COSEWIC
Assessment and Status Report

on the

Ivory Gull
Pagophila eburnea

in Canada

ENDANGERED
2023

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):

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COSEWIC 2001. COSEWIC assessment and update status report on the Ivory Gull *Pagophila eburnea* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 10 pp. (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html).

Alvo, Robert and S.D. Macdonald. 1996. Updated COSEWIC status report on the Ivory Gull *Pagophila eburnea* in Canada. Committee on the Status of Endangered Wildlife in Canada. 8 pp.

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COSEWIC
Assessment Summary

Assessment Summary – December 2023

Common name
Ivory Gull

Scientific name
Pagophila eburnea

Status
Endangered

Reason for designation
This medium-sized gull occupies ice-dominated habitats in the Arctic year-round, nesting in Canada in isolated colonies on nunataks (rock outcrops within extensive snow and ice) in northern Nunavut. It overwinters along the sea-ice edge in Davis Strait and the northern Labrador Sea, with birds from northern Eurasian colonies. Counts of birds at colonies have not declined in recent years, and an estimated 2,150 mature individuals now nest in Canada. However, the Canadian breeding range has contracted appreciably to the northeast, with about 98% of the known population confined to 11 colonies on Ellesmere Island, where nesting birds rely exclusively on the North Water Polynya for foraging. Key threats reflect climate-related changes linked to increasing sea-surface temperature, diminishing extent and duration of sea-ice cover, and increasing intensity and duration of storms, as well as the risk of intermittent disturbance by tourists. Other threats include hunting, oil pollution, and airborne contaminants.

Occurrence
Nunavut, Newfoundland and Labrador, Northwest Territories, Arctic Ocean, Atlantic Ocean.

Status history
Designated Special Concern in April 1979. Status re-examined and confirmed in April 1996 and in November 2001. Status re-examined and designated Endangered in April 2006. Status re-examined and confirmed in December 2023.

COSEWIC
Executive Summary

Ivory Gull
Pagophila eburnea

Wildlife Species Description and Significance

The Ivory Gull (*Pagophila eburnea*) is a stocky, medium-sized gull with an agile, graceful flight. The entirely white adult plumage is unmistakable. Immature birds have a dark bill, dusky speckled face, and black spots on the breast, flanks, and the tips of the tail and wing feathers. The Ivory Gull has relatively short black legs and large dark eyes. The sexes are similar in appearance, although males are slightly larger.

Ivory Gulls that breed in Canada may represent a different designatable unit (DU) from that of wintering visitors, as the two groups nest in widely separated areas of the High Arctic and do not disperse between these areas. However, there are no recognized subspecies of the Ivory Gull, which exhibits little genetic variation across its global range. Only the status of the Canadian breeding assemblage is considered in this report.

Aboriginal (Indigenous) Knowledge

All species are significant and are interconnected and interrelated. Canadian Inuit regard the Ivory Gull with great affection and consider its decline in Arctic Canada as an indicator of systemic issues in the northern environment.

Distribution

The Ivory Gull spends the entire year in the Arctic, with patchily distributed breeding populations in Canada, Greenland, Norway (Svalbard archipelago) and Russia (Severnaya Zemlya and Franz Joseph Land). In North America, it breeds exclusively in northern Nunavut. Birds from the Canadian colonies winter primarily in Davis Strait and the Labrador Sea, together with appreciable but unknown numbers of birds from the Eurasian colonies.

Habitat

The Ivory Gull is closely associated with ice-dominated habitats year-round. The Canadian colonies are located on nunataks (exposed rock outcrops surrounded by extensive snow or ice) and, in the past, on flat areas of rock or gravel, all in extremely remote areas. The species' need to access polynyas (persistent areas of open water in the sea ice) limits the distribution of breeding sites. Polynyas are reliable sources of marine prey and are critical to the species early in the breeding season. The Ivory Gull remains close to the edge of the sea ice during migration and in winter, when it uses polynyas and leads in the pack ice.

Biology

The Ivory Gull probably first breeds at two years of age, with a generation time of about eight years. In Canada, it typically nests in isolated, single-species colonies containing from two pairs to several hundred pairs. Most pairs lay 1–2 eggs in rudimentary nests on rocky ledges on nunataks far from shore. The incubation period is roughly 25 days. The chicks fledge after about 30 days. The Ivory Gull feeds primarily on marine fish and invertebrates captured by surface-dipping or plunging, but also scavenges extensively on marine mammal carcasses and parts discarded by Polar Bears (*Ursus maritimus*) or human subsistence hunters.

Population Sizes and Trends

In response to concerns raised by Inuit from northern Nunavut, extensive aerial surveys targeting nesting Ivory Gulls were conducted from 2001 to 2005 in Arctic Canada. Most previously known colonies were no longer occupied, suggesting that Canadian breeding numbers had declined by as much as 80% since the 1980s. Surveys in 2006 and 2009 showed that the southwesternmost colonies had been abandoned, and comprehensive monitoring in 2019 found that none had been reoccupied. The species' breeding range has contracted to the northeast, where a few colonies on Ellesmere Island now host over 98% of the known Canadian breeding assemblage, all relying on the North Water Polynya for foraging.

An estimated 1,950–2,250 mature individuals now breed in Canada's High Arctic, which is roughly similar to the numbers estimated over the past two decades, despite an extensive search effort covering a wider area. Ivory Gulls that breed in Canada overwinter with birds from the Eurasian colonies and, at some point during the winter, Canadian waters may support over half the global population of about 16,000–25,300 mature individuals.

Threats and Limiting Factors

Habitat alteration due to climate change is the most serious threat overall to the persistence of the Ivory Gull in Canada. The species is vulnerable to changes in habitat and prey availability caused by increasing sea-surface temperatures, the diminishing extent and duration of sea-ice cover, and the increased intensity and duration of storms. Hunting pressure may still be a concern in Greenlandic waters. As climates warm, the Ellesmere Island colonies have become accessible by helicopter from cruise ships, and the resulting disturbance may lead to reduced productivity or colony abandonment. The Ivory Gull is also at risk from oil pollution from increasing shipping and oil and gas exploration, as well as from the sublethal effects of airborne contaminants such as mercury. Population recovery is limited by the Ivory Gull's low productivity, small clutch size and intermittent breeding attempts, which are adapted to the extreme and variable nature of Arctic environments.

Protection, Status, and Recovery Activities

The Ivory Gull is listed as Endangered under Schedule 1 of the *Species at Risk Act* (2002), and individuals, eggs and nests are protected in Canada under the *Migratory Birds Convention Act, 1994*. The species is listed as vulnerable in Greenland (Denmark) and Svalbard (Norway) and as rare in Russia, and is considered Near Threatened globally by the International Union for Conservation of Nature (IUCN). It is ranked as Apparently Secure by NatureServe at the global level, but Critically Imperiled at the national level in Canada and at the territorial or provincial level in Nunavut, Northwest Territories, and Newfoundland and Labrador. The 2014 federal recovery strategy established four population and distribution objectives, although no direct recovery activities have been implemented, apart from monitoring and research in support of these objectives.

TECHNICAL SUMMARY

Pagophila eburnean

Ivory Gull

Mouette blanche

Naujavaaq, Kaniq, Naujarluk (Inuktitut)

Range of occurrence in Canada (province/territory/ocean): Nunavut, Newfoundland and Labrador, Northwest Territories, Arctic Ocean, Atlantic Ocean.

Demographic Information:

Generation time (usually the average age of parents in the population)	Approximately 8 years	Based on Bird *et al.* (2020)
Is there an [observed, estimated, inferred, or projected] continuing decline in number of mature individuals?	Unknown	Substantial uncertainty in estimating population size, due to differences in search effort and shifts in nesting sites; makes trend assessment difficult
[Observed, estimated, or projected] percent of continuing decline in total number of mature individuals within [3 years or 1 generation; whichever is longer up to a maximum of 100 years].	Unknown	Survey counts do not provide clear evidence of a continuing decline in the number of mature individuals over the past generation (8 years).
[Observed, estimated, or projected] percent of continuing decline in total number of mature individuals within 5 years [or 2 generations; whichever is longer up to a maximum of 100 years].	Unknown	Survey counts do not provide clear evidence of a continuing decline in the number of mature individuals over the past two generations (16 years).
[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last 10 years, [or 3 generations; whichever is longer up to a maximum of 100 years].	Unknown	Survey counts do not provide clear evidence of a continuing decline in the number of mature individuals over the past three generations (24 years).
[Projected, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the next 10 years [or 3 generations, whichever is longer up to a maximum of 100 years].	Unknown	

[Observed, estimated, inferred, projected, or suspected] percent [reduction or increase] in total number of mature individuals over any period of 10 years [or 3 generations, whichever is longer up to a maximum of 100 years], including both the past and future (up to a maximum of 100 years in the future).	Unknown	
Are the causes of the decline clearly reversible?	No	Broad-scale impacts from climate change are likely irreversible.
Are the causes of the decline clearly understood?	No	Impacts of climate change and other possible causes are complex and poorly understood.
Have the causes of the decline clearly ceased?	No	Harvest has likely lessened; other causes are ongoing.
Are there extreme fluctuations in number of mature individuals?	No	

Extent and Occupancy information:

Estimated extent of occurrence (EOO)	Maximum of 92,614 km^2 (8,021 km^2, excluding the Seymour Island colony)	Based on a minimum convex polygon around the nesting sites recorded in 2019. The Seymour Island colony may now be abandoned.
Index of area of occupancy (IAO), reported as 2x2 km grid value.	Likely maximum of 40 km^2, based on known colonies (36 km^2, excluding the Seymour Island colony)	Based on a 2 km x 2 km grid over the nesting sites recorded in 2019. The Seymour Island colony may now be abandoned.
Is the population "severely fragmented" i.e., is >50% of individuals or >50% of the total area "occupied" (as a proxy for number of individuals) in habitat patches that are both (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. Unknown b. No	
Number of "locations" (use plausible range to reflect uncertainty if appropriate)	1–2	Birds from all colonies using the same polynya are considered to be one location; the bulk of the breeding assemblage now relies on the North Water Polynya.
Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?	Yes	Observed decline of 55–96% within three generations, with loss of southernmost and westernmost colonies

Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?	Yes	Observed decline of 75–78% within three generations, with loss of southernmost and westernmost colonies
Is there an [observed, inferred, or projected] continuing decline in number of subpopulations?	Not applicable	No subpopulations
Is there an [observed, inferred, or projected] continuing decline in number of “locations”*?	Yes	Observed decline from at least 4 locations (polynyas) down to 1 or 2, with loss of colonies associated with southernmost and westernmost polynyas
Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality of] habitat?	Yes	Observed and projected decline in extent and quality of breeding habitat
Are there extreme fluctuations in number of subpopulations?	Not applicable	
Are there extreme fluctuations in number of “locations”?	No	
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):

Subpopulations	N Mature Individuals (plausible range)	Notes on individual estimates
Canada (no subpopulations identified)	Canadian breeding assemblage: ~ 2,150 (range: 1,950–2,250)	Size of the Canadian breeding assemblage based on counts of 978 adult birds at nests in 2019 (and assuming each bird represents a pair; Gilchrist and Mallory unpubl. data), and accounting for additional missed individuals or colonies

Quantitative Analysis:

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

Threats and Limiting Factors:

Was a threats calculator completed for this species?	Yes, 23 June 2021 (see Appendix 1)	Overall assigned threat impact: Very High - High
Key threats were identified, in decreasing order of threat impact, as: IUCN 11.1 Habitat Shifting & Alteration – *High - Medium impact* IUCN 6.1 Recreational Activities – *High - Low impact* IUCN 9.5 Air-Borne Pollutants – *Medium - Low impact* IUCN 3.1 Oil & Gas Drilling – *Low impact* IUCN 5.1 Hunting & Collecting Terrestrial Animals – *Low impact* IUCN 11.4 Storms & flooding – *Low impact*		
What limiting factors are relevant? Key limiting factors for the Ivory Gull in Canada include low annual productivity due to small clutch size, and intermittent breeding due to extreme and variable environmental conditions, which both contribute to the species' low reproductive success and its limited ability to rebuild depressed population numbers.		

Rescue Effect (from outside Canada):

Status of outside population(s) most likely to provide immigrants to Canada.	Stable	Populations in Greenland (2,000–2,500 pairs) and Russia (3,500–7,000 pairs) appear to be relatively stable.
Is immigration known or possible?	Yes	The Ivory Gull is highly mobile, and individuals from several countries share the Canadian wintering areas with Canadian breeders; there is no evidence of movement of birds between colonies in Canada and northern Eurasia.
Would immigrants be adapted to survive in Canada?	Yes	Breeding and wintering habitats in Canada are similar to those used by potential source populations.
Is there sufficient habitat for immigrants in Canada?	Unlikely	Extent of suitable habitats in Canada appears to be declining.
Are conditions deteriorating in Canada?	Yes	Quality and extent of primary foraging habitat are declining.
Are conditions for the source (i.e., outside) population deteriorating?	Yes	Quality and extent of primary habitat are declining across most of global range.
Is the Canadian population considered to be a sink?	Unknown	
Is rescue from outside populations likely, such that it could lead to a change in status?	No	Immigrants would be subject to the same deteriorating habitat conditions currently impacting the Canadian breeding assemblage.

Wildlife Species with Sensitive Occurrence Data (general caution for consideration):

Could release of certain occurrence data result in increased harm to the Wildlife Species or its habitat?	Yes	Geographical coordinates of Canadian colonies have been kept confidential, due to sensitivity of breeding birds to disturbance and high risk of breeding failure from human impacts such as tourism and illegal egg collection.

Status History:

COSEWIC	Designated Special Concern in April 1979. Status re-examined and confirmed in April 1996 and in November 2001. Status re-examined and designated Endangered in April 2006. Status re-examined and confirmed in December 2023.

Status and Reasons for Designation:

Status	Endangered
Alpha-numeric codes	B2ab(I,ii,iii,iv)
Reason for change of status	Not applicable – no change
Reasons for designation (2023)	This medium-sized gull occupies ice-dominated habitats in the Arctic year-round, nesting in Canada in isolated colonies on nunataks (rock outcrops within extensive snow and ice) in northern Nunavut. It overwinters along the sea-ice edge in Davis Strait and the northern Labrador Sea, with birds from northern Eurasian colonies. Counts of birds at colonies have not declined in recent years, and an estimated 2,150 mature individuals now nest in Canada. However, the Canadian breeding range has contracted appreciably to the northeast, with about 98% of the known population confined to 11 colonies on Ellesmere Island, where nesting birds rely exclusively on the North Water Polynya for foraging. Key threats reflect climate-related changes linked to increasing sea-surface temperature, diminishing extent and duration of sea-ice cover, and increasing intensity and duration of storms, as well as the risk of intermittent disturbance by tourists. Other threats include hunting, oil pollution, and airborne contaminants.

Applicability of Criteria

A: Decline in Total number of Mature Individuals:	
Not applicable.	There is no evidence of a reduction in the number of mature individuals in the Canadian breeding population over the past three generations.
B: Small Range and Decline or Fluctuation	
Meets Endangered, B2ab(i,ii,iii,iv).	The maximum estimate of the index of area of occupancy of 40 km² is below the threshold of 500 km²; the population is known to exist at < 5 locations; and the species is undergoing an observed continuing decline in extent of occurrence, index of area of occupancy and number of locations, with an observed and projected decline in extent and quality of habitat.

