–2005 average (IPCC 2013). By 2035, Christensen *et al*. (2013) predicted mean annual surface temperature in the Arctic to rise by 1.5 °C, with mean winter (December to February) temperature expected to increase more than mean summer (June-August) temperature (+1.7 °C winter vs. 1 °C summer). From 1951 to 2008, mean annual precipitation increased by 0.63-5.83 mm/yr/decade across the Arctic (IPCC 2013). Records from NWT Climate stations indicate an increase in snowfall by 20-40% in the Arctic tundra (GNWT 2014). Mean annual precipitation is projected to further increase by 6% in 2035, more in winter than summer (Christensen *et al*. 2013).

This suite of changes will directly affect Dolphin and Union Caribou by leading to sea ice loss, terrestrial habitat changes, and sea level rise. Individually and collectively, these are expected to affect all of Dolphin and Caribou range, with the overall impact ranging from moderate to serious, depending on multiple competing factors.

Sea ice loss:

The most significant impact to Dolphin and Union Caribou habitat from a changing climate is likely to be a reduction in sea ice along the migratory route. Warming temperatures are already delaying ice freeze-up and hastening spring thaw (Miller *et al*. 2005; Gunn 2004; Poole *et al*. 2010; First Joint Meeting 2015; Kugluktuk HTO 2016; Second Joint Meeting 2016). Warmer fall temperatures on the south coast of Victoria Island affect the chances of sea ice becoming sufficiently and uniformly thick during the season. For example, the formation of new ice (<10 cm thick) was delayed by 10 days and grey ice (10-15 cm thick) by 8 days in 2008 compared to 1982 (Poole *et al*. 2010).

There are various consequences to such changes in ice thickness. Deaths of Dolphin and Union Caribou migrating over thin, unstable and freshly formed sea ice are increasingly reported, e.g., through drowning events from falling through thin ice (First Joint Meeting 2015; Second Joint Meeting 2016; SARC 2013). Some proportion of individuals can become stranded on the ice and drift out to sea (Kugluktuk HTO 2016), dying from exhaustion, starvation or hypothermia. Delays in freeze-up can result in attempts to change movement patterns, resulting in wasted energy (GNU and GNWT 2017). The condition of Dolphin and Union Caribou fall ranges can also be affected by later sea ice formation, with delayed migration and longer staging times on the fall range forcing individuals to use up summer fat reserves and increase grazing pressures on the range, as well as increasing the vulnerability of individual animals to predation and hunting (Poole *et al*. 2010). Linked to the longer staging times and consequent increased local densities and social and nutritional stresses, is increased exposure, and susceptibility, to parasites in the environment and those that are contact transmitted (Altizer *et al*., 2013, Kutz *et al*., 2014).

Ultimately, melting of sea ice could eliminate the migration to and from Victoria Island for Dolphin and Union Caribou as a result of the combined impact of climate change and increased shipping. Although migration did cease at one point for this population (see **Migration and Dispersal** and **Population Abundance and Trends**), this resumed once the population reached sufficient numbers, suggesting that a sea-ice connection may be fundamental to the size, sustainability and recovery of Dolphin and Union Caribou (GNU and GNWT 2017; Miller *et al*. 2005; Dumond *et al*. 2013).

The reduction in sea ice and warming of Arctic sea waters also has changed circum-arctic vegetation although the patterns are complex: a satellite-based measure of plant greening (NDVI) increased during 1982–1998, suggesting an earlier green-up of the vegetation but then NDVI declined from 1999–2015 (Bhatt *et al*. 2017). The causes are only just beginning to be understood and underscore the complexity of predicting how climate change will affect Dolphin and Union Caribou.

