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Short communication

Declines in abundance and distribution of the ivory gull (*Pagophila eburnea*) in Arctic Canada

H. Grant Gilchrist [a,*], Mark L. Mallory [b]

[a] *Canadian Wildlife Service, Prairie and Northern Region, National Wildlife Research Centre, 1125 Colonel By Drive, Raven Road, Carleton University, Ottawa, Ont., Canada K1A 0H3*
[b] *Canadian Wildlife Service, Prairie and Northern Region, Box 1714, Iqaluit, Nunavut, Canada X0A 0H0*

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Abstract

The ivory gull (*Pagophila eburnea*) is a seabird that inhabits Arctic oceans throughout the year, often in association with polar pack ice. It is rare (<14,000 breeding pairs globally) and remains one of the most poorly known seabird species in the world. Canada supports breeding populations of international significance, and residents of communities in the Canadian High Arctic currently observe fewer ivory gulls than they did in the 1980s. However, no population trend data existed for this species in Canada prior to this study. We initiated aerial surveys in July 2002 and 2003 of most known ivory gull colonies in Canada to assess current population levels. Forty two colonies were visited, 14 of which were new discoveries. We recorded an 80% decline in numbers of nesting ivory gulls. Several of the largest known colonies were completely extirpated and those that remained supported significantly fewer nesting birds than previously observed. Results were similar in both years despite some differences in local sea ice conditions, suggesting a numerical decline in the population and not simply annual fluctuations in colony occupation. Declines have occurred in all habitat types and across the known Canadian breeding range, suggesting that causes of the decline may be related to factors occurring during migration or on wintering grounds. We recommend that international efforts now be directed at assessing population status and trends of this species in other circumpolar countries.

1. Introduction

Marine birds are effective indicators of the health of marine ecosystems (Cairns, 1987; Nettleship and Duffy, 1993), and in the Arctic, these ecosystems appear to be changing (Etkin, 1990; Stern and Heide-Jørgensen, 2003). Fluctuations in marine bird populations or breeding success often signify shifts in the physical or biological characteristics of marine environments (e.g., Furness and Nettleship, 1991). While some of these changes have been observed in marine birds with large populations (e.g., Gaston, 2003; Montevecchi and Myers, 1997), the effects on species with small populations are more poorly known and of greater conservation concern. For example, the ivory gull (*Pagophila eburnea*) is an uncommon species that feeds in association with sea ice throughout the year (Haney and Macdonald, 1995; Stirling, 1997), and it may be particularly sensitive to changes in sea ice cover known to be occurring in Arctic oceans (Etkin, 1990; Roots, 1989; Vinnikov et al., 1999). Moreover, both its population size and distribution in North America appear to have been shrinking since the late 1800s (Haney and Macdonald, 1995).

The ivory gull is a small, pure white gull that spends the entire year in circumpolar marine environments. Compared to other marine birds, little is known about this species (Haney and Macdonald, 1995). Canada was thought to support approximately 6–10% of the global breeding population (14,000 pairs; Anker-Nilssen et al., 2000), representing nesting colonies of continental and international importance. The ivory gull was assigned

* Corresponding author.
E-mail addresses: grant.gilchrist@ec.gc.ca (H. Grant Gilchrist), mark.mallory@ec.gc.ca (M.L. Mallory).

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"Vulnerable" status in Canada because of its rarity (<2000 pairs breeding in Canada; Thomas and MacDonald, 1987), there were few breeding colonies, and it was potentially threatened by disturbance and oil development.

While the ivory gull is one of the few marine birds breeding in Canada that has been formally identified as a conservation concern, no population surveys or detailed research of this species have been conducted since 1985 (Thomas and MacDonald, 1987). This merits concern because Inuit (the aboriginal residents of Arctic Canada) living in several communities in the high Arctic recently reported declines of ivory gull sightings since the 1980s (Mallory et al., 2003). Although the ivory gull has traditionally held little direct economic or survival value to Inuit, it is a highly visible species and its disappearance in areas where it was once common is a concern to Inuit who rely on the Arctic marine environment for traditional foods.