C: Small and Declining Number of Mature Individuals	
Not applicable.	Although the number of mature individuals in the Canadian breeding population is below the Endangered threshold of 2,500, there is no evidence of a continuing decline in the number of mature individuals.
D: Very Small or Restricted Population	
Not applicable.	The number of mature individuals in the Canadian breeding population exceeds thresholds.
E: Quantitative Analysis	
Not applicable.	Analysis not conducted

PREFACE

The Canadian population of the Ivory Gull includes birds that both breed and overwinter in Arctic Canada, as well as those present in Canada only as non-breeding visitors in winter (Mallory *et al.* 2020). These two different assemblages can be distinguished, because they nest in widely separated areas of the High Arctic. The winter visitors breed in Greenland, Svalbard (Norway), Severnaya Zemlya (Russia) and Franz Joseph Land (Russia) in the Eurasian Arctic (Figure 1). These areas are separated from the Canadian breeding colonies in northeastern Nunavut by at least 1,000 km of ice-fast ocean, and despite extensive banding of adult and young Ivory Gulls in Canadian and Eurasian colonies, there are no records of birds moving between these assemblages (Gilchrist pers. comm. 2023).

Birds from these two breeding assemblages apparently occur together in winter, in Canadian (and Greenlandic) waters in Davis Strait and the Labrador Sea (Strøm *et al.* 2019; Figure 1). As the two assemblages breed in widely separated areas of the High Arctic, with no birds dispersing between them, they may represent separate designatable units (DUs), although the Ivory Gull shows a high degree of genetic homogeneity across its global range (Yannic *et al.* 2016). In line with guidance on regional and national assessments by the International Union for Conservation of Nature (IUCN) (IUCN 2012), the status of these two separate assemblages of the Ivory Gull in Canada can be assessed separately.

Very little information is available on key population parameters for Ivory Gulls present in Canada as non-breeding winter visitors, such as the number of birds from each source country, the time spent in Canadian waters, the size and delineation of the area used, and the nature of their dependence on Canadian resources. Very significantly, data are not available on year-to-year variations and overall trends in these parameters. Therefore, there is insufficient information to assess the status of these winter visitors; such information is difficult to collect, given the extreme remoteness and inaccessible nature of the largely ice-covered marine areas that they occupy. In contrast, these and other relevant parameters are fairly well documented for Ivory Gulls breeding in Canada, and their status can be assessed. Consequently, only the status of the Canadian breeding assemblage is considered in this update status report. This approach is consistent with IUCN guidance (IUCN 2012), and similar to that used in previous COSEWIC status reports to assess the status of Ivory Gulls breeding in Canada (Macdonald 1979; Alvo and Macdonald 1996; COSEWIC 2001, 2006).

The Ivory Gull was designated Endangered by COSEWIC, after concerns were raised by Inuit communities (Akearok *et al.* 2002; Mallory *et al.* 2003) and colony surveys indicated a marked decline in the size of the Canadian breeding assemblage (COSEWIC 2006). Since then, colony surveys across the Canadian breeding range, including an extensive effort in 2019 that covered several additional breeding areas, have provided updated information on population numbers and distribution in Canada, indicating a substantial contraction in the species' range in the Canadian Arctic (Gilchrist and Mallory unpubl. data).

The coordinated satellite tracking of Ivory Gulls across much of the breeding range has clarified the species' global distribution and movements during the non-breeding period (Gilg *et al.* 2016; Strøm *et al.* 2019). Studies in Canada and other countries have provided new insights into levels of contaminants and their likely impacts (Miljeteig *et al.* 2009, 2012; Bond *et al.* 2015; Mallory *et al.* 2015; Lucia *et al.* 2016). Genetic analyses have highlighted the overall lack of strong genetic diversity among Ivory Gull colonies in most of the global range (Royston and Carr 2016; Yannic *et al.* 2016b; Charbonnel *et al.* 2022).

Stable-isotope analysis of stomach samples has added further information on the trophic level and diet of Ivory Gulls that use the North Water Polynya in northern Baffin Bay (Karnovsky *et al.* 2009). New banding records indicate that the species has a longer lifespan than previously known (> 25 years; Mallory *et al.* 2012), and satellite-tagging studies have clarified the annual movements of Canadian Ivory Gulls between their nesting and wintering areas (Spencer *et al.* 2014, 2016). However, despite these new data, the general ecology of the Ivory Gull still remains largely unknown.

The initial management plan for the Ivory Gull in Canada (Stenhouse 2004) was replaced by a federal recovery strategy in 2014 (Environment Canada 2014), which identified four population and distribution objectives. However, apart from monitoring and research in support of these objectives, no direct recovery activities have been implemented in Canada.

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
(2023)

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 is 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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Ivory Gull

Pagophila eburnea

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2023

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WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Current classification:

Class: Aves
Order: Charadriiformes
Family: Laridae
Genus: *Pagophila*
Species: *eburnea*

Common names:

English: Ivory Gull
French: Mouette blanche

Indigenous: Naujavaaq, Kaniq (Inuit/Inuktitut), Naujarluk (Inuit/Nunatsiavummiut), Naajavaasuk (Inuktitut/Labrador), Naajavaarsuk (Greenlandic)

Other names: Ice Gull, Ice Partridge, Snow Gull, Slob Gull, Winter Gull, Swile Bird, Seal Bird (English; Newfoundland and Labrador)

Taxonomic relationships:

The Ivory Gull is the sole member of the monotypic genus *Pagophila*, which is closely related to another monotypic genus, *Xema*, which represents Sabine's Gull, another Arctic-breeding species (*X. sabini*; Chu 1998; Crochet *et al.* 2000; Pons *et al.* 2005). Their common ancestor likely diverged from other gulls about 2 million years ago (Crochet *et al.* 2000). Although some phylogenetic studies group larid species by morphology (Chu 1998; Crochet *et al.* 2000; Pons *et al.* 2005), these two genera are usually retained based on their distinct morphological, ecological and behavioural differences (Pons *et al.* 2005).

Description of Wildlife Species

The Ivory Gull is a stocky, medium-sized gull, distinctive at all ages and unlikely to be mistaken for other species. Its pure-white adult plumage is particularly striking (cover photo). Adults average 40–43 cm in length, with a wingspan of 108–120 cm, and weigh 500–720 g (Mallory *et al.* 2020). The sexes are similar in appearance, although males are slightly larger (Yannic *et al.* 2016a) and, once maturity has been reached, there is no seasonal variation in plumage characteristics. The Ivory Gull has relatively short legs, which are black at all ages and fully feathered to the tibiotarsal joint, and a large, dark eye. Adult plumage is entirely white, and the fairly heavy bill is generally grey-blue at the base, becoming pale greyish-green, and usually tipped with yellow-orange. Immature birds have an all-dark bill, dusky or darkly speckled face, and black spots on the breast, flanks, tips of the primaries, and tail and outer wing coverts (Grant 1986). The extent of speckling varies

substantially among individuals. The period of immaturity is relatively short for a gull of this size, with adult plumage acquired in the second winter. The rounded crown, stocky chest, short legs and rolling gait give the species a pigeon-like appearance on the ground. Although it is a relatively thickset bird, it is agile and graceful in flight. Its many vernacular names reflect aspects of its physical characteristics, foraging behaviour and habitat associations.

Designatable Units

The Canadian breeding assemblage of the Ivory Gull was considered to be one designatable unit (DU) in previous COSEWIC status assessments (Macdonald 1979; Alvo and Macdonald 1996; COSEWIC 2001, 2006). As recent studies have found no evidence for discrete or evolutionarily significant genetic or morphological differences among Ivory Gulls breeding in Canada (Royston and Carr 2016; Yannic *et al.* 2016b; Charbonnel *at al.* 2022), the Canadian breeding assemblage is again considered here as one designatable unit.

The assemblage of birds that occur in Canada solely as non-breeding winter visitors nest in areas of the Eurasian Arctic far from Canada (Strøm *et al.* 2019). As there is no documented dispersal between the two assemblages and their breeding areas are separated by over 1,000 km of ice-fast ocean, these assemblages may represent separate DUs, although the species shows a high degree of genetic homogeneity across its global range (Yannic *et al.* 2016; Charbonnel *at al.* 2022). Only the status of the Canadian breeding assemblage is assessed here (see **Preface**).

Special Significance

The Ivory Gull is one of the least known seabirds in the world, with little research conducted to date on its life history and ecology. It holds a unique phylogenetic position as the sole member of its genus, as well as near-mythical status among birdwatchers due to its rarity and striking appearance. The Ivory Gull is recognized to be particularly vulnerable to the effects of climate change, due to its close association with Arctic Sea ice (Gilg *et al.* 2016), and, for that reason, has been highlighted as a "poster species" (Vyn 2009).

ABORIGINAL (INDIGENOUS) KNOWLEDGE

Aboriginal Traditional Knowledge (ATK) is relationship-based. It involves information on ecological relationships between humans and their environment, including characteristics of species, habitats and locations. Laws and protocols for human relationships with the environment are passed on through teachings and stories, and Indigenous languages, and can be based on long-term observations. Place names provide information about harvesting areas, ecological processes, spiritual significance or the products of harvest. ATK can identify life history characteristics of a species or distinct differences between similar species.

Cultural Significance to Indigenous Peoples

The Ivory Gull is culturally significant to Indigenous Peoples, who hold detailed knowledge on the evolving, dynamic nature of the species. ATK has been included under relevant headings of the report, and sources of information are indicated.

The Ivory Gull is known to Indigenous groups across the Arctic as an uncommon and unpredictable visitor. Canadian Inuit regard it with great affection and consider its decline in Canada as an indicator of systemic issues in the northern environment (Akearok *et al.* 2002; Mallory *et al.* 2003). The Ivory Gull was traditionally hunted for food in its breeding and wintering areas across the circumpolar Arctic. This harvest was likely always opportunistic in nature, due to the species' relatively small numbers and the remote nature of its colonies, and it is unlikely that it served as a significant food source for subsistence hunters (Mallory *et al.* 2003).

DISTRIBUTION

Global Range

The Ivory Gull spends its entire annual cycle in the Arctic (Figure 1), with small, patchily distributed breeding populations in Nunavut (Canada), northern and eastern Greenland (Denmark), Svalbard (Norway) and the Russian Arctic islands of Severnaya Zemlya and Franz Joseph Land (Strøm *et al.* 2019; Mallory *et al.* 2020). It winters along sea-ice edges, primarily in Davis Strait and the Labrador Sea, as well as off southeast Greenland and in the Bering Strait region (Figure 1; Gilg *et al.* 2010; Spencer *et al.* 2016).

In North America, the Ivory Gull breeds solely in northeastern Nunavut (Figure 2; Robertson *et al.* 2007; Gilchrist *et al.* 2008). Canadian Ivory Gulls travel south from their breeding colonies via Foxe Basin or Davis Strait to winter along the sea-ice edge in Davis Strait and the Labrador Sea in the company of birds from Greenland, Svalbard, Severnaya Zemlya and Franz Josef Land (Figure 3; Gilg *et al.* 2010; Spencer *et al.* 2014; Spencer *et al.* 2016).

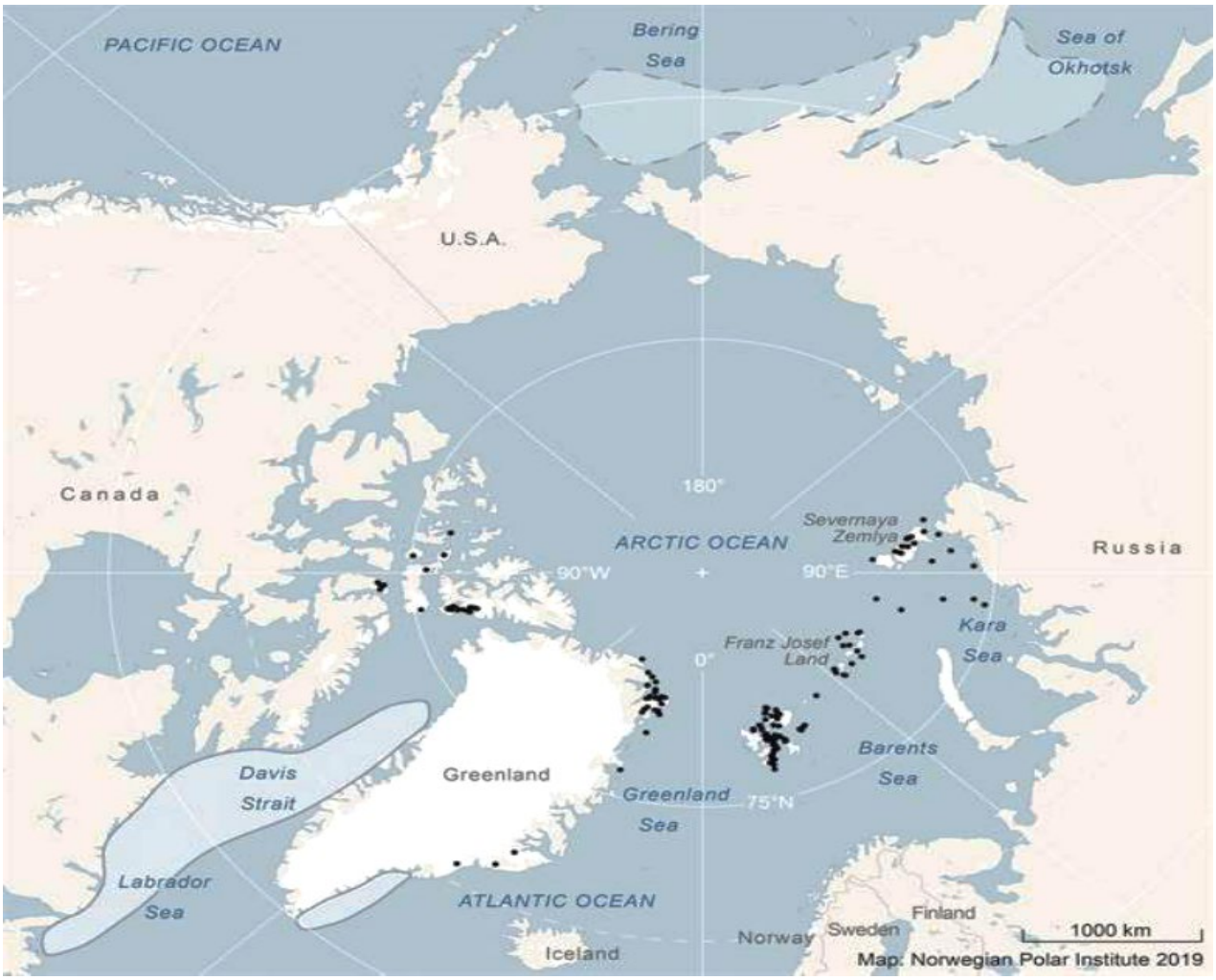

Figure 1. Global distribution of known Ivory Gull breeding colonies occupied for one or more years between 2000 and 2017 (black dots), and primary wintering areas (light grey). The wintering area in the North Pacific is roughly outlined with a broken line, as it is less well defined (from Strøm *et al.* 2019, used with permission).