Terrestrial habitat changes:

Temperature increases (and possibly other climate changes such as increased CO^2) have brought about increases to plant biomass. Ahern (2010) used analysis of the satellite-sensed normalized-difference vegetation index (NDVI) to show that plant growth has increased in the range of Dolphin and Union Caribou over the past 30 years. These changes include plants leafing out and blooming earlier, which correlates with the general warming over the same time period (Oberbauer *et al*. 2013). Ecosystem responses are likely to include displacement of treeline northward by 5–10 km/year, or 500 km this century, and shrinking the global area of tundra by half (Callaghan *et al*. 2005). Although this suggests that forage may be increasingly available on Victoria Island, the greening is due primarily to a vegetation shift to woody biomass (especially evergreen shrubs). Therefore, the extent to which it will improve habitat or forage, and be of sufficient nutritional content for Dolphin and Union Caribou, is unknown.

Sea level rise:

Sea level has risen about 0.19 m in the last 110 years (IPCC 2013). In the next 90 years, sea level is likely to rise further between 0.26 to 0.82 m (IPCC 2013). Such an increase could cause unknown areas of land on Victoria Island to be inundated, resulting in habitat loss for Dolphin and Union Caribou.

Parasites and Diseases (IUCN Threat # 8.1 [Invasive non-native alien species]) (Medium-Low Impact)

Dolphin and Union Caribou are subject to increased levels of parasites, disease and insect harassment, all of which are already exacerbated by a changing climate. Population-level impacts can result from declines in individual body condition, fertility and productivity, and survival. Local communities have reported increasing numbers of diseased Caribou (Poole *et al*. 2010; First Joint Meeting 2015; Tomaselli *et al*. 2018).

Warming temperatures may result in range expansion and/or amplification of temperature-limited pathogens (Dobson *et al*. 2015). For example, in 2010, the Caribou Lungworm, *Varestrongylus eleguneniensis*, previously limited to the mainland, became established on Victoria Island and now cycles in both Caribou and Muskoxen on the island — likely a direct result of climate warming in the region (Kutz *et al*., 2013; Kafle *et al*., unpubl. data). While this parasite is not considered to be particularly pathogenic unless occurring at high intensities, its recent emergence on Victoria Island demonstrates that ecological conditions have changed and are facilitating survival and transmission of some pathogens. This is supported by ATK, IQ and local knowledge where community members are reporting increasing numbers of sick Caribou (Poole *et al*. 2010; First Joint Meeting 2015; Tomaselli *et al*2018). Local people have also noted increased incidence of *Taenia* (tapeworm) cysts and are concerned about the possibility that the Dolphin and Union Caribou are being exposed to more disease by travelling farther to the south (ENR 1998 cited in SARC 2013).

Among the key known parasites and pathogens of concern for the Dolphin and Union Caribou are: the bacteria *Erysipelothrix rhusiopathiae* and *Brucella suis* Biovar 4; gastrointestinal nematodes; and increasing levels of insect harassment.

Erysipelothrix rhusiopathiae, a generalist and opportunistic bacterium, emerged from 2010-2014 as a previously unknown cause of widespread Muskoxen mortalities on Victoria and Banks islands (Kutz *et al*. 2015a). In domestic pigs and poultry, disease caused by this bacterium is often associated with increased stress and can manifest as a variety of syndromes including: skin lesions, arthritis, endocarditis and acute mortality. This bacterium recently has also been implicated in the mortality of boreal woodland Caribou and Muskoxen in Alaska (Schwantje *et al*. 2014; Forde *et al*., 2016; Kutz *et al*., 2017) and there is widespread evidence of exposure (seropositivity) in Caribou across North America, including the Dolphin and Union Caribou (Kutz, Anholt unpubl data). However, its impact on Caribou populations is not known.

Brucella suis Biovar 4 is the bacterium responsible for brucellosis. Brucellosis is an important cause of lameness and infertility in Caribou and has been associated with declines in other populations, e.g., Southampton Island (Kutz *et al*. 2015b). This bacterium is known from Barren-ground Caribou across its range. However, increasing observations of limping animals (Tomaselli *et al*., 2018), recent isolation of the bacterium from a Dolphin and Union Caribou (CWHC) and an increasing number of cases and seropositivity in Muskoxen on Victoria Island (Kutz *et al*. 2015b; Tomaselli *et al*. 2018; Tomaselli, Kutz *et al*., unpubl. data) suggest that this disease may be increasing in frequency on the island.