In July 2002 and 2003 (and August 2001 for the Brodeur Peninsula), we conducted aerial surveys of almost all known nesting sites of the ivory gull in the Canadian Arctic, and conducted extensive aerial surveys of surrounding areas in search of new or previously unreported colonies. Prior to this, no population trend information existed for this species in Canada. Here, we report on the status of breeding colonies on Ellesmere, Cornwallis, Seymour, Devon, and Baffin Islands, and we present the first regional population trend data for this species in the world. Finally, we discuss the implications of our results for future research and monitoring strategies of this species in the circumpolar Arctic.

2. Methods

2.1. Study area and surveys

We conducted a literature review of all existing data relating to ivory gull colonies in Canada (e.g., Haney and Macdonald, 1995, Thomas and MacDonald, 1987), and we interviewed scientists and Inuit in northern communities for additional information, to come up with the locations mentioned in Table 1. This provided 14 colony locations on Ellesmere Island, 4 on Devon Island, 10 on the Brodeur Peninsula, Baffin Island, and 1 on Seymour Island.

Because of their remote locations, all surveys were conducted by helicopter between 0900 and 1700 EDT in the second week of July each year (incubation stage; chick-rearing stage on the Brodeur Peninsula on 9th August, 2001), and in 2003 sites at the Brodeur Peninsula, Seymour Island and one colony on Ellesmere were traversed by foot. Weather was sunny with little cloud in each year. We surveyed mountain nunataks (mountain peaks surrounded by glaciers) by flying 80–100 m from cliff faces at 40–60 km/h in a Bell 206 L4 helicopter. We flew from one nunatak to the next, assuming that no birds nested on the glacial ice in between them. Gulls were easily spotted; at the approach of the helicopter, some gulls remained on their nests, white against the dark rock, while others flew off the cliff and circled over the colony, bright against the blue sky. When birds were spotted, the helicopter slowed to a hover so that all three crew members could count individual birds sitting on cliff ledges or flying.

In every region where we conducted surveys, we flew over alternative areas of suitable habitat to determine if

Table 1
Number of individual ivory gulls present at colonies in Canada in relation to location and year

General location	Colony No.	Longitude	Latitude	No. of colonies	No. of ivory gulls			
					Historically	2002	2003	Source of historical data
Seymour Island	1	76°48′	101°16′	1	340	0	200	MacDonald (1976)
Ellesmere Island	2	76°23′	84°58′	1	287	0	0	Thomas and MacDonald (1987)
	3	76°47.5′	80°25′	1	70	0	0	France and Sharp (1992)
	4	76°48.223′	80°15.645′	1	90	6	0	France and Sharp (1992)
	5	76°42.57′	80°7.75′	1	70	10	0	France and Sharp (1992)
	9	76°46.117′	79°53.242′	1	28	1	0	France and Sharp (1992)
	11	76°48′	79°55′	1	28	0	0	France and Sharp (1992)
	14	76°51.79′	79°44.837′	1	20	5	0	France and Sharp (1992)
	15	76°56.135′	80°31.002′	1	60	0	0	Frisch and Morgan (1979)
	17	77°1.463′	80°34.482′	1	24	0	0	France and Sharp (1992)
	18	79°58′	76°55′	1	15	0	–	Frisch and Morgan (1979)
	21	77°9.5′	79°20′	1	50	0	5	Frisch and Morgan (1979)
	22–24	77°27′	79°14′	1	50	0	0	Frisch and Morgan (1979)
	25–29	78°50′	78°11′	1	30	0	0	Frisch and Morgan (1979)
Devon Island	30	75°28.120′	81°22.103′	1	25	0	0	Frisch (1983)
	31	75°20.447′	80°44.663′	1	30	6	0	Frisch (1983)
	32	74°46.300′	80°42.000′	1	30	0	0	Frisch (1983)
Brodeur Peninsula, Baffin Island	33–42	–	–	10	560–580	0	0	Thomas and MacDonald (1987)