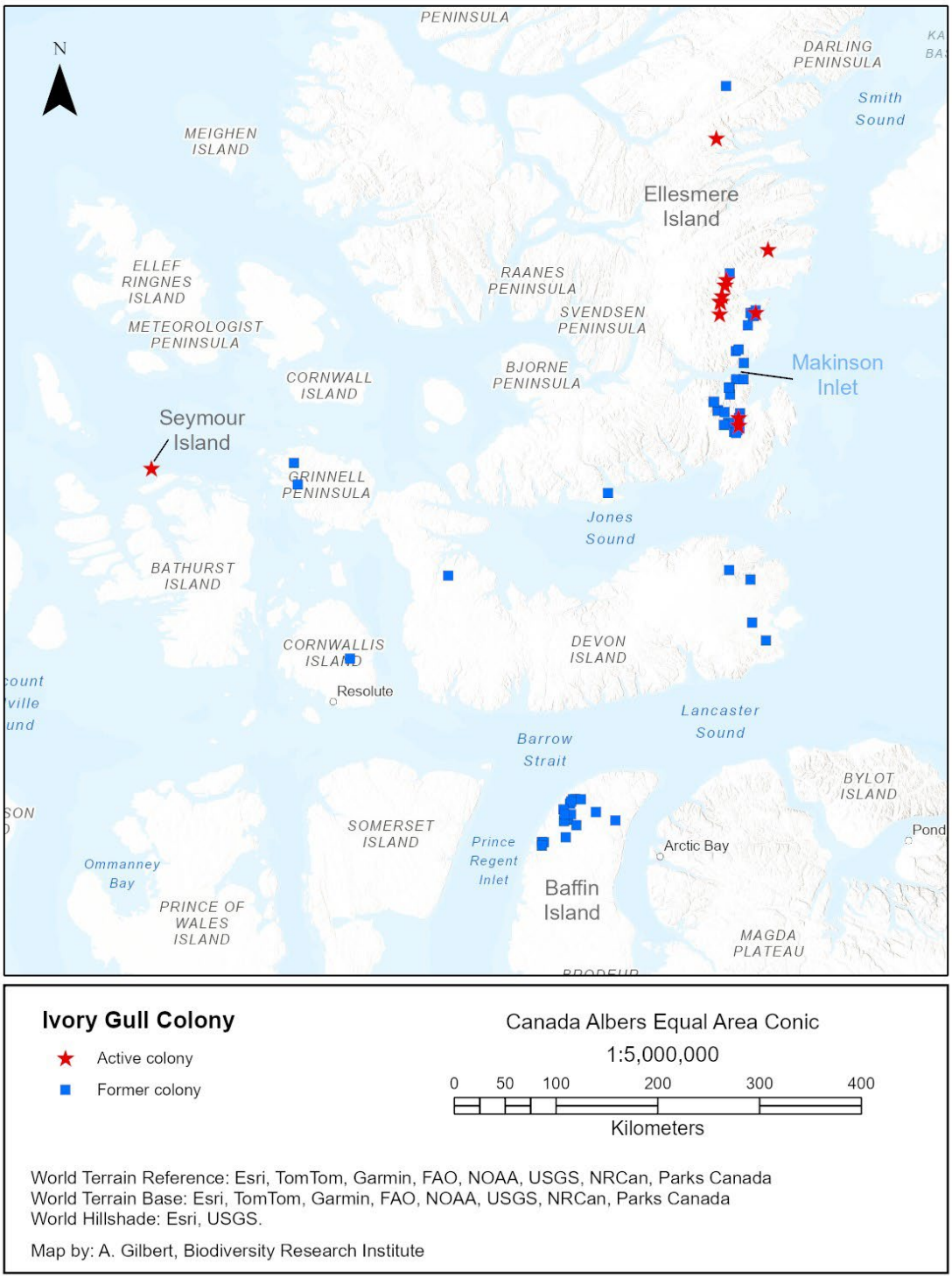

Figure 2. Distribution of all known Ivory Gull colonies in the Canadian Arctic as of 2019, indicating active (or possibly active: Seymour Island) colonies (red stars) and no longer active (former) colonies (blue squares; map prepared by Andrew Gilbert, Biodiversity Research Institute).

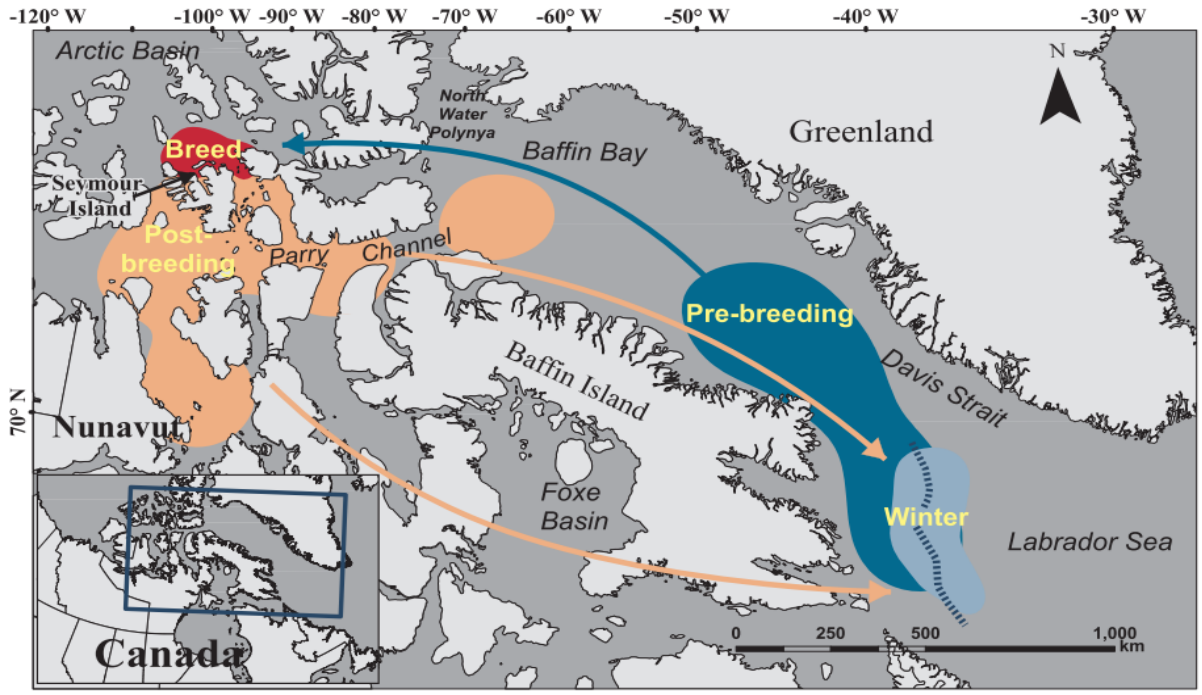

Figure 3. Distribution and movements of 12 satellite-tagged Ivory Gulls breeding on Seymour Island, Nunavut, in 2010, during the breeding (red), post-breeding (orange), winter (light blue) and pre-breeding (dark blue) periods. The general direction of fall post-breeding migration is indicated by orange arrows, and of spring pre-breeding migration by the blue arrow. The dashed line within the winter distribution represents the typical edge of the pack ice from December through April during the study period (2010–2013; from Spencer *et al.* 2014, used with permission).

Canadian Range

During the breeding season, Canada currently hosts about 10–13% of the estimated global breeding population (Table 1; Gilchrist and Mallory unpubl.) and the entire North American breeding population (Figure 2). Ivory Gull colonies have traditionally been located primarily around Jones Sound and Lancaster Sound, on the Brodeur Peninsula of northwestern Baffin Island, and on Ellesmere, Devon and Cornwallis islands (Figure 2; Gilchrist and Mallory 2005). Seymour Island, a small gravel island that is northwest of Bathurst Island and is associated with the Penny Strait polynya, has been an important breeding area at the western edge of the species' breeding range. In past decades, this island has supported the largest known Ivory Gull colony in Canada, with 340 pairs in 1974 and 200 pairs in 2003 (Table 2; Mallory and Gilchrist 2003). However, surveys in 2009 and 2019 found only two pairs at this site (Gilchrist and Mallory unpubl. data), making the current and future status of this colony uncertain, and it may no longer be active.

Table 1. Estimated size of Ivory Gull breeding population (approximate number of mature individuals) by country, based on most recent survey results.

Country	Current Estimate (mature individuals)	Most Recent Survey Year	Population Trend	Assessment Period	Information Source
Canada	1,950–2,250	2019	Uncertain	2009–2019	Gilchrist and Mallory unpubl. data; this report
Greenland (Denmark)	4,000–5,000	2019	Stable	2009–2019	Boertmann *et al.* 2020
Norway	3,000–4,000	2019	40% decline over 15 years	2006–2019	Strøm *et al.* 2020
Russia	7,000–14,000	2006–2007	Likely stable	1990s–2000s	BirdLife International 2018
Total global estimate	**16,000–25,300**				

Table 2. Number of individual adult Ivory Gulls (mature individuals) counted at colonies surveyed in Arctic Canada, by island and survey year. Each bird counted is assumed to represent one breeding pair of two mature individuals.

Colony code	Source	1974	1975	1976	1977	1981	1982	1983	1984	1990	2001	2002	2003	2004	2005	2006	2009	2019
Ellesmere Island																		
EI-1	4, 7	.	.	.	.	.	287	?	.	.	.	0	0	0	0	0	0	0
EI-2	2, 4, 7	.	.	.	60	.	42	?	.	.	.	0	0	0	0	0	0	0
EI-3	2, 4, 7	.	.	.	15	.	.	?	.	.	.	0	.	.	0	.	.	0
EI-4	2, 4, 7	.	.	.	50	.	18	?	.	.	.	0	5	0	0	0	0	0
EI-5	2, 4, 7	.	.	.	50	.	125	0	.	.	.	0	5	0	0	0	0	0
EI-6	2, 4, 7	.	.	.	30	.	20	?	.	.	.	0	8	0	0			
EI-7	4, 7	.	.	.	.	.	.	.	.	24	.	0	0	0	0	0	0	0
EI-8	4, 7	.	.	.	.	.	.	.	.	28	.	0	8	0	0	0	0	0
EI-9	4, 7	.	.	.	.	.	.	.	.	20	.	5	0	0	0	0	0	0
EI-10	4, 7	.	.	.	.	.	.	.	.	28	.	1	1	0	0	0	0	1
EI-11	4, 7	.	.	.	.	.	.	.	.	70	.	0	0	0	0	0	0	0
EI-12	4, 7	.	.	.	.	.	.	.	.	90	.	6	0	0	0	0	0	0
EI-13	4, 7		.	.	.	.	.	.	.	70	.	10	0	0	0	0	0	0
EI-14	7	.	.	.	.	.	.	.	.	.	.	11	0	0	1	0	0	0
EI-15	7	.	.	.	.	.	.	.	.	.	.	2	0	0	0	0	0	0
EI-16	7	.	.	.	.	.	.	.	.	.	.	2	1	0	0	0	0	0
EI-17	7	.	.	.	.	.	.	.	.	.	.	1	0	0	0	0	0	0
EI-18	7	.	.	.	.	.	.	.	.	.	.	19	3	0	0	0	0	44
EI-19	7	.	.	.	.	.	.	.	.	.	.	20	0	0	0	0	0	0

Colony code	Source	1974	1975	1976	1977	1981	1982	1983	1984	1990	2001	2002	2003	2004	2005	2006	2009	2019
EI-20	7	.	.	.	.	.	.	.	.	.	.	1	0	0	0	0	0	0
EI-21	7	.	.	.	.	.	.	.	.	.	.	1	0	0	0	0	0	0
EI-22	7	.	.	.	.	.	.	.	.	.	.	4	0	0	2	0	0	0
EI-23	7	.	.	.	.	.	.	.	.	.	.	.	2	0	0	0	0	0
EI-24	7	.	.	.	.	.	.	.	.	.	.	.	8	50	23	0	0	0
EI-25	7	.	.	.	.	.	.	.	.	.	.	.	.	2	0	0	0	0
EI-26	7	.	.	.	.	.	.	.	.	.	.	.	.	2	0	0	0	0
EI-27	7	.	.	.	.	.	.	.	.	.	.	.	.	42	1	0	0	0
EI-28	7	.	.	.	.	.	.	.	.	.	.	.	.	131	92	100	105	0
EI-29	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	0	0
EI-30	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	0	0
EI-31	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	150	145	65
EI-32	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20	0	55
EI-33	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	150	160	244
EI-34	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	200	194	200
EI-35	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50	80	82
EI-36	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
EI-37	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	260
EI-38	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
EI-39	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12
Subtotal		.	.	.	205	.	492	0	.	330	.	83	33	227	119	697	684	976
Baffin Island																		
BI-1	7, 9, 10	.	.	.	.	18	.	.	.	.	.	0	0	0	0	.	.	.
BI-2	7, 9, 10	.	.	.	.	30	13	.	.	.	.	0	0	0	0	.	.	.
BI-3	4, 7, 9	.	.	.	.	.	.	75	.	.	.	0	0	0	0	.	.	.
BI-4	4, 7, 9	.	.	.	.	.	.	175	.	.	.	0	0	0	0	.	.	.
BI-5	4, 7, 9	.	.	.	.	.	.	6	.	.	.	0	0	0	0	.	.	.
BI-6	4, 7, 9	.	.	.	.	.	.	37	.	.	.	0	0	0	0	.	.	.
BI-7	4, 7, 9	.	.	.	.	.	45	.	.	.	.	0	0	0	0	.	.	.
BI-8	4, 7, 9	.	.	.	.	.	13	.	.	.	.	0	0	0	0	.	.	.
BI-9	4, 7, 9	.	.	.	.	.	84	.	.	.	.	0	0	0	0	.	.	.
BI-10	4, 7, 9	.	.	.	.	.	.	130	.	.	.	0	0	0	0	.	.	.
BI-11	4, 7, 9	.	.	.	.	.	.	45	.	.	.	0	0	0	0	.	.	.
BI-12	4, 7, 9	.	.	.	.	.	.	25	.	.	.	0	0	0	0	.	.	.
BI-13	6, 7	.	.	.	.	.	.	.	.	.	35	.	0	0	0	.	.	0
BI-14	6, 7	.	.	.	.	.	.	.	.	.	20	.	0	1	0	.	.	0
BI-15	7, 8	.	.	.	.	.	.	.	.	.	.	.	55	54	0	.	.	0
BI-16	7, 8	.	.	.	.	.	.	.	.	.	.	.	26	0	0	.	.	0
BI-17	7, 8	.	.	.	.	.	.	.	.	.	.	.	7	0	0	.	.	0
Subtotal		.	.	.	.	48	155	493	.	.	55	0	88	55	0	.	.	0
Devon Island																		
DI-1	3, 7	.	.	.	.	.	25	.	.	.	.	0	0	0	3	.	0	0
DI-2	3, 7	.	.	.	.	.	30	.	.	.	.	6	0	2	1	.	0	0

Colony code	Source	1974	1975	1976	1977	1981	1982	1983	1984	1990	2001	2002	2003	2004	2005	2006	2009	2019
DI-3	3, 7	.	.	.	.	.	30	.	.	.	.	0	0	0	0	.	.	.
DI-4	3, 7	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.
DI-5	8	.	.	.	.	.	.	.	.	.	.	.	.	.	3	0	17	0
DI-6	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
DI-7	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Subtotal		.	.	.	.	.	91	.	.	.	.	6	0	2	7	0	17	0
Cornwallis Island																		
CI-1	8	.	.	.	.	.	.	.	.	.	.	.	7	.	0	.	0	0
Subtotal		.	.	.	.	.	.	.	.	.	.	.	7	.	0	.	0	0
Seymour Island																		
SI-1	1, 4, 7, 9	340	300	300	.	.	.	225	351	.	.	0	200	120	110	143	2	2
Subtotal		340	300	300	.	.	.	225	351	.	.	0	200	120	110	143	2	2
Total count		**340**	**300**	**300**	**526**	**48**	**718**	**718**	**351**	**330**	**55**	**89**	**321**	**402**	**241**	**842**	**703**	**978**

Sources from COSEWIC 2006: (1) MacDonald 1976; (2) Frisch and Morgan 1979; (3) Frisch 1983; (4) Thomas and MacDonald 1987; (5) France and Sharp 1992; (6) A.J. Gaston pers. comm. 2004; (7) Gilchrist and Mallory 2005; (8) Mallory and Gilchrist unpubl. data; (9) V.G. Thomas pers. comm. 2005 (?) “plus an additional 130 adults on the Brodeur at other colonies in 1983”; and (10) Reed and Dupuis 1983.