Gastrointestinal nematodes, particularly those that parasitize the abomasum, are known to negatively impact body condition and fecundity of Caribou (Albon *et al.*, 2002; Stien *et al.* 2002; Irvine *et al.*, 2006; Hughes *et al*., 2009). Hughes *et al*. (2009) found that mature Dolphin and Union Caribou females lost weight with increasing nematode burden, and were thinner with a lower probability of being pregnant with increasing warble infestation — effects that were greater in the non-pregnant fraction of the population.

Rising levels of increased insect harassment (e.g., by mosquitoes, bot flies and warble flies) are already occurring due to longer summers (First Joint Meeting 2015; Russell and Gunn 2016). On Victoria Island, harassment by warble flies and nasal bot flies (*Cephenemyia trompe*) is increasing and warbles are now being seen earlier in summer (Dumond 2007). Cambridge Bay Inuit also reported increasingly numerous mosquitoes on Victoria Island (Bates 2006 in SARC 2013).

Russell and Gunn (2016) found an increasing trend in cumulative June-July growing degree days in the mainland part of the range from 2000-2014 brought about by warming temperatures. The same warming temperatures have increased the trend in the warble fly index, which is based on temperature and wind. SARC (2013) describes how the cumulative warble index and length of warble season increased on average 7% and 2% per decade, respectively, between 1979 and 2009. The number of warbles counted on late winter hides has increased since the later 1980s (SARC 2013).

Each pathogen on its own is often not a concern, but together, and/or with increasing stressors such as climate warming, freezing, disturbance, etc., these can become a significant cumulative factor influencing population dynamics. This is likely going to become an increasingly important issue for the Dolphin and Union Caribou for which climate and isolation resulted in low exposure levels for quite a number of both native and novel pathogens.

<u>Storms and Flooding (11.4) (Medium-Low Impact)</u>

Several high-mortality incidences following severe weather events have been recorded in arctic Caribou populations over the past four decades. For example, Peary Caribou die-offs were linked to unusually warm weather in early winter, which caused the upper few centimetres of snow to melt and then subsequently freeze solid, preventing access to forage. This resulted in 46% (1973-74) and 30% (1996-97) mortality in one winter, and >90% when there were three successive years of severe weather. An event

such as this tends to occur as an ice crust on top of the snow, or the melted snow percolates through the snowpack and refreezes at depth or on contact with the ground (COSEWIC 2015). Such events tend to be localized, but could conceivably affect a large proportion of the Dolphin and Union population, and result in significant mortality through starvation. In the winter of 1987-88, Cambridge Bay hunters reported freezing rain and Dolphin and Union Caribou dying from what appeared to be malnourishment (Gunn and Fournier 2000).

How much of a threat climate change may be to Dolphin and Union Caribou will depend on the frequency and severity of icing (rain-on-snow and melt-freeze) events within their range. Although severe weather events are predicted to increase in frequency and severity (Hansen *et al.* 2011; IPCC 2013), there is considerable uncertainty with respect to location and timing of such events, and the consequent effects on population dynamics within the next three generations. Climate models predict increased frequency and intensity of weather events (Gunn and Skogland 1997; Gunn 1998b; Miller and Gunn 2003; Harding 2004; Tews *et al.* 2007; Sharma *et al.* 2009; Tews *et al.* 2012).

Energy Production and Mining (IUCN Threat #3) (Low Impact)

Within the range of Dolphin and Union Caribou in Kitikmeot region of Nunavut west of Bathurst Inlet, there are currently two operating and two abandoned mines, and four proposals (NIRB 2017) and active mineral leases. These projects have associated infrastructure (roads, transmission lines, ports) and activity (helicopter traffic, vehicle traffic, air charters, blasting, etc.) that will extend the area that is disturbed, and have the potential to facilitate additional development projects. Transport of materials into the mine sites and transport of ore and waste out will likely increase shipping traffic and icebreaking activity in areas used by the Dolphin and Union Caribou in their migrations. For example, a partnership was forged in 2017 between the Government of Nunavut and the Kitikmeot Inuit Association on a proposal for a deep-water port on the Arctic Ocean with a 230-kilometre all-season road into the mineral-rich Slave Geological Province. A future phase would link Nunavut to Canada by road for the first time in Canada's history by extending the all-season road a further 95 km to the NWT border (GNU 2017).