In 2019, four new colonies were found on east-central Ellesmere Island north of Makinson Inlet, in areas that had not been previously searched. However, many colonies at the southern edge of the species’ breeding range, on the Brodeur Peninsula, Devon Island and southeast Ellesmere Island, have disappeared since the early 2000s (Table 2; Gilchrist and Mallory unpubl. data). While other small colonies may yet be discovered, possibly on western Ellesmere Island or Axel Heiberg Island (Mallory pers. comm. 2020), extensive aerial surveys undertaken since the early 2000s (2002–2006, 2009 and especially 2019; Gilchrist and Mallory unpubl. data) suggest that it is unlikely that additional large undiscovered colonies exist.

The key wintering area for Canadian-breeding Ivory Gulls is the ice edge in Davis Strait and the northern Labrador Sea (Figure 3; Spencer *et al.* 2014), where they are joined by a large, but uncertain, proportion of the Eurasian breeding assemblage (Gilg *et al.* 2010). A study based on aerial transects flown in March 1978 estimated that approximately 35,000 Ivory Gulls were present in Davis Strait and the Labrador Sea (Orr and Parsons 1982). The authors of the study acknowledged that the survey resolution was weak (i.e., with wide confidence limits of 23,800 ± 12,100 and 11,300 ± 6,750 individuals between two habitat types), as relatively few Ivory Gulls were actually observed (n = 1,013) and the results were extrapolated over the entire survey area. A coordinated circumpolar research program using satellite tracking to link breeding and wintering areas has confirmed that many Ivory Gulls breeding in Greenland (Gilg *et al.* 2009), Arctic Canada (Spencer *et al.* 2014), the Russian Arctic and Svalbard, Norway (Strøm *et al.* 2019) converge in Davis Strait and the Labrador Sea in winter. Combined, the aerial survey and tracking studies indicate that Canadian waters may support most individuals in the global Ivory Gull population at some point during winter.

Population Structure

No clinal morphological differences have been found in individual Ivory Gulls across the species' Holarctic range (Yannic *et al.* 2016b), and no subspecies have been described (Mallory *et al.* 2020). Using microsatellite- and single nucleotide polymorphism (SNP)-based genetic analyses, Charbonnel *et al.* (2022) observed only a very low level of genetic differentiation among Ivory Gulls from across the range. That study supported the finding of Yannic *et al.* (2016b) that the species displays considerable genetic homogeneity across its entire range, and their conclusion that there is a single global Ivory Gull population. Analysis of tissue samples from museum specimens showed that the mitochondrial DNA composition of Canadian breeding birds differs slightly from that of birds wintering in Alaska (probably breeding in Russia), but not from birds breeding in Greenland and Norway (Royston and Carr 2016).

The Canadian breeding assemblage congregates in Davis Strait and the northern Labrador Sea in fall and winter (Orr and Parsons 1982; Spencer *et al.* 2014), together with birds from Greenland and the Eurasian Arctic colonies (Gilg *et al.* 2010; Spencer *et al.* 2014). For example, a bird banded on Franz Josef Land (Russia) was recovered in Labrador in early March (Dementev and Gladkov 1969). Among Ivory Gulls banded in Arctic Canada and recovered on migration along the coast of southwestern Greenland, the recovery rates for birds banded at northern nesting sites were significantly higher than those from southern sites, suggesting that the migration routes of these groups may differ slightly (Stenhouse *et al.* 2004).

Extent of Occurrence and Area of Occupancy

Current extent of occurrence:

The current extent of occurrence (EOO) of the Canadian breeding assemblage of the Ivory Gull is approximately 92,614 km^2 (Figure 4), based on the area of a minimum convex polygon drawn around all active colonies in Canada observed during the 2019 survey (including Seymour Island; Gilchrist and Mallory unpubl. data). The current status of the Seymour Island colony is uncertain, and only two pairs were observed there in 2009 and 2019. If the colony is now inactive, the EOO would be much smaller, at 8,021 km^2 (Figure 4).

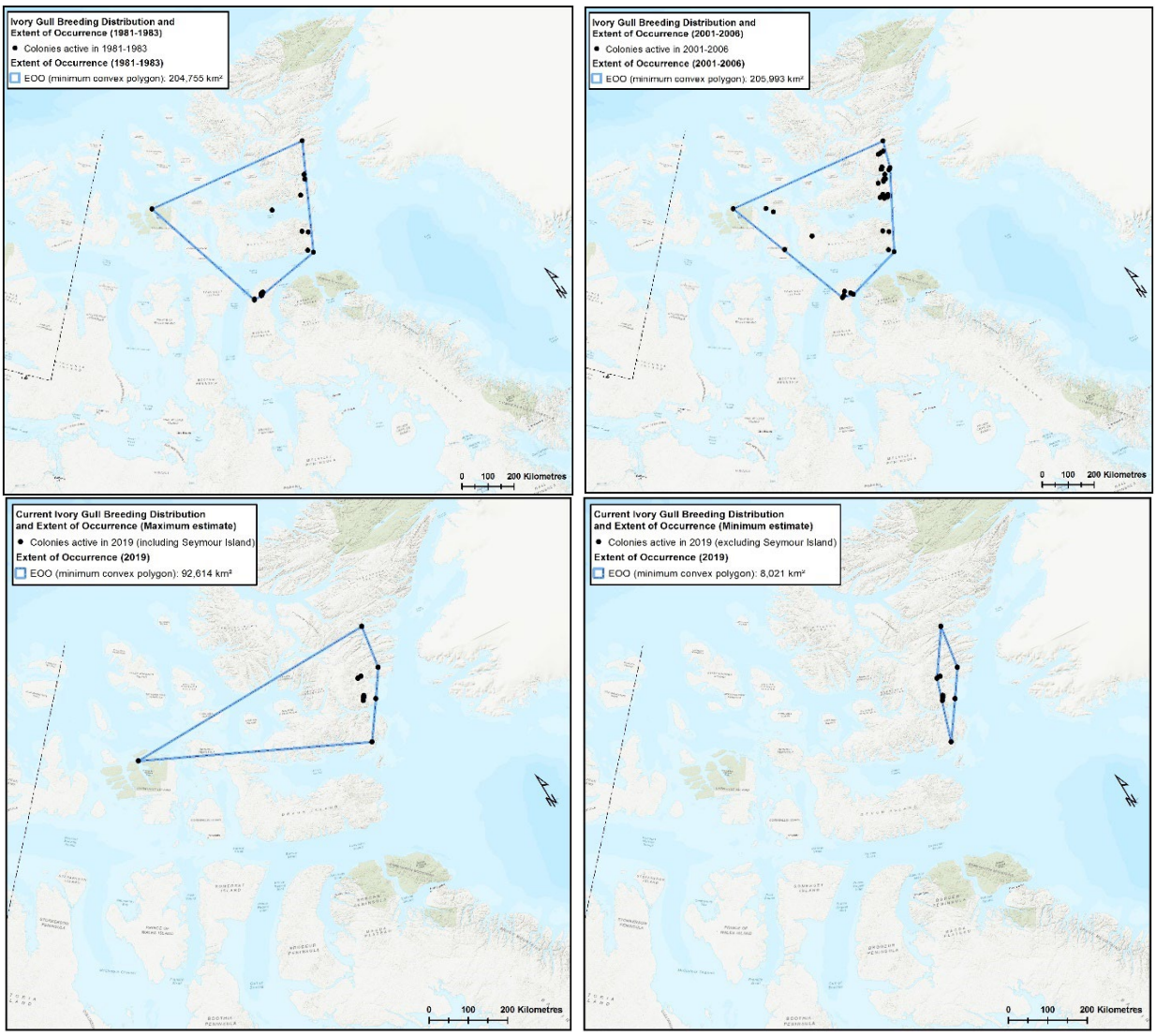

Figure 4. Extent of occurrence (EOO) calculated for three periods with adequate colony survey data (1981–1983 [top left], 2001–2006 [top right], and 2019 [both lower panels]), showing the breeding range contraction between survey periods. The lower panels show alternative estimates of EOO for 2019, based on the assumptions that the Seymour Island colony is active (left panel) and inactive (right panel).

Current index of area of occupancy:

The current index of area of occupancy (IAO) of the species' Canadian breeding assemblage is 40 km^2, calculated using a 2 km x 2 km grid drawn over the active colonies in Canada observed during the 2019 survey (including Seymour Island), or 36 km^2 (excluding Seymour Island; Figures 2 and 4; Gilchrist and Mallory unpubl. data).

Fluctuations and Trends in Distribution

The two current estimates of the EOO are both considerably smaller than those for the early 1980s (1981–1983; 204,755 km^2) and the early 2000s (2001–2006; 205,993 km^2; Figure 4), which were calculated in the same way. If the Seymour Island colony is assumed to be extant, the EOO has declined by about 55% in less than three generations (24 years); if Seymour Island is considered to be abandoned, the EOO has declined by about 96% over the same period (Figure 4). This marked decline is driven by the abandonment of most colonies in the southern and western portions of the Canadian breeding range between 2001 and 2019, including the colonies on northern Baffin Island, Cornwallis Island and Devon Island (Figure 4), and does not reflect a reduced search effort, which actually increased between these periods.

The two current estimates of the IAO indicate a considerable decline compared with the estimates calculated in the same way for the 1980s (1981–1983; 80 km^2) and the 2000s (2001–2006; 164 km^2). This rapid decline in IAO is also driven by the loss of the colonies on northern Baffin Island, Cornwallis Island and Devon Island between 2001 and 2019. This represents a decline in the IAO of about 75–78%, depending on whether the Seymour Island colony is considered extant, in a period of less than three generations. Given the comprehensive survey of previous, active and potential colony sites undertaken in 2019, these differences reflect an actual reduction in occupied area, rather than a reduced search effort.

BIOLOGY AND HABITAT USE

Life Cycle and Reproduction

The species' mean adult life expectancy has been estimated at 6.9 ± 1.4 years (Stenhouse *et al.* 2004). However, at least four adult Ivory Gulls have lived for more than 25 years, based on 24 recoveries from 1,545 birds banded on Seymour Island, Nunavut (Mallory *et al.* 2012). One banded Ivory Gull was at least 28 years old, a longevity record exceeding that of most North American birds (Mallory *et al.* 2012). The species' longevity may be related to its intermittent breeding strategy, involving the occasional skipping of annual breeding opportunities in order to achieve a trade-off between current and future reproduction, driven by constraints such as predation, limited food availability and other environmental factors (Shaw and Levin 2013).

Ivory Gull plumage and moult patterns indicate that sexual maturity is reached at two years of age (Mallory *et al.* 2020), although age at first breeding is given by BirdLife International as 2.6 years (Bird *et al.* 2020), suggesting that many Ivory Gulls may not breed until they are three years old. Generation time (the average age of parents in the population) has been calculated at 7.9 years (Bird *et al.* 2020), giving a three-generation period of 24 years. Yannic *et al.* (2016a) found a male-biased sex ratio of about 68:32 across all Ivory Gull populations studied, including samples from Alert, in northern Nunavut, although the cause and biological implications of this are unclear.

The need for predator-free nest sites leads Ivory Gulls to select ledges and fissures on steep cliffs or rock jumbles, or isolated gravel patches, often surrounded by permanent ice, including patches on floating ice islands (Thomas and MacDonald 1987; Boertmann *et al.* 2010). Ivory Gulls nest in colonies ranging from 2 to 200 pairs, usually placing nests 2–3 m apart (Strøm *et al.* 2019; Mallory *et al.* 2020). Mud, feathers, vegetation or seaweed may be used to line a simple nest scrape in a sheltered crevice or among loose pebbles, depending on local availability. Entire colonies may be unattended for one or more years, likely in response to predation risk or inadequate food supply due to environmental conditions, and to the tendency for individual pairs to skip breeding in some years (Mallory *et al.* 2020). Some studies indicate that birds may concentrate in fewer colonies as breeding numbers decline (Robertson *et al.* 2007; Gilg *et al.* 2009). Evidence of considerable natal philopatry is provided by band recoveries at natal colonies (Mallory *et al.* 2012), and tracking studies showing that adults often return to the same colony over consecutive years (Spencer *et al.* 2014).

The nesting period is typically completed within about 60 days, with pair formation presumably taking place just prior to or after arrival at the colony. Copulation has been observed at breeding colonies, as well as during spring migration (Kylin 2011). Nest-building and egg-laying take place in late June to late July, incubation in early July to early August, and hatching through to late August, with most chicks fledging by early September. Typically, only 1–2 eggs are laid, and a second clutch is not produced unless the first one is lost early in incubation, thus limiting the species' annual reproductive potential (Mallory *et al.* 2020). Eggs are incubated for 24–26 days, and chicks fledge after another 30–35 days (Macdonald 1976).

Survival rates are poorly understood, but an initial analysis of band recoveries suggested annual adult survivorship of 0.86 ± 0.04 SE (Stenhouse *et al.* 2004), similar to that of other medium-sized gulls (Bird *et al.* 2020). However, as harvest levels are no longer expected to have a measurable impact on population trends (see **Threats: 5.1 Hunting & Collecting Terrestrial Animals**), mean adult survivorship may now be somewhat higher. Overall, the reproductive rate of the Ivory Gull appears to be low, based on its small clutch size and the extreme and variable nature of the environment where it nests, which leads to periodic missed or abandoned breeding attempts. Exposure to high levels of airborne mercury may further reduce productivity (see **Threats: 9.5 Air-Borne Pollutants**). Other factors limiting breeding success include unsuitable environmental conditions (e.g., sea-ice extent), predation, disturbance and weather-related abandonment of eggs or chicks (Yannic *et al.* 2014; Mallory *et al.* 2020). No details are available on hatching or fledging success.

Habitat Requirements

Breeding Habitat:

Since breeding Ivory Gulls depend on a reliable marine prey base early in the season, when the sea is typically covered by ice, access to persistent areas of open water, such as polynyas or shore leads, is critical (Mallory *et al.* 2020). Ivory Gulls also require nesting areas largely free from mammalian predators, as they are generally unable to defend their nests against them (COSEWIC 2006). However, the Canadian High Arctic contains few predator-free sites near open water, and the availability of suitable breeding areas is limited (Mallory *et al.* 2020).

In Canada, Ivory Gull colonies are typically found on remote nunataks (isolated steep cliffs of rock protruding from surrounding expanses of snow or ice), but formerly also occurred on flat areas of rock or gravel, often on isolated islands. Such sites lack the significant vegetation cover associated with microtine rodents, especially lemmings (*Lemmus* spp., *Dicrostonyx* spp.), which reduces their attractiveness to predators—which could also depredate Ivory Gull nests (COSEWIC 2006). As the Ivory Gull usually relies on the extreme remoteness of nest sites to avoid predators, colonies may be 20–30 km from ocean foraging areas (COSEWIC 2006; Gilchrist *et al.* 2008). Colonies have occasionally been found on patches of gravelly moraine on floating ice islands (MacDonald and Macpherson 1962; Boertmann *et al.* 2010; Nachtsheim *et al.* 2016).

Migration habitat:

The timing and magnitude of the Ivory Gull's migratory movements appear to be dependent on the formation and distribution of sea ice (Mallory *et al.* 2020), suggesting that, during migration, the species uses similarly dense ice pan and ice floe habitat in the ice pack as it does during much of the rest of the year (Spencer *et al.* 2014). Although migrating birds appear to generally avoid extensive areas of open water (Spencer *et al.* 2014), some individuals are known to use the North Water Polynya, in northern Baffin Bay, as a post-breeding staging area in late summer (Karnovsky *et al.* 2009).

Winter habitat:

The Ivory Gull is strongly associated with sea ice throughout the winter, and is rarely found over large expanses of open water (Spencer *et al.* 2016). It uses leads and polynyas in the pack ice, and follows the edges of the advancing and receding ice. An analysis of satellite-tagged birds from Canadian colonies found that Ivory Gulls spend about 90% of the winter over sea ice, including 30% of the time over dense pack ice with at least a 50% concentration (Spencer *et al.* 2016). The species forages along ice edges for ice-associated fish and invertebrates, seal placentas and feces, and the remains of seals and other marine mammals killed by Polar Bears or human hunters (Mallory *et al.* 2020).

Movement, Migration, and Dispersal

Although the Ivory Gull remains in the Arctic throughout its annual cycle, it travels large distances between its breeding and wintering areas (Figure 3). Ivory Gulls satellite-tagged on Seymour Island, Nunavut, left the area in late September and moved relatively slowly past Baffin Island to Davis Strait and the Labrador Sea (median travel time of 74 days, Spencer *et al.* 2014). They travelled either through Foxe Basin and Hudson Strait (located west and south of Baffin Island respectively), or Parry Channel and Lancaster Sound (located to the north of Baffin Island), reaching the wintering area in December (Spencer *et al.* 2014). There, they remained along the ice edge between Baffin Island, eastern Labrador, northern Newfoundland and western Greenland until May, before returning to the breeding area relatively quickly (median travel time of 18 days) and with few stops, arriving in early June (Figure 3).

The Ivory Gull's affinity for sea ice likely explains the variability in its migration routes and timing, as it responds to changes in the position of the ice edge. It also suggests why migration in fall may be longer than in spring, as the birds follow the developing sea ice, which slowly expands southward (Spencer *et al.* 2014). Although most of the species' migratory movements appear to occur along coastlines and ice edges (Figure 5), the Ivory Gull is also capable of extended movements over land. For example, an adult was tracked on spring migration across the Greenland ice cap on an almost non-stop flight of 29 hours and roughly 1,345 km, during which it reached an altitude of over 4,000 m (Frederiksen *et al.* 2020).

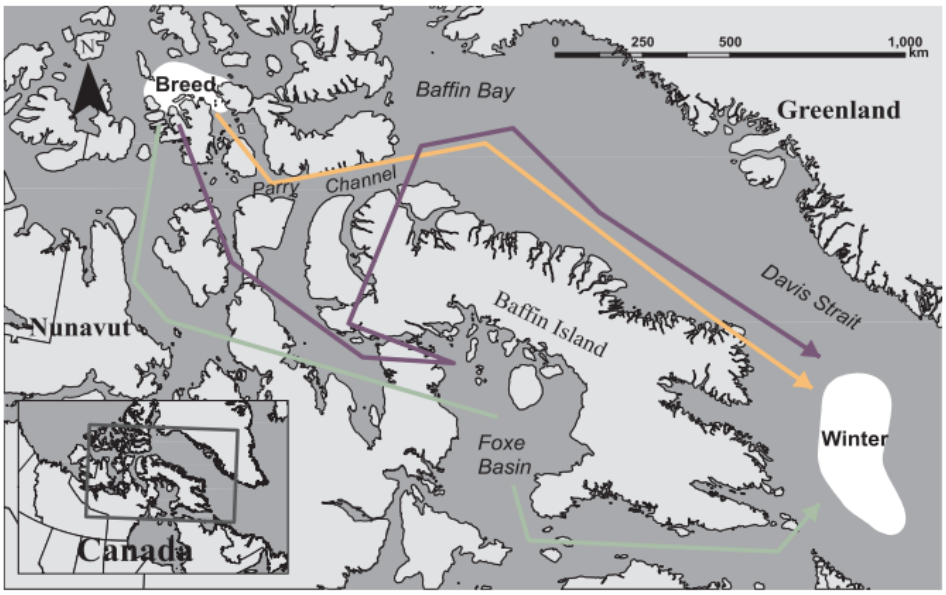

Figure 5. Post-breeding migratory movements of Ivory Gulls satellite tagged at Seymour Island, Nunavut, in 2010. Birds travelled either southeast via Davis Strait (orange arrow) or via Foxe Basin (green), or southeast via Foxe Basin, north across Baffin Island and south through Davis Strait (purple) during the study period (2010–2013). It is unknown whether individuals follow the same route in successive years (from Spencer *et al.* 2014, used with permission).

Band recoveries from studies at Canadian colonies indicate that the Ivory Gull exhibits considerable colony-site fidelity (Mallory *et al.* 2012), which is supported by the results of tracking studies showing that adults returned to the same colony over consecutive years (Spencer *et al.* 2014). Satellite transmitters were attached to 12 breeding adults in June 2010 on Seymour Island, Nunavut (Spencer *et al.* 2014). These birds then dispersed to the Parry Channel and Lancaster Sound, with one using the North Water Polynya, before starting their southward migration towards the wintering area in Davis Strait (Figure 5; Spencer *et al.* 2014), corroborating previous observations (Orr and Parsons 1982; Mallory *et al.* 2020). Dispersal of young Ivory Gulls is poorly understood, and they are rarely seen at or near colonies once fledged or as non-breeding immatures in subsequent years (Mallory *et al.* 2020).

Interspecific Interactions

Diet:

The Ivory Gull feeds primarily on marine fish and invertebrates near the sea surface, foraging by surface-dipping or plunging. Arctic Cod (*Boreogadus saida*) constituted 86% of prey items in the stomachs of five Ivory Gulls collected at the North Water Polynya in late May and early June 1998 (Karnovsky *et al.* 2009), and other Canadian studies have found Arctic Cod, lanternfish, squid, euphausiids and copepods in stomach samples (Mallory *et al.* 2020). Carrion from seals and other marine mammals killed by Polar Bears is also eaten, as are placentas and feces of whelping Hooded Seal (*Cystophora cristata*) and other seals (Mallory *et al.* 2020). Overall, the Ivory Gull occurs at a relatively high trophic level (Karnovsky *et al.* 2009). Human garbage and refuse from carcasses of hunted animals, such as seals and narwhals (*Monodon monoceros*), may also be locally important food sources (Mallory *et al.* 2003). Small terrestrial mammals, such as lemmings, are taken on the breeding grounds (Mallory *et al.* 2020).

A study of carbon and nitrogen stable isotopes (^{13}C, ^{15}N, with the values of $\delta^{13}C$, and $\delta^{15}N$ as indicators of foraging area and trophic position, respectively) in feathers from museum specimens of Canadian Ivory Gulls found no overall change in values from 1877 to 2007 (Bond *et al.* 2015). These results suggest that the Ivory Gull's diet has remained relatively consistent over a 130-year period, although birds could have switched to different prey that had similar isotopic values.

Predators and competitors:

The Ivory Gull breeds in single-species colonies, and those on flat ground (now rare in Canada) are vulnerable to mammalian predators such as Arctic Fox (*Vulpes lagopus*) and Polar Bear, as well as avian predators such as Snowy Owl (*Bubo scandiaca*), Glaucous Gull (*Larus hyperboreus*) and Common Raven (*Corvus corax*), all of which take both eggs and chicks (Mallory *et al.* 2020). Glaucous Gulls and Common Ravens also threaten nests on steep cliffs, where adults may also be targeted by Gyrfalcons (*Falco rusticolus*; Mallory *et al.* 2020). Among all potential predators, the Arctic Fox likely has the most detrimental impact on nesting Ivory Gulls, sometimes causing total colony abandonment (Macdonald 1976). Reports from the Russian Arctic speculate that stray domestic dogs (*Canis familiaris*) may also prey on eggs and chicks from some accessible nests there (Gilchrist *et al.* 2008).

The Ivory Gull may join mixed-species feeding aggregations in the sea ice with Black-legged Kittiwakes (*Rissa tridactyla*) and Glaucous Gulls (Kylin 2011). Klepto-parasitism by Glaucous Gulls of prey captured by adult Ivory Gulls has been observed during migration at sea in early May (Kylin 2011).

Other interactions:

A study of local ecological knowledge (LEK) in the High Arctic communities of Ausuittuq (Grise Fiord), Qausuittuq (Resolute Bay) and Ikpiarjuk (Arctic Bay) in Nunavut, described Ivory Gulls associating with Polar Bears, as well as with human hunters, to feed on carcasses of hunted seals and whales (Mallory *et al.* 2003). LEK gathered in coastal Newfoundland and Labrador indicated that, although Ivory Gulls wintering there sometimes associated with other gull species on the ice or around seals, they did not typically associate with other animals (Ryan *et al.* 2006). The Ivory Gull has been reported following ships near Svalbard during spring migration to feed on plankton stirred up by their wakes (Kylin 2011), and following an ice breaker in the Russian Arctic, feeding on Arctic cod trapped when the ice was overturned (Smith pers. comm. 2021).

Physiology, Behaviour, and Other Adaptations

The Ivory Gull copes in part with the extreme environmental and weather conditions in the Arctic by having a relatively high metabolic rate compared with other gull species of similar size (Gabrielsen and Mehlum 1989), resulting in significant energetic requirements. Owing to its consequent high rates of food consumption, the Ivory Gull is at risk of increased contaminant loading, as well as a higher probability of contaminant bioaccumulation in keeping with its high trophic level (position in the food web; Braune *et al.* 2006, 2007; see **Threats, 9.5 Air-Borne Pollutants**).

The changing climate in the Arctic is significantly altering sea-ice dynamics (Steele and Dickinson 2016), primary productivity (Holding *et al.* 2015), and trophic dynamics (Pratte *et al.* 2019), which in turn are impacting seabird communities (Mallory *et al.* 2010). Although phenological data for the Ivory Gull are limited, other surface-feeding, Arctic-breeding seabirds, including the Black-legged Kittiwake and Red-legged Kittiwake (*Rissa brevirostris*), have advanced their reproductive phenology by about 10 days since 1982, linked to the earlier onset of spring conditions (Descamps *et al.* 2019). The changing climate will continue to impact marine birds in the Canadian Arctic (Wong *et al.* 2014), although the Ivory Gull's degree of phenological and behavioural plasticity is unclear.

Although the Ivory Gull is known to forage around human habitations and at kills made by human hunters, there are contradictory reports regarding its sensitivity to anthropogenic disturbance at colonies (COSEWIC 2006). A single low-flying airplane reportedly caused the complete abandonment of a colony in northern Europe (Cramp and Simmons 1983), suggesting high sensitivity to such disturbance. However, reports from biologists conducting long-term studies of breeding Ivory Gulls suggest that, while parent birds may initially react to disturbance at about 100 m (Birkenmajer 1969), they often settle quickly and continue to incubate while humans are close (COSEWIC 2006). Consequently, the sensitivity of breeding Ivory Gulls to disturbance needs to be assessed further to ensure that disturbance effects can be avoided or minimized.

Ivory Gulls have shown sensitivity to capture, handling and tagging by researchers. For example, all 12 adults tagged and released on Seymour Island, Nunavut, in June 2010 abandoned their breeding attempt for that year, but returned to the colony for the next breeding season (Spencer *et al.* 2014).

Limiting Factors

Limiting factors are generally not human-induced and include intrinsic characteristics that make the species less likely to respond to conservation efforts. Limiting factors may become threats if they result in population decline.

The main limiting factor for the Ivory Gull is its relatively low productivity, due to its small clutch size (1–2 eggs), strategy of intermittent breeding, and high likelihood of abandoning colonies during years with poor nesting conditions (Mallory *et al.* 2020). The extreme and variable nature of the species' environment—with the associated likelihood of unsuitable sea-ice extent or adverse weather during any given breeding season—often results in missed or abandoned breeding attempts, likely limiting both the species' annual reproductive success (Yannic *et al.* 2014; Mallory *et al.* 2020) and its ability to rebuild depressed breeding numbers.

POPULATION SIZES AND TRENDS

Data Sources, Methods, and Uncertainties

Historical surveys:

Prior to 2002, 33 Ivory Gull colonies were known to exist in Canada, based on information largely collected from literature reviews and interviews with scientists and Inuit (Thomas and MacDonald 1987; Mallory *et al.* 2003). Over 45 years, geologists flying by helicopter discovered most of the inland colonies, including 14 on Ellesmere Island south of Makinson Inlet, 14 on the Brodeur Peninsula of northern Baffin Island, four on Devon Island, and one on Seymour Island (Gilchrist pers. comm. 2021; Table 2).

2002–2006 Surveys:

A comprehensive effort to survey nesting colonies in Canada in July was undertaken from 2002 to 2006, or five consecutive years (Gilchrist and Mallory 2005; Robertson *et al.* 2007). These surveys were carried out in response to concerns expressed by Inuit in four Nunavut communities that Ivory Gull numbers appeared to be declining, based on their observations during the spring and fall migration periods (Mallory *et al.* 2003). The survey goals were to revisit as many previously known colony sites as possible and to provide updated estimates of abundance and population trends.

The aerial survey team for the 2002–2005 surveys consisted of two biologists and the pilot of the Bell LongRanger 206L helicopter. Coordinates of previously known colony sites were entered in the helicopter's GPS-based navigation system in advance. Areas of suitable habitat (e.g., gravel islands, cliffs and nunataks) within 10–20 km of each historical colony site were also investigated to determine whether Ivory Gulls were nesting nearby. Information on the use of adjacent areas was utilized to assess whether changes in numbers of birds detected at colonies may have resulted from colony redistribution (including the establishment of new colonies), changes in the overall number of nesting birds, or both. In addition to the known colony sites, crews surveyed more than 300 alternative sites on Devon and Ellesmere islands (Gilchrist and Mallory 2005). Surveys followed methods used previously and, since colonies on Devon and Ellesmere islands were located on vertical cliffs where survey crews were unable to land to conduct ground counts, individual gulls in these colonies were counted from the hovering helicopter.

In 2003, additional flights were undertaken to search for new colonies on the Brodeur Peninsula of Baffin Island using a fixed-wing DHC-6 Twin Otter aircraft, with a survey crew of two biologists and a pilot and co-pilot. Eight aerial transects were flown across the peninsula at intervals of approximately 3' latitude (roughly 5 km), an altitude of 120–150 m and a ground speed of 200 km/h. The three previously unreported colonies discovered were revisited the next day by helicopter, enabling the crew to land and assess the number of nesting Ivory Gulls using binoculars.

In 2003, 2004 and 2005, 16 small islands along the Penny Strait polynya, near Seymour Island, were also surveyed, although no Ivory Gulls were detected there (Mallory and Gilchrist 2003; Mallory and Gilchrist unpubl. data).

In 2006, the range of surveys was expanded in response to favourable weather conditions and the availability of additional flying hours. Known Ivory Gull colonies and additional areas north of Makinson Inlet on Ellesmere Island were surveyed by helicopter, allowing seven new colonies to be discovered, including a sizable colony with 200 birds present (Robertson *et al.* 2007).

Aerial search efforts from 2002 to 2006 encompassed all previously known colony sites and considerable areas of additional suitable habitat, where several new colonies were discovered. The survey area included about 80% of all the known nunataks on southeastern Ellesmere Island and Devon Island, and 50–60% of the area of the Brodeur Peninsula on Baffin Island (Gilchrist and Mallory 2005; Robertson *et al.* 2007).

2009 Survey:

All regions (except the Brodeur Peninsula) were surveyed by helicopter in 2009, following the protocols described above. The survey team revisited three previously known colony sites on Devon Island, one on Seymour Island, and 40 on Ellesmere Island, including those found north of Makinson Inlet in 2006 (Gilchrist and Mallory unpubl. data).

2019 Survey:

The 2019 survey benefited from ideal weather conditions and fuel caches strategically placed in advance by the Polar Continental Shelf Project. The crew also used an iPad mounted on the dash of the helicopter and linked directly to its GPS. Locations of historical colonies were entered in the GPS in advance, and the flight software calculated the most efficient order in which to visit colony waypoints in order to minimize flight duration and fuel consumption. These advances increased the efficiency, range and thoroughness of the survey relative to previous years (Gilchrist pers. comm. 2020).