Habitat loss from cumulative impacts of individual projects and associated infrastructure is a chief cause of concern for Caribou in general (Vistnes *et al.* 2008; Festa-Bianchet *et al.* 2011). The scale of development currently being contemplated by industry and the Government of Canada — new ports, mines, roads and expanding human populations (Government of Canada 2013) — may be a threat if not managed as to intensity (cumulative impacts), location, and timing (e.g., migration routes, calving and rutting areas) of construction. Caribou change their behaviour and sometimes avoid industrial activities including roads and off-road vehicle traffic, especially if hunting is associated with the road (Plante *et al.* 2016, Nellemann and Cameron 1998); they also respond to helicopters (Gunn and Miller 1980). Although these effects are localized, they may involve increased energy expenditure during nutritionally challenging periods and displacement from preferred habitats.

Number of Locations

The opening of the Northwest Passage bordering Victoria Island as a shipping channel and ensuing boat traffic, if it occurs during times when members of the population are crossing the ice or prevents/delays ice formation, is a plausible threat to Dolphin and Union Caribou (see **Threats**). If this were to occur, it would disrupt the annual migration, with unknown but potentially serious consequences to the population, thereby meeting the definition of one location.

PROTECTION, STATUS AND RANKS

Dolphin and Union Caribou are co-managed in Nunavut according to the NLCA, and are co-managed in the Northwest Territories according to the Inuvialuit Final Agreement. These agreements confer primary wildlife management authority on the respective management boards: the Nunavut Wildlife Management Board and, in the NWT, the Wildlife Management Advisory Council (NWT), and the Inuvialuit Game Council.

Legal Protection and Status

Dolphin and Union Caribou are currently classified as Special Concern under the federal *Species at Risk Act* (Part 4 Schedule 1; Canada Gazette Part II, Vol. 145, No. 4, 2011-02-16). Under the territorial *Species at Risk (NWT) Act*, they were listed as Special Concern in 2015. Regulations for Species at Risk designation under the *Nunavut Wildlife Act* (2011) have not yet been enacted. COSEWIC originally assessed Dolphin and Union Caribou as Special Concern in May 2004, and this population was reassessed as Endangered in November 2017.

Non-Legal Status and Ranks

Globally, Caribou was listed by the International Union for Conservation of Nature (IUCN) as Least Concern until 2016, when the species was re-assessed as Vulnerable (IUCN 2016). Caribou subspecies or ecotypes are not differentiated.

NatureServe ranked Caribou (*R. tarandus*) as secure globally and Not Yet Ranked for Dolphin and Union Caribou (as defined by COSEWIC) in 2012. It is ranked imperiled-vulnerable at the national level (N2N3), imperiled-vulnerable (S2S3) in the NWT and unranked (SNR) in Nunavut (NatureServe 2017). The 2015 national general status for Caribou in Canada will not be available until the 2015 General Status Report is published in August 2017. This Canada-wide rank will apply to all designatable units of Caribou combined, with no specific rank to Dolphin and Union Caribou. The 2015 territorial rank for NWT is S3 (Sensitive) (WGGSNS 2016). At present, there is no specific rank for Barren-ground Caribou for NU; however, for all DUs combined, the territory-specific general status rank in Nunavut is S4 (Apparently Secure) (Etiendem, pers. comm. 2017).

Habitat Protection and Ownership

Tuktuk Nogait National Park includes coastline in the southwestern portion of Dolphin and Union Caribou range. The Queen Maud Gulf Bird Sanctuary, located on the mainland across from Cambridge Bay, overlaps with a portion of the wintering range. This offers some level of habitat protection against industrial and major infrastructure developments.