The 2019 survey was the most extensive to date, covering 46 previously known colony sites and discovering 4 new colonies on Ellesmere Island north of Makinson Inlet (Table 2; Gilchrist and Mallory unpubl. data). The areas covered included 5 colony sites on Devon Island, 1 on Seymour Island, 1 on Cornwallis Island, 5 on the Brodeur Peninsula of Baffin Island, and 38 on Ellesmere Island.

Estimating abundance:

A conservative approach was taken in developing a current estimate of the abundance of the Canadian breeding assemblage. A minimum estimate was obtained by counting the number of adult Ivory Gulls present at all previously known and new nesting colonies visited during the 2019 aerial surveys. It is assumed that every adult bird counted represents a nest and therefore a breeding pair of two mature individuals, as nests are generally attended by only one member of the pair while the mate is away from the colony, presumably foraging or roosting (Mallory *et al.* 2020). As in 2009, only two Ivory Gulls were recorded in 2019 at the site of the former large colony on Seymour Island. It is assumed that the gulls formerly breeding there were dead, alive but dispersed among other nesting sites that were counted in 2019, or alive but had elected not to breed that year and were therefore not counted.

Although survey searches were undertaken for other known and potential colony sites in 2019, additional adult Ivory Gulls may still exist in Arctic Canada at undetected colonies or may have been absent from surveyed colony sites after abandoning nesting attempts or skipping breeding during the survey year. On the basis of expert opinion, an additional 10% was added to the minimum estimate to provide a "best" estimate that accounts for those individuals breeding at colonies missed during the 2019 survey, and 15% to provide a realistic range (Gilchrist pers. comm. 2020). A similar method of extrapolating population estimates from colony counts has been used in the past for the species in Canada (e.g., Gilchrist *et al.* 2005; COSEWIC 2006). Similar methods and assumptions have been also used in assessing the results of recent surveys in Greenland (Boertmann *et al.* 2020), Russia and Svalbard (Strøm *et al.* 2020).

Abundance

The comprehensive 2019 survey revisited 46 of 61 previously known colony sites (75.4%) and many adjacent areas (with four previously unknown colonies detected), counting a total of 978 breeding individuals (Table 2). As these surveys were conducted under ideal flying and visibility conditions, there was a high probability of detecting all gulls present at these sites. At 13 of the 15 remaining colony sites not visited in 2019, gulls had not been detected on any visits since 1982–1983 (Table 2).

The minimum estimate of the current Ivory Gull breeding assemblage in Canada is 1,956 mature individuals, equal to twice the number of individuals observed at colonies in 2019. A best estimate is about 2,152 mature individuals, calculated by adding 10% to account for breeding individuals that may have been missed during the 2019 survey. A plausible range of 1,950–2,250 mature individuals in the Canadian breeding assemblage is obtained by rounding the values of the initial estimate and a maximum 15% greater.

Fluctuations and Trends

During the 1980s, the eastern Canadian Arctic was thought to have supported a breeding population of at least 1,200 pairs of Ivory Gulls, equivalent to at least 2,400 mature individuals (Thomas and MacDonald 1987), although the survey effort at that time was far less than from 2002 onwards (Table 2). This is equivalent to about 20–30% of the estimated global Ivory Gull breeding population at the time, and included several colonies of global importance (Haney and MacDonald 1995).

Colony surveys conducted from 2002 to 2005 detected an annual maximum of 402 individuals (Table 2; Gilchrist and Mallory 2005), and no gulls were present at 25 historical colony sites during this period, including a significant site on the Sydkap Glacier on southern Ellesmere Island that had previously supported 287 birds (Figure 4; COSEWIC 2006). On the basis of slightly different colony count totals obtained by Gilchrist and Mallory (2005), COSEWIC (2006) provided a Canadian breeding population estimate of 500–700 mature individuals, accounting for some individuals not counted in surveys. This suggested an overall decline of about 75–80% over the previous 18-year period, with an average annual rate of decline of approximately 8.4% relative to the published historical estimates of breeding numbers at the same sites (Table 2; Thomas and MacDonald 1987; COSEWIC 2006). Surveys undertaken from 2006 on have confirmed that none of the colonies recorded as abandoned during 2002–2005, regardless of whether they were located on nunataks or gravel plateaus, have been reoccupied (Table 2, Figure 4; Gilchrist and Mallory unpubl. data.).

Surveys in 2006, 2009 and 2019 have confirmed that all historical breeding sites on Devon Island and the Brodeur Peninsula of Baffin Island, and most of those on southern Ellesmere Island (i.e., in the southern portion of the species' breeding range in Canada), have now also been abandoned (Table 2; Figures 2 and 4). The number of birds nesting on Seymour Island, formerly the largest known Ivory Gull colony in Canada, has declined to the point that the colony may no longer be viable (Table 2). Twelve incubating gulls were tagged by researchers at Seymour Island in 2010, although the size of the colony was not reported, and visits by satellite-tagged birds during the breeding period in 2011 suggest that the colony was active then (Spencer *et al.* 2014). However, only two Ivory Gulls (likely equivalent to two pairs) were observed there during each of the most recent surveys (2009 and 2019; Table 2, Figure 6; Gilchrist and Mallory unpubl. data.). Together, these southernmost colonies had formed the stronghold of the known Canadian breeding assemblage.

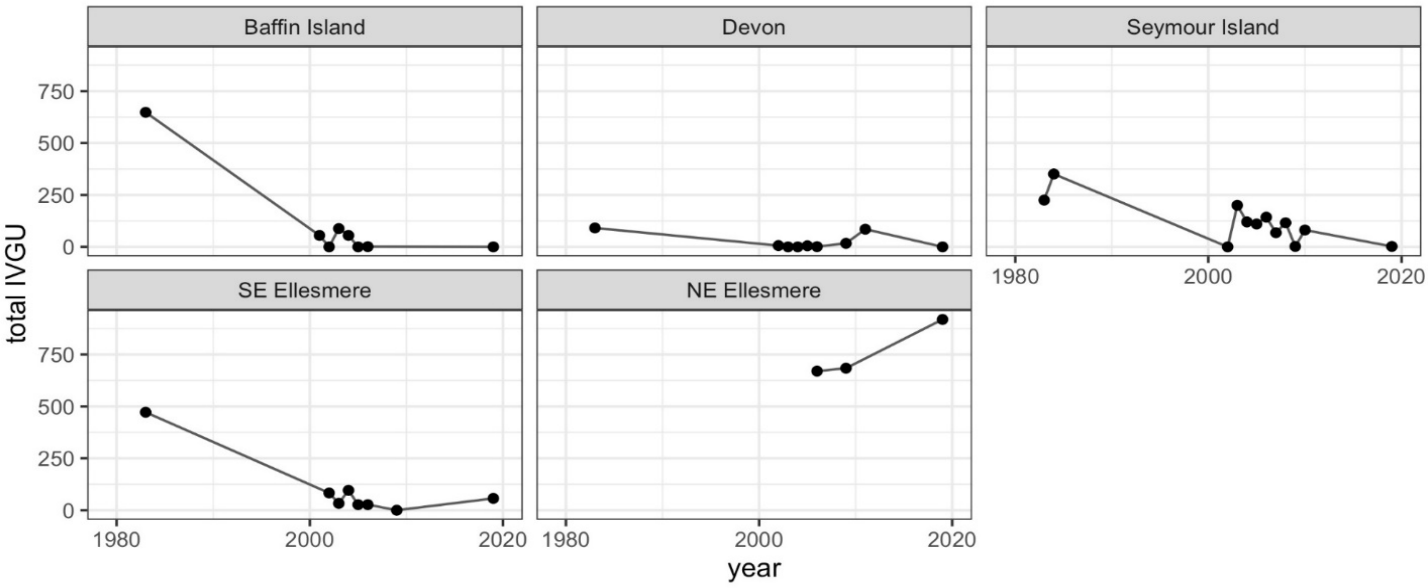

Figure 6. Number of adult Ivory Gulls counted in Canadian colonies surveyed from 1980 to 2019, based on aerial survey data and presented by survey region (Gilchrist and Mallory unpubl. data). The trend for Ellesmere Island is presented in two panels: the SE Ellesmere panel indicates the trend for the historically known colonies south of Makinson Inlet, and the NE Ellesmere panel, the trend for the recently discovered colonies north of Makinson Inlet, some of which were first discovered (and counted) in 2019.

Despite the abandonment of these colonies, the overall number of Ivory Gulls counted in recent years is higher than historically reported (Table 2). Most of these birds were found at the newly discovered colonies on Ellesmere Island, north of Makinson Inlet. During these three surveys, 697, 684 and 931 individuals were counted in the surveyed portions of this northern area, respectively, while numbers recorded at historical nesting sites farther south continued to decline (Figure 6). All colonies known from the 1970s, when breeding surveys began, have now disappeared, or nearly so in the case of Seymour Island.

A challenge in interpreting these trends in the Ivory Gull population is in determining whether the colonies recently discovered on Ellesmere Island north of Makinson Inlet were present, but undetected, during earlier survey periods, since this region was not surveyed prior to 2006. It is unknown at this point whether the geologists who discovered the Ivory Gull colonies on Devon Island and Ellesmere Island in the 1970s and 1980s had also surveyed inland areas north of Makinson Inlet and found no colonies, or whether Ivory Gulls may have been breeding there undetected (Gilchrist pers. comm. 2021, 2023). Given the extreme remoteness of these isolated far northern sites, which are located many kilometres from the coast, it is likely that colonies could indeed have existed there in past decades.

An indication of the age of the newly discovered colonies may be provided by the vegetation at the colonies. Although most nunataks are nutrient poor and largely unvegetated, nutrients from the excrement deposited by nesting seabirds, especially nitrogen and phosphorous, enable the growth of nitrophilous lichens and other vegetation that can tolerate the high nutrient concentrations in seabird colonies (Olech 1990). As most of these "ornithocoprophilous" lichens are a vivid orange or yellow, in contrast to other dull-coloured polar lichens (Olech 1990), they are readily noticeable on bare rock faces and slopes in seabird colonies. Observations by colony surveyors in 2019 of coprophilous lichens and other ground vegetation at some colonies north of Makinson Inlet (Gilchrist pers. comm. 2021, 2023) suggest that some of these colonies have probably been established for a fairly long time. However, it is unknown how long it may take these relatively slow-growing lichens to develop substantial growth visible from the air.

The increase in the minimum estimate of the Canadian Ivory Gull breeding assemblage from 500 mature individuals in 2005 (COSEWIC 2006) to 1,956 mature individuals in 2019 likely primarily reflects the expanded search effort (see **Table 2**), which identified several sizable and previously unknown colonies in the portion of the search area that had not been surveyed prior to 2006 (Gilchrist pers. comm. 2021). This interpretation is supported by the above evidence that many of these may be long-established colonies. However, since it is conceivable that some of the increase in the number of birds counted may reflect an actual increase in abundance, it is not possible to conclude whether the size of the Canadian Ivory Gull breeding assemblage is declining, stable or increasing overall. While historical estimates put the number of mature individuals at 2,400 in the 1980s (Thomas and MacDonald 1987), the actual number may well have been higher, if the Ivory Gull was breeding undetected on eastern Ellesmere Island at that time.

The 2019 surveys show a clear and dramatic range contraction northward to eastern Ellesmere Island, where almost all of the known Canadian breeding assemblage is now located (Figures 1 and 7). The Ivory Gull appears to have abandoned virtually all of the southern and western portions of its historical Canadian breeding range, retreating north and east to a few small pockets of suitable nesting habitat on nunataks close to a single foraging area, the North Water Polynya, where several colonies were first discovered in the expanded 2019 survey. Ellesmere Island likely now supports the only stable Ivory Gull breeding colonies remaining in Arctic Canada. If the colony on the gravel plateau on Seymour Island is no longer extant, all known colonies are now located on nunataks and cliffs in the glaciated portion of Ellesmere Island.

Population Fluctuations, Including Extreme Fluctuations

The size of the Canadian breeding assemblage of the Ivory Gull does not fluctuate widely, although the number of mature individuals attempting to breed in any given year may vary appreciably, likely in response to predation risk or adverse sea-ice or weather conditions prior to or during the breeding season (Mallory *et al.* 2020).

Severe Fragmentation

Although adult Ivory Gulls exhibit considerable colony-site fidelity (Mallory *et al.* 2012; Spencer *et al.* 2014), individuals frequently abandon existing colonies and move to new ones (Mallory *et al.* 2020; Gilchrist pers. comm. 2021). This ability to move among colony sites, the long foraging trips undertaken by breeding birds, and the species' long but flexible migratory routes, indicate that the Ivory Gull can readily move among available habitat patches.

Rescue Effect

Ivory Gull breeding colonies in other Holarctic countries provide potential source populations for rescue (Figure 1; Table 1), as the global population of the species is considered to be a genetically homogeneous metapopulation, with little internal population structure (Royston and Carr 2016; Charbonnel *et al.* 2022) and a high degree of connectivity across the global range (Yannic *et al.* 2016b), with the possible exception of the far-eastern Russian colonies.

The closest Ivory Gull population to the Canadian colonies breeds at least 1,000 km to the east, in northeastern and eastern Greenland (Figure 1); it is estimated to consist of 2,000–2,500 breeding pairs and to be relatively stable, at least over the past decade (Table 1; Gilg *et al.* 2009; Boertmann *et al.* 2020). Unusual weather events in Greenland, especially heavy rainstorms, are known to have caused complete breeding failure in some years (Yannic *et al.* 2014). The next closest breeding population, about 1,500–2,000 pairs nesting on the Svalbard archipelago (Norway), has shown a declining trend overall between 2006 and 2019 (Table 1; Strøm *et al.* 2020). The more distant Russian colonies appear to support a relatively large, quite stable population (3,500–7,000 pairs; Birdlife International 2018), although colony abandonments and breeding failures have been noted there in recent years (Gavrilo and Martynova 2017). In addition, Ivory Gulls nesting in the eastern Russian colonies may be genetically separate from Canadian birds (Royston and Carr 2016), and likely use a different wintering area in the North Pacific and the Bering Sea (Strøm *et al.* 2019).

Therefore, the probability of a recruiting population being available seems low, although Ivory Gulls that nest in the Eurasian colonies are known to winter in Davis Strait, within ~1,000 km of the species' current Canadian breeding grounds (Gilg *et al.* 2010). However, the marked decline in the quality and extent of the species' main ice-edge foraging habitat in Canada suggests that rescue from Greenlandic or Russian populations is unlikely, as immigrants would be subject to the same deteriorating habitat conditions that currently impact the Canadian breeding assemblage.

THREATS

Historical, Long-term, and Continuing Habitat Trends

The Ivory Gull is a pack-ice specialist, spending much of its time foraging among densely packed ice pans during the breeding season, in migration and throughout the winter (Spencer *et al.* 2014, 2016; Gilg *et al.* 2016). The extent and thickness of Arctic Sea ice and the amount of multi-year ice have been in decline for several decades (Serreze and Meier 2018), and those declines are predicted to accelerate (Holland *et al.* 2006). This may result in open water year-round in much of the Canadian Arctic by 2050 (Stephenson *et al.* 2011). Forecasting models suggest that sea ice will likely continue to thin and retreat and, by mid-century, dense sea ice will be restricted to the area around the main islands in the archipelago north of Lancaster Sound and Barrow Strait (e.g., Queen Elizabeth Islands, Ellesmere Island and Devon Island) (Sou and Flato 2009). Continued declines in sea-ice extent may require the Ivory Gull to expend greater foraging effort, with increased energetic costs due to the longer foraging times and greater flight distances, or to concentrate at even more northerly colony sites. This could contribute to continuing distributional changes, range reductions and population declines.

Current and Future Threats

The Ivory Gull is vulnerable to the cumulative effects of various threats, categorized below and in Appendix 1, following the IUCN-CMP (International Union for the Conservation of Nature – Conservation Measures Partnership) unified threats classification system (based on Salafsky *et al.* 2008). The evaluation assesses the impacts on the Canadian breeding assemblage of the Ivory Gull, for each of 11 main categories of threats and their subcategories, based on the scope (proportion of population exposed to the threat over the next 10-year period), severity (predicted population decline among those exposed to the threat, during the next 10 years or three generations, whichever is longer), and timing of each threat (Appendix 1). An overall threat impact of Very High - High was calculated by considering the separate impacts of all threat categories (Appendix 1). Threats are discussed below in order of decreasing severity of impact (greatest to least). Three threats of negligible impact (6.3 Work & Other Activities; 9.2 Industrial & Military Effluents; and 9.4 Garbage & Solid Waste) are not discussed here, but are noted in Appendix 1.

<u>IUCN 11. Climate Change & Severe Weather</u>

11.1 Habitat Shifting & Alteration (High - Medium impact)

Arctic Canada continues to warm rapidly and, since 1979, the volume of Arctic Sea ice has declined by up to 75% in some months, altering many of the fundamental characteristics of Arctic ecosystems (AMAP 2019). The overall impacts of changes in marine and ice conditions and prey availability on the Ivory Gull are unknown. However, the relatively sudden decline in the species' abundance in the southern part of its Canadian breeding range between the 1980s and the early 2000s (Gilchrist and Mallory 2005), and the recent significant contraction of the breeding range towards the northeast (Gilchrist and

Mallory unpubl. data; Figure 4), appear to be related to broad-scale alterations in the duration, extent and quality of sea-ice habitat (AMAP 2019). Due to the Ivory Gull's heavy year-round reliance on ice-dominated habitats and ice edges (Spencer *et al.* 2014), the species appears to be extremely vulnerable to changes in habitat and prey availability linked to long-term increases in sea-surface temperatures, declines in sea-ice cover and other widespread impacts of climate change (Gilg *et al.* 2016). Given the impact and broad implications of climatic disruptions on Arctic ecosystems across the species' range, particularly the decline in the duration and extent of sea ice, climate change is thought to be the most serious threat to the persistence of the Ivory Gull (Gilg *et al.* 2008).

Ivory Gulls appear to have abandoned the Canadian colonies previously associated with the Lancaster Sound, Queens Channel/Penny Strait and Jones Sound/Lady Ann Strait polynyas (Gilchrist pers. comm. 2021), presumably due to changes in food availability in these water bodies, which are linked to changes in ice and oceanographic conditions. All remaining Canadian breeders likely rely now on the North Water Polynya. As very little suitable unoccupied nesting habitat appears to be present on northern Ellesmere Island to support the movement of breeding birds farther northward (Gilchrist pers. comm. 2021), climate-related habitat shifting may pose a very significant threat to the persistence of breeding by Ivory Gulls in Canada. However, the probable impact of climate-related habitat shifts on the Canadian breeding assemblage is uncertain, which is reflected in the severity score of Moderate - Serious.

11.4 Storms & Flooding (Low impact)

Increasing humidity and precipitation are important consequences of climate change in the Arctic (AMAP 2019). The increasing frequency and intensity of heavy summer rainstorm events in much of the Arctic poses a threat to colonies of this ground-nesting species, due to the risk of erosion and the flooding of its nests. Ivory Gull colonies in North Greenland have been completely abandoned during severe weather events involving exceptionally strong winds and extended periods of heavy rain (e.g., July 2009, 2011), with a consequent loss of productivity during those years (Yannic *et al.* 2014). However, the flooding risk is highest for gulls nesting on flat gravel sites, which are likely no longer occupied in Canada, although storms may also have significant effects on the nesting sites on cliffs currently in use on Ellesmere Island.

<u>IUCN 6. Human Intrusions & Disturbance</u>

6.1 Recreational Activities (High - Low impact)

The Ivory Gull is easily disturbed in its colonies and is more likely than other gull species to abandon a colony due to disturbance rather than to mount a collective aggressive response to intruders (Haney and MacDonald 1995). Although subsistence hunters may occasionally pass by colonies on snowmobiles or off-road vehicles, the species' breeding sites are remote, and disturbance due to such recreational activities is likely extremely rare.

However, with the ongoing decrease in the extent of summer sea ice in Baffin Bay and Davis Strait (AMAP 2018b), the remaining known colonies on Ellesmere Island are now readily accessible by helicopter from cruise ships. This puts these colonies at risk of disturbance due to the current demand for High Arctic tourism, which is anticipated to increase. The consequences of repeated visits by tourists near colonies are uncertain but may include reduced or lost annual productivity at the colony visited, or temporary or permanent colony abandonment, potentially involving a substantial portion of the Canadian breeding assemblage (Gilchrist pers. comm. 2021). Although Nunavut government regulations are intended to control visitation, the Ivory Gull's great sensitivity to disturbance makes the threat posed by ecotourism a significant concern, although one that could be mitigated by appropriate regulation and effective enforcement.

IUCN 9. Pollution

9.5 Air-Borne Pollutants (Medium - Low impact)

Contaminants, such as persistent organic pollutants (POPs) and mercury, bioaccumulate in the marine food web and can have serious effects on wildlife, including decreased fitness, reduced fecundity and direct mortality (AMAP 2018a). The Ivory Gull has a relatively high trophic position in the Arctic food web (Karnovsky *et al.* 2009) due to its habit of scavenging marine mammal carcasses (Mallory *et al.* 2020), and is exposed to high levels of contaminants. The deposition of airborne contaminants is particularly high in the Arctic as a result of atmospheric transport and lower temperatures, and the Ivory Gull's exclusively Arctic distribution makes it more inherently vulnerable to contamination (AMAP 2018a).

Ivory Gulls have the highest recorded mercury levels in their eggs among all Arctic bird species (Braune *et al.* 2006), and Canadian breeders have the highest levels across the species' global range (Miljeteig *et al.* 2009; Lucia *et al.* 2015). Concentrations of methylmercury (the most toxic form of mercury) in Ivory Gull feathers increased by a factor of 45 over the past 130 years, while the gull's diet remained largely unchanged, suggesting an increased intake of anthropogenically derived environmental methylmercury (Bond *et al.* 2015). The deleterious effects of mercury on marine birds include reduced body condition and reproductive success, due to the lower likelihood of eggs hatching or chicks fledging (Goutte *et al.* 2014). Most mercury enters the environment as a result of human activities, especially the burning of coal (AMAP 2011). Unusually high mercury levels in the Canadian Arctic compared with other northern areas may result from the deposition of anthropogenic mercury from Asian air masses originating in China (AMAP 2011). Mercury levels in the Arctic are anticipated to remain high as global emissions continue to increase (Krabbenhoft and Sunderland 2013), so mercury uptake by the Ivory Gull is likely to persist or increase. Climate change is also expected to impact rates of mercury release in the Arctic, as warmer temperatures result in earlier thawing and increased glacial melt, in turn leading to increased river discharge, although the effects that rising temperatures and decreased sea-ice coverage will have on overall mercury bioavailability are uncertain (Stern *et al.* 2012).

Measurements of chlorinated and brominated compounds in Canadian Ivory Gull eggs from 1976 to 2004 showed that the levels of some compounds, such as polybrominated diphenyl ethers, increased over time, while those of many organochlorines remained the same or decreased; overall, this did not suggest lethal exposure (Braune *et al.* 2007). However, studies in Svalbard and the Russian Arctic have linked similar contaminants to a 7–17% decrease in eggshell thickness in the species since 1930 (Mijeteig *et al.* 2012). These values are close to the 16–20% threshold associated with declines in bird populations due to reduced reproductive success (Walker *et al.* 2001), suggesting that some Ivory Gull populations may be seriously threatened by contaminant-induced eggshell thinning.

Further study is required to better understand the cumulative effects of sublethal exposure to multiple contaminants. Overall, high levels of contaminants recorded in Ivory Gull tissues in Canada suggest that these substances may already play a role in reducing productivity or survival (Braune *et al.* 2006, 2007).

IUCN 3. Energy Production & Mining

3.1 Oil & Gas Drilling (Low impact)

Chronic oil pollution is a significant conservation concern affecting marine birds in the eastern Canadian Arctic and northwest Atlantic (Wiese and Robertson 2004). In general, gulls are highly vulnerable to oil pollution (Camphuysen 1998), with its short-term effects including mortality from feather fouling, which compromises birds' waterproofing and thermoregulation abilities (O'Hara and Morandin 2010; Horak *et al.* 2020), and its longer-term effects including altered physiology and reduced body condition from sublethal exposure (Alonso-Alvarez *et al.* 2007). Most oil and gas exploration and production activities in Arctic Canada take place south of the Ivory Gull's breeding and wintering ranges, although these activities are currently underway in the waters off West Greenland (AMAP 2018b), which are likely used by post-breeding birds from the Ellesmere Island colonies. Although there has been interest in oil and gas exploration in Lancaster Sound (AMAP 2018b), this area is now protected, as it is in the Tallurutiup Imanga National Marine Conservation Area. The quantitative impact of oil pollution on Ivory Gull wintering areas is unknown, but is likely relatively low, given the current marginal levels of petroleum exploration, with the severity of the threat considered Slight at most.

IUCN 5. Biological Resource Use

5.1 Hunting & Collecting Terrestrial Animals (Low impact)

The remoteness of the species' Canadian colonies greatly limits hunting opportunities during the breeding season, although the Ivory Gull has traditionally been shot by Inuit for food in spring and fall, primarily during migration along the west coast of Greenland (Stenhouse *et al.* 2004). Hunting appears to have declined in Canada, although some opportunistic harvesting by Inuit hunters likely still occurs in Greenland despite legal protection there (Mallory *et al.* 2020). Although current harvest levels are thought to be very low (Boertmann pers. comm. 2021), the fact that the Canadian breeding assemblage is concentrated in the Ellesmere Island colonies suggests that birds may be at some risk from hunting in Greenlandic waters, with the potential for slight impacts at the population level.

Number of Threat-based Locations

The most serious plausible threat to Ivory Gulls in the Canadian breeding assemblage appears to be ongoing shifts in habitat quality and prey availability resulting from climate-change-induced modifications to the duration, extent and quality of sea-ice habitat (AMAP 2019; see **Threats** above). The existence of colonies seems to be linked to the availability and quality of nearby polynyas, which provide essential access to productive ice edge and open water foraging habitats, beginning in May and June (Spencer *et al.* 2014). Since habitat shifts associated with the changing climate and diminishing sea-ice cover likely affect each polynya differently, Ivory Gulls from all the colonies using a single polynya are considered to make up a unique location.

At the time of the previous status report (COSEWIC 2006), Ivory Gull colonies in Canada were associated with at least four separate polynyas: the Lancaster Sound polynya (Brodeur Peninsula colonies on Baffin Island), Queens Channel/Penny Strait polynya (Seymour Island colony), Jones Sound/Lady Ann Strait polynya (Devon Island colonies) and the large North Water Polynya (Ellesmere Island colonies) (Michel 2013; Canadian Geographic 2021; Gilchrist pers. comm. 2021).

Surveys in 2019 identified active Ivory Gull colonies exclusively in a core breeding area on Ellesmere Island north of Makinson Inlet, with another small group south of Makinson Inlet, and two pairs on Seymour Island (Gilchrist and Mallory unpubl. data; Figures 4 and 7). Therefore, with the abandonment of the southern and westernmost colonies, the bulk of the Canadian breeding assemblage now nests on Ellesmere Island and relies on a single open water area or location within the High Arctic Sea ice: the North Water Polynya (Michel 2013; Gilchrist and Mallory unpubl. data). However, with the observed and projected freshening and warming of water and thinning of sea ice in associated Nares Strait/Smith Sound, the North Water Polynya is likely to experience reduced primary productivity (AMAP 2018b). If future surveys confirm that the Seymour Island colony is still active, this would result in two locations, as that colony is adjacent to the Queens Channel/Penny Strait polynya. Thus, the present number of locations is estimated to be 1–2, with an observed decline from at least four locations (polynyas) within the past 2–3 generations.

PROTECTION, STATUS, AND RECOVERY ACTIVITIES

Legal Protection and Status

The Ivory Gull was listed as Endangered in Canada in April 2006, under Schedule 1 of the *Species at Risk Act* (SARA) (2002) (Government of Canada 2019a) and is protected under the *Migratory Birds Convention Act, 1994* (Government of Canada 2017), which prohibits the harming of individual birds and the disturbance or destruction of nests and eggs.

The Ivory Gull is generally considered a species at risk across its range. It is protected in the United States under the *Migratory Bird Treaty Act* (USFWS 2017), and is listed as Vulnerable in Greenland (Boertmann and Bay 2018) and Norway (Henriksen and Hilmo 2015), and as Rare in Russia (Iliashenko and Iliashenko 2000). The IUCN considers the Ivory Gull to be Near Threatened at the global level (Birdlife International 2018).

A federal recovery strategy for the Ivory Gull in Canada, completed in 2014, identified research and conservation priorities for the species (Environment Canada 2014). An International Ivory Gull Conservation Strategy and Action Plan was developed in 2008 by the Circumpolar Seabird Group (CBird), a working group under the Arctic Council's Conservation of Arctic Flora and Fauna program (CAFF; Gilchrist *et al.* 2008).

Non-Legal Status and Ranks

The Ivory Gull is listed as Near Threatened globally by the IUCN (BirdLife International 2018). Globally, NatureServe considers it Apparently Secure (G4; Table 3; NatureServe 2020) and, in Canada, Critically Imperiled as both a breeder and a migrant (N1B, N1M, N1N; NatureServe 2020). At the provincial/territorial levels, the Ivory Gull is considered Critically Imperiled as both a breeder and a migrant in Nunavut (S1B, S1N, S1M); Critically Imperiled as a non-breeder and migrant in Newfoundland and Labrador (S1N, SUM); and Critically Imperiled as a non-breeder and Possibly Extirpated as a breeder in the Northwest Territories (S1N, SHB; NatureServe 2020). In the United States, it is considered Apparently Secure as a non-breeder at the national level (N4N) but, at the state level, Vulnerable (S3N) in Alaska and Unranked (SNRN) in New York State (NatureServe 2020).

Table 3. Conservation status of the Ivory Gull globally, in Canada, and in the United States (NatureServe 2020).

Global	G4[1]	Apparently Secure
Canada	N1B, N1N, N1M	Critically Imperiled
Newfoundland and Labrador	S1N, SUM	Critically Imperiled
Northwest Territories	SHB, S1N	Possibly Extirpated
Nunavut	S1B, S1N, S1M	Critically Imperiled
United States		
Alaska	S3N	Vulnerable

[1] At start of rank: G = Global; N = National; S = Subnational. At end of rank: B = Breeding; N = Non-breeding, M = Migrant. Rank: 1 = Critically Imperiled; 3 = Vulnerable; 4 = Apparently Secure.

[2] Listing as Endangered, Threatened, Special Concern (or equivalent designations) at a jurisdictional level

Land Tenure and Ownership

Seymour Island, which has hosted a large Ivory Gull colony since at least the 1970s, was designated a Migratory Bird Sanctuary in 1975 along with its surrounding waters, based largely on the presence of the Ivory Gull (Government of Canada 2019b), although that colony may no longer be extant (Gilchrist and Mallory unpubl. data). Seymour Island has also been designated a Key Marine Habitat Site in Nunavut (Mallory and Fontaine 2004) and is recognized by Birds Canada and BirdLife International as an Important Bird Area (IBA; NU045; Birds Canada 2020).