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BIOGRAPHICAL SUMMARY OF REPORT WRITER(S)

Dr. Justina Ray is President and Senior Scientist of the Wildlife Conservation Society Canada and has been co-chair of COSEWIC's Terrestrial Mammals Subcommittee since 2009. In addition to overseeing the operations of WCS Canada, she is involved in research and policy activities associated with conservation planning in northern landscapes, with a particular focus on Wolverine and Caribou. Although she worked for years in African and Asian tropical forests, North America has been her predominant geographic focus over the past two decades. She is a member of the IUCN Taskforce on Biodiversity and Protected Areas. She is Adjunct Professor at the University of Toronto (Faculty of Forestry) and Trent University (Environmental & Life Sciences Graduate Program).

Dr. Lee E. Harding has a BSc in wildlife management and a PhD in wildlife toxicology. He is the principal of SciWrite Environmental Sciences Ltd. and was formerly a senior biologist and science program manager with Environment Canada from 1976 until he took early retirement in 1997. From 1977 to 1980 he managed the Impact Assessment division of the Environmental Protection Service district office in Yellowknife, NWT. During 1972-1976, as an environmental consultant assessing the impact of industrial developments in the Arctic, he studied Barren-ground Caribou and reindeer in the Mackenzie Delta, Mountain Caribou in British Columbia and Yukon and Peary Caribou on Bathurst, Melville and Little Cornwallis Islands. He first called attention to the possible endangered status of British Columbia's Mountain Caribou in a magazine article in 1975. He was the author of the 2004 COSEWIC re-assessment of Peary Caribou and Dolphin and Union Caribou.

Appendix 1. Threats Assessment for Caribou, Dolphin and Union population.

Species or Ecosystem Scientific Name	Dolphin & Union Caribou (DU2)
Element ID	**Elcode**
Date (Ctrl + ";" for today's date):	08/12/2014
Assessor(s):	Meeting #1: Justina Ray (COSEWIC), Dave Fraser (COSEWIC, BC), Suzanne Carriere (COSEWIC, NWT), Nic Larter (COSEWIC, NWT), Donna Hurlburt (COSEWIC, ATK), Lee Harding (report writer), Tracy Davison (GNWT), Lisa Worthington (GNWT), Lisa-Marie LeClerc (GNU), Melanie Wilson (GNU), Donna Bigelow (EC/ CWS), Dawn Andrews (EC/CWS), Lisa Pirie (EC/CWS), Kim Poole (Aurora Wildlife Research), David Nivingalok (Kugluktuk HTA), Kevin Klengenberg (Kugluktuk HTA), Ema Qaggutaq (Kitikmeot Regional Wildlife Board), Joseph Oliktoak (Olohaktomiut HTC) Meeting #2: Justina Ray (COSEWIC), David Fraser (COSEWIC), Lisa-Marie LeClerc (GNU), Ema Qaggutaq (KRWB), Amy Ganton (EC/CWS), Isabelle Duclos (EC/CWS), Peter Sinkins (Parks Canada), Jimmy Haniliak (Ekaluktutiak HTA), Howard Greenley (Ekaluktutiak HTA), George Angohiatok (Ekaluktutiak HTA), Joshua Oliktoak (Olohaktomiut HTC), Myles Lamont (GNU), Diane Ruben (Paulatuk HTC), Joe Illasiak (Paulatuk HTC).
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Overall Threat Impact Calculation Help:

Threat Impact		**Level 1 Threat Impact Counts: high range**	**low range**
A	Very High	0	0
B	High	2	1
C	Medium	2	0
D	Low	1	4
	Calculated Overall Threat Impact:	Very High	High

Assigned Overall Threat Impact:	**AB = Very High - High**
Impact Adjustment Reasons:	
Overall Threat Comments	***Two threat calculator meetings were held (8/12/2014 and 8/2/2016), and results were combined***