A number of areas in Nunavut where Ivory Gulls have been recorded are identified as IBAs. These include several past or potential breeding sites—Inglefield Mountains (NU014), Sydkap Ice Field (NU055), Cape Vera (NU053), Eastern Devon Island Nunataks (NU057), Northwestern Brodeur Peninsula (NU065), Southwest Bylot (NU013), and Cape Graham Moore (NU068)—and several sites used in fall, including Southwest Bylot, Cape Graham Moore, and Cape Hay (NU004; Birds Canada 2020). However, none of these IBAs currently support nesting Ivory Gulls. The species has also been recorded at two IBAs in Newfoundland and Labrador—Cape Freels Coastline and Cabot Island (NF025) in spring, and Quidi Vidi Lake (NF022) in winter (Birds Canada 2020). IBA designations do not formally protect the species or its habitat, although as a Schedule 1 SARA-listed species, Ivory Gulls and their nests are afforded protection against disturbance or harm.

Recovery Activities

The recovery strategy for the Ivory Gull in Canada (Environment Canada 2014) identified four population and distribution objectives: (1) secure and maintain population numbers on eastern Ellesmere Island at 2009 levels over a five year-average; (2) maintain the size of the Seymour Island colony at 100 birds; (3) maintain the presence of Ivory Gulls on Baffin, Cornwallis and Devon Islands; and (4) maintain the presence of wintering Ivory Gulls in Canadian waters, including Davis Strait, Baffin Bay and the coast of Labrador. Surveys undertaken in 2019 (Gilchrist and Mallory unpubl.) suggest that only the first and last objectives are currently being met.

Changing climatic conditions in the Arctic pose considerable risks to the Ivory Gull, but as Robertson *et al.* (2007) concluded, little can be done in the short term to mitigate their effects. Recent research has centred on the assessment of population trends and the population's status across the circumpolar breeding range, aimed at determining whether possible declines in the Canadian breeding assemblage are a result of regional threats or those impacting the global population.

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COLLECTIONS EXAMINED

No collections were examined for the preparation of this report.

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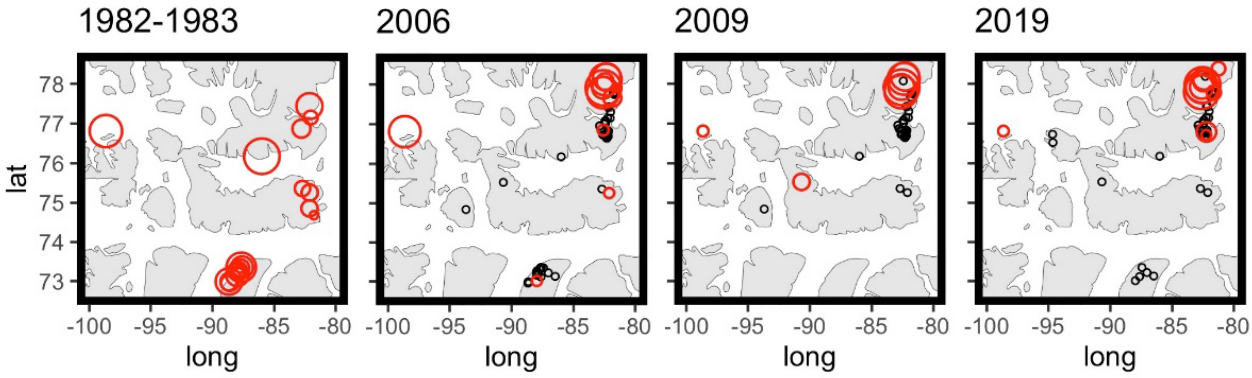

Figure 7. Distribution and relative size of Ivory Gull colonies visited in the Canadian Arctic during four survey periods, comparing the distribution of colonies in the 1980s with that found in more recent surveys (three) in 2006, 2009 and 2019 (Gilchrist and Mallory unpubl. data). Active colonies are shown as red circles, and inactive colonies visited are shown as black circles. The size of the red circles gives an indication of the relative number of birds observed at each colony.

BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Iain J. Stenhouse has studied avian ecology for 30 years, with most of those years focused on northern-breeding seabirds. During his doctoral and postdoctoral studies at Memorial University of Newfoundland, he spent a number of years in the Canadian Arctic carrying out research on Arctic-breeding gulls, including the Ivory Gull, and has published a series of papers on their behaviour and ecology. He served as a member of COSEWIC's Birds Specialist Sub-Committee from 2010 to 2017. He is currently the Director of the Arctic Program and the Marine Bird Program at the Biodiversity Research Institute, in Portland, Maine.

Edward Jenkins has conducted avian research in Australia, Canada, China, Israel, the United States and the United Kingdom, focusing on ecology and conservation. His experience working with threatened seabirds includes two years with the Department of Conservation in New Zealand, and one with BirdLife in Malta. Edward received his MSc in Biological Sciences from the University of Manitoba, where he studied the dietary niche dynamics of the seabird assemblage in northeastern Newfoundland. As an Avian Biologist with the Biodiversity Research Institute in Portland, Maine, Edward works on the songbird, marine bird, and renewable energy teams.

Appendix 1. Threats calculator table for the Ivory Gull

Species or Ecosystem Scientific Name	Ivory Gull (*Pagophila eburnea*)			
Element ID			**Elcode**	
Date (Ctrl + ";" for today's date):	2021-06-23			
Assessor(s):	Dwayne Lepitzki (facilitator), Iain Stenhouse (writer), Ed Jenkins (writer), Richard Elliot (Birds SSC Co-chair), Marie-France Noel (COSEWIC Secretariat), Amit Saini (COSEWIC Secretariat), Christian Artuso, Louise Blight, Dave Fifield, Marcel Gahbauer, Grant Gilchrist, Tara Imlay, Mark Maftei, Mark Mallory, Greg Robertson, Kyle Ritchie, Paul Smith			
References:	Draft threats calculator, draft status report.			
Overall, Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	2	0
	C	Medium	1	1
	D	Low	2	4
Calculated Overall Threat Impact:			Very High	High
Assigned Overall Threat Impact:				
Impact Adjustment Reasons:			No change	
Overall, Threat Comments			Generation time for the Ivory Gull is approximately 8 years, so time frame used for severity and timing is 24 years. All birds in the Canadian breeding assemblage nest in the High Arctic and winter in Davis Strait and the Labrador Sea. Population size is small (estimated 1,950–2,250 mature individuals), and breeding range has declined markedly in the last 20 years. Birds from all known colonies (with one possible small exception) are now believed to nest in cliff habitat on nunataks in extensive ice fields on Ellesmere Island, and use a single foraging area, the North Water Polynya, during breeding.	

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development						
1.1	Housing & urban areas						
1.2	Commercial & industrial areas						
1.3	Tourism & recreation areas						The limited infrastructure planned for new national parks and marine protected areas in Arctic Canada is not expected to affect the Ivory Gull.
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						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3	Energy production & mining	D	Low	Small (1–10%)	Slight (1–10%)	High (Continuing)	
3.1	Oil & gas drilling	D	Low	Small (1–10%)	Slight (1–10%)	High (Continuing)	Most oil and gas exploration and production activities in Canada occur south of the Ivory Gull's breeding and wintering range, but both take place in west Greenland waters likely used by post-breeding birds from Canadian colonies. Severity is uncertain, but likely to be Slight at most. Effects of oil spills are considered under **9.2 Industrial & Military Effluents**.
3.2	Mining & quarrying						Ongoing reduction in extent and duration of sea ice will increase human access to the Arctic, with likely increased mineral exploration and extraction, although mostly outside the ten-year period. Mining exploration was a past threat on Brodeur Peninsula and at other flat gravel nesting areas not currently used. Almost all Canadian Ivory Gulls now nest on Ellesmere Island, far north of current mining operations such as the Mary River iron mining project on Baffin Island.
3.3	Renewable energy						
4	Transportation & service corridors		Not a Threat	Large (31–70%)	Neutral or Potential Benefit	High (Continuing)	
4.1	Roads & railroads						
4.2	Utility & service lines						
4.3	Shipping lanes		Not a Threat	Large (31–70%)	Neutral or Potential Benefit	High (Continuing)	Ivory Gulls do not generally follow ships, but may be attracted to plankton and broken ice in a ships' wake. Most Ivory Gulls breeding in Canada migrate through Davis Strait, away from the Mary River Project shipping lane in Lancaster Sound. Effects of oil spills from shipping activities are considered under **9.2 Industrial & Military Effluents.**
4.4	Flight paths						There are no frequently used commercial or non-commercial Arctic air routes near areas used by the Ivory Gull, although overflights by mining companies may have contributed to the apparent abandonment of Seymour Island colony in past years.
5	Biological resource use	D	Low	Pervasive - Large (31–100%)	Slight (1–10%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	D	Low	Pervasive - Large (31–100%)	Slight (1–10%)	High (Continuing)	Hunting has declined over time in Canada, likely to negligible levels. Opportunistic harvesting by Greenlandic Inuit still occurs, although illegal and thought to be lessening. A small but significant proportion of the Canadian breeding assemblage is likely exposed, as Ivory Gulls from the Ellesmere Island colonies often migrate along the coast of Greenland and thus are at greatest risk.
5.2	Gathering terrestrial plants						

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
5.3	Logging & wood harvesting						
5.4	Fishing & harvesting aquatic resources						Arctic fisheries in wintering areas in Canadian waters have little effect on the Ivory Gull, which is not generally attracted to fishing vessels.
6	Human intrusions & disturbance	BD	High - Low	Large - Restricted (11–70%)	Serious - Moderate (11–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
6.1	Recreational activities	BD	High - Low	Large - Restricted (11–70%)	Serious - Moderate (11–70%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	The Ivory Gull is easily disturbed in colonies, and colony abandonment may result. The remote nature of its breeding sites has limited past disturbance. However, there is rapidly increasing interest in and opportunity for unregulated adventure tourism visits by helicopter to increasingly accessible Ellesmere Island colonies. This is a significant concern within the next 10 years, although the likely rate of increased exposure is unclear. Consequences of repeated tourism visits are also uncertain, but may result in reduced productivity or colony abandonment, possibly involving much of the Canadian breeding assemblage. Most negative impacts of tourism could be mitigated by appropriate regulation and effective enforcement.
6.2	War, civil unrest & military exercises						
6.3	Work & other activities		Negligible	Pervasive (71–100%)	Negligible (<1%)	High (Continuing)	Industrial work and other activities near colonies or foraging areas may degrade habitat, and cause noise and other disturbance, although no industrial activity has been noted near current colonies. Most remaining colonies are on nunataks in large icefields well away from anticipated work areas. It is unclear how the Ivory Gull may react to low-flying aircraft or other industry-related transportation activities. Disturbance from helicopter surveys by researchers (scored here) generally occurs only briefly, and about once per decade, and is managed to minimize impacts on productivity, colony placement and survival.
7	Natural system modifications						
7.1	Fire & fire suppression						
7.2	Dams & water management/use						
7.3	Other ecosystem modifications						Human activities that modify habitats in breeding or wintering areas, other than those related to climate change and considered under **11.1 Habitat Shifting & Alteration**, are unlikely to affect Ivory Gull or its food resources.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes						
8.1	Invasive non-native/alien species/diseases						
8.2	Problematic native species/diseases						Ivory Gull adults, chicks and eggs at isolated cliff-nesting sites are at risk of predation by aerial predators, such as Glaucous Gull, Common Raven and jaegers, although such predation likely occurs at natural levels. Risk of predation by Polar Bear at flat gravel coastal sites may be enhanced as a consequence of human-induced climate change, but as such nest sites are generally no longer in use in Canada, this additional risk is considered insignificant and is not ranked.
8.3	Introduced genetic material						
8.4	Problematic species/diseases of unknown origin						
8.5	Viral/prion-induced diseases						
8.6	Diseases of unknown cause						
9	Pollution	CD	Medium - Low	Pervasive (71–100%)	Moderate - Slight (1–30%)	High (Continuing)	
9.1	Domestic & urban waste water						
9.2	Industrial & military effluents		Negligible	Negligible (<1%)	Extreme (71–100%)	High (Continuing)	Ivory Gulls nesting in Canadian High Arctic colonies are not currently exposed to oil spills, although shipping traffic near foraging areas used by birds from known colonies may increase with future climate warming. Ivory Gulls from Canadian colonies wintering in the Labrador Sea may be at very slight risk to spills from ships servicing coastal communities and mining operations in northern Labrador and Baffin Island, and offshore oil and gas platforms on the northern Grand Banks, although most Ivory Gulls occur north of these areas.
9.3	Agricultural & forestry effluents						
9.4	Garbage & solid waste		Negligible	Large - Restricted (11–70%)	Negligible (<1%)	High (Continuing)	Although unstudied in the Ivory Gull, threats posed by plastic pollution may be increasing as shipping activities increase in the Canadian Arctic. Surface-feeding Ivory Gulls may mistake small plastic debris on the surface of Arctic marine waters for prey items. As there is no evidence that microplastics impact the health of gulls in general and larger plastics are regurgitated by most gull species, severity is expected to be negligible.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
9.5	Air-borne pollutants	CD	Medium - Low	Pervasive (71–100%)	Moderate - Slight (1–30%)	High (Continuing)	Ivory Gull eggs contain high levels of mercury, and methylmercury levels in feathers have increased by a factor of 45 over 130 years. Polybrominated diphenyl ethers increased in Canadian Ivory Gull eggs from 1976 to 2004, and studies have linked similar contaminants to a decrease of 7–17% in Ivory Gull eggshell thickness since 1930. Many airborne contaminants persist in the Arctic at levels likely to cause sublethal effects. Severity is scored as Moderate - Slight, as it is very likely that these high contaminant loads have some effect in reducing Ivory Gull productivity or survival in Canada.
9.6	Excess energy						
10	Geological events						
10.1	Volcanoes						
10.2	Earthquakes/tsunamis						
10.3	Avalanches/landslides						
11	Climate change & severe weather	BC	High - Medium	Pervasive (71–100%)	Serious - Moderate (11–70%)	High (Continuing)	
11.1	Habitat shifting & alteration	BC	High - Medium	Pervasive (71–100%)	Serious - Moderate (11–70%)	High (Continuing)	The relatively sudden decline in Ivory Gull abundance between the 1980s and the early 2000s, and the recent contraction of the breeding range towards the northeast and the abandonment of colonies in three polynya systems, likely result from broad-scale climate-related alterations to High Arctic habitats. The mechanisms for these changes are unclear, but are likely related to shifts in timing, magnitude and quality of food availability, increasing sea surface temperatures, and changes in the duration, extent and quality of sea-ice habitat. As there is little suitable unoccupied nesting habitat on Ellesmere Island to support the northward movement of colonies, climate-related habitat shifting appears to be a very significant threat to the persistence of Ivory Gulls in Canada. All Canadian breeders now likely rely on the North Water Polynya at certain times of year, while now-abandoned colonies previously used four polynyas. The range of severity scores reflects uncertainty in the likely effect of climate-related habitat shifts on the population.
11.2	Droughts						
11.3	Temperature extremes						Although some Low Arctic gull species respond to unusually high temperatures by abandoning nests, this effect has not been observed in Ivory Gulls. The shift from nesting on gravel plains to using cliff sites may reduce the risk posed by extreme temperatures.

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
11.4	Storms & flooding	D	Low	Restricted - Small (1–30%)	Moderate - Slight (1–30%)	High (Continuing)	Increasing frequency and intensity of heavy Arctic rainstorm events pose a threat to the Ivory Gull, through flooding and destruction of nests. Colonies on gravel sites in North Greenland have been abandoned following storms with exceptionally strong winds and rain, with loss of productivity that year. Flooding risk is highest for birds nesting on flat gravel sites, which are likely no longer occupied in Canada, while storms may have significant effects on remaining cliff sites.
12	Other impacts						
Classification of Threats adopted from IUCN-CMP, Salafsky *et al.* (2008).							