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	
1.1	Housing & urban areas		Negligible	Negligible (<1%)	Extreme (71-100%)	High (Continuing)	Scope includes portion of species range that is alienated by human settlements plus a buffer zone for animals displaced by disturbance. There is the possibility that municipal boundaries may increase in the coming years, but this still makes the scope very low. Although very few D&U animals are or will be exposed to this threat, any that come within a certain distance of human settlements will very likely be killed, hence the high severity.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						
2	Agriculture & aquaculture						
2.1	Annual & perennial non-timber crops						
2.2	Wood & pulp plantations						
2.3	Livestock farming & ranching						
2.4	Marine & freshwater aquaculture						
3	Energy production & mining	D	Low	Restricted (11-30%)	Slight (1-10%)		
3.1	Oil & gas drilling		Not Calculated (outside assessment timeframe)			Insignificant/Negligible (Past or no direct effect)	No seismic activity or O&G development at present, and not expected in the foreseeable future within the D&U range
3.2	Mining & quarrying	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	The scope is currently very low, but it is plausible for this to increase with a higher percentage of the population being directly affected by mines themselves within the next 10 years. This does not include shipping, flights, or roads associated with mines, which are counted elsewhere here. Most direct mortality from the mines themselves will be very low.
3.3	Renewable energy						
4	Transportation & service corridors	B	High	Pervasive - Large (31-100%)	Serious (31-70%)	Moderate (Possibly in the short term, < 10 yrs)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
4.1	Roads & railroads	D	Low	Restricted (11-30%)	Slight (1-10%)	Moderate (Possibly in the short term, < 10 yrs)	Currently the scope is negligible but if MMG/Izok Corridor proceeds with its project for a mine with an all-weather road from the coast 325 km inland, (or a similar one, e.g., within the Hope Bay greenstone belt) the impact of roads would greatly increase. It is possible that other development will happen in next 10 years. It is not believed that this project would include a network of winter roads coming off the all-weather road. Even one road, depending on where it is situated, could be encountered by a large proportion of the population. The direct impact of that road (mortality) will still be low, even if indirect effects are high
4.2	Utility & service lines		Negligible	Negligible (<1%)	Negligible (<1%)	Unknown	
4.3	Shipping lanes	B	High	Pervasive - Large (31-100%)	Serious (31-70%)	High (Continuing)	Category includes both open water and ice-breaker shipping. Open water shipping (which currently occurs) is not an issue, rather impact is entirely from winter shipping that involves any ice breaking (including relatively thin ice that does not qualify as ice breaking by Transport Canada definitions). Currently most activity is local ice-breaking activity early season around Cambridge Bay, but occasional ships are passing through so this threat is already occurring. The current proposal for shipping out of the bottom of Bathurst inlet could affect half the D-U population. Impact of shipping depends on timing. Caribou can start crossing as early as October 15 and into December. 2-3 boats during migration could entirely stop migration and cause 40% of the animals to drown. On the other hand, the whole population doesn't cross at same time and ice can refreeze between crossings. Not every icebreaking event will cause massive fatalities.
4.4	Flight paths	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Category is for regularly scheduled flights, i.e., to mines. The possibility of scheduled flights increasing significantly, especially when/if proposed projects start operating. Large planes to mines could be more than flights to communities. On the other hand, flights are mostly high, and only go only low for landing. Modelling work has shown relatively low direct impact. Severity is likely at the low end of slight (1-10%) range. If flight paths were to change to impact calving, the severity would increase.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5	Biological resource use	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Harvesting of Dolphin-Union Caribou is unregulated. There is no hunting season or limit. Harvest levels change depending on location of Caribou in a given year, and availability of other harvested species. 3 communities harvest Dolphin-Union Caribou: Ulukhaktok (harvest in summer), Cambridge Bay (harvest in fall), and Kugluktuk (harvest in winter and spring when they come across the ice). There may be a shift in harvest from mainland Caribou, which are in steep decline. D&U population has declined since the last surveys, but has also changed its distribution such that animals are not so accessible to these communities anymore. This will decrease harvest. Very large range of uncertainty in severity due to unknown harvest levels and uncertainty of population numbers in the future. Score for severity encompasses both worst and best case scenarios. Also, a change in distribution may expose animals to harvest elsewhere.
5.2	Gathering terrestrial plants						
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						
6	Human intrusions & disturbance		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	
6.1	Recreational activities		Negligible	Negligible (<1%)	Negligible (<1%)	High (Continuing)	
6.2	War, civil unrest & military exercises		Not Calculated (outside assessment timeframe)			Insignificant/Negligible (Past or no direct effect)	Military exercises not a threat in this region; no seasonal overlap with D&U Caribou
6.3	Work & other activities		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	Includes (primarily) research activities (e.g., surveys and capture/collaring)
7	Natural system modifications						
7.1	Fire & fire suppression						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						
8	Invasive & other problematic species & genes	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	
8.1	Invasive non-native/alien species	CD	Medium - Low	Large - Restricted (11-70%)	Moderate (11-30%)	High (Continuing)	This category includes all diseases and pathogens (both native and non-native). Climate change expected to increase parasites and disease. Parasites increasing and expected to increase further. Lungworm increasing in muskox, but not necessarily fatal. We do have to include that we seeing evidence that there is potential for more to occur. Biting flies are also an issue
8.2	Problematic native species	BD	High - Low	Pervasive (71-100%)	Serious - Slight (1-70%)	High (Continuing)	This category includes all predator/competitor interactions (both native and non-native). Grizzly bears have moved into Victoria Island in the last decade or so can have an impact on numbers. Wolves have increased on Victoria Island. Given the multi-prey interactions, predators like wolves have potential to wipe out Caribou when muskox numbers are high. Impact is greater with a small population, and less when they have the opportunity to escape the predators. Severity and Scope could be high during the fall migration while they are waiting for the sea ice to form, but there is enormous uncertainty.
8.3	Introduced genetic material		Unknown	Large - Small (1-70%)	Unknown	High (Continuing)	Interbreeding with Barren-ground and Peary Caribou. Although there are some claims that D&U is a hybrid (Rangifer groenlandicus x pearyi), this is not accurate. Genetics work over past decade shows Dolphin-Union as a genetically distinct population with a very small amount of Peary intergradation. A significant number of individuals would need to be inter-breeding to impact population. Communities have seen Peary Caribou traveling with D&U, Barrenground traveling with D&U (more rare). Chances of hybridization are low due to the separation of the rutting grounds. Likely on the low end of both the scope and severity ranges, although the higher degree of uncertainty on severity reflects our lack of knowledge on the impacts of interbreeding. Really, particularly considering ATK, the impacts are unknown.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9	Pollution						
9.1	Household sewage & urban waste water						
9.2	Industrial & military effluents						
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste						Contaminants are not currently regarded as a threat, given successful clean-up of the Dew Line.
9.5	Air-borne pollutants						
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	
11.1	Habitat shifting & alteration	CD	Medium - Low	Pervasive (71-100%)	Moderate - Slight (1-30%)	High (Continuing)	Category includes changes to habitat (vegetation and ice) conditions due to climate change over the next decade. Scope will affect entire population. With respect to severity, there is and will be much variability (i.e., positive and negative effect). Could get a trophic shift where there is a mismatch of greening and Caribou life cycle, which could affect calving and calf survival. There is also a possibility that forage could increase with climate change. In either case, severity is not likely to be very severe. Could get a bad year or two, but will recover unless hits every year repeatedly, which is unlikely. With respect to ice, there is a small core area for Dolphin-Union, so ice conditions aren't as big a threat as they were to Peary Caribou.
11.2	Droughts						
11.3	Temperature extremes						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding	CD	Medium - Low	Large (31-70%)	Moderate - Slight (1-30%)	Moderate (Possibly in the short term, < 10 yrs)	Icing events (storms) not as big an issue for Dolphin-Union as it is for Peary, and is currently unknown for D&U. Scope: Because winter range is a small area, one storm event could impact a large portion of the population. Over 3 generations, expect to be able to recover from a weather event, unless happens repeatedly year after year. Less likely to have bad weather events for multiple years in a row, which would knock back the population without a chance for recovery.

Classification of Threats adopted from IUC