Table 2
Number of individual ivory gulls present at colonies discovered for the first time in 2001–2003 in relation to location and habitat

General location	Colony No.	Latitude	Longitude	No. of ivory gulls			
				2001	2002	2003	Habitat type
Ellesmere Island	6	76°41.547′	80°03.560′	–	11	0	Sheer cliff
	7	76°42.836′	80°00.167′	–	2	0	Sheer cliff
	8	76°43.79′	79°53.969′	–	2	1	Sheer cliff
	10	76°46.117′	79°53.242′	–	1	0	Sheer cliff
	12	76°49.677′	79°50.855′	–	19	3	Sheer cliff
	13	76°49.3′	79°50.250′	–	20	0	Sheer cliff
	16	77°01.414′	80°35.658′	–	1	0	Sheer spire
	19	77°07.112′	79°53.500′	–	1	0	Sheer cliff
	20	77°11.052′	79°35.459′	–	4	0	Eroded cliff
	48	77°03.460′	79°56.650′	–	–	2	Sheer cliff
Brodeur Peninsula, Baffin Island	43	73°19.410′	87°54.400′	–	–	55	Flat ground
	44	73°25.000′	86°21.200′	–	–	26	Flat ground
	45	73°25.200′	87°32.900′	–	–	7	Flat ground
	46	73°30.865′	86°54.399′	35	–	0	Flat ground
	47	73°38.801′	87°18.100′	20	–	0	Flat ground
Cornwallis Island	49	75°5.000′	94°15.000′	–	–	7	Flat ground

ivory gulls had moved to nest elsewhere. We flew more than 300 alternate cliffs or nunataks in 2002 and 2003, in addition to the known or new colonies. In 2003, we expanded our survey coverage of the Brodeur Peninsula in search of new colonies by flying eight aerial transects at intervals of approximately 3 min latitude in a De-Havilland Twin Otter, and then revisiting observed colonies by helicopter. Transects were flown across the Brodeur Peninsula at 400–500 feet and at 200 km/h groundspeed, with three observers. Information on non-colony locations was required to determine whether population changes at colonies (if detected) were a result of colony redistribution or numerical declines in the number of nesting birds.

2.2. Data analysis

We applied two-tailed, matched-pairs *t*-tests to determine if colony sizes had changed significantly between our surveys and when the colonies were first discovered. Our analyses were constrained because some of the original information was presented as data pooled for a region (notably for the Brodeur Peninsula), limiting the number of possible pair-wise colony comparisons. No population trend data could be determined for colonies discovered for the first time (Table 2). All data collected during this survey in 2002 and 2003 and our original survey maps have been archived at the Canadian Wildlife Service Arctic Seabird Colony Registry in Iqaluit, Nunavut.

3. Results

3.1. Population trend

In July 2002 and 2003, we resurveyed locations where colonies had previously occurred on Ellesmere (19), Devon (3), and Baffin Islands (10) (Figs. 1 and 2). Irrespective of location or nesting characteristics (e.g., nunatak or gravel plateau), the number of ivory gulls present had declined (Table 1). The mean number of ivory gulls present at colonies (pooled for some sites) was lower in both 2002 (1.6 ± 3.1 S.D. birds, $n = 17$) and 2003 (0.3 ± 1.2 birds, $n = 16$) compared to the mean number found at the same colonies surveyed in the 1980s (86.9 ± 139.5; 1980s–2002, $t_{16} = -2.5$, $P = 0.02$; 1980s–2003, $t_{15} = -2.5$, $P = 0.02$). Several colonies supported no gulls in either 2002 or 2003, including the one on the Sydkap Glacier (previously 275 birds).

In 2002, we observed no ivory gulls nesting on Seymour Island and no obvious signs of nesting attempts. In 2003, we observed approximately 200 gulls on Seymour Island, which included close observations of three nesting birds during ground surveys, and many others observed on nests from the air. The number of gulls observed remains below the 340 ivory gulls reported for the island in 1974 (MacDonald, 1976).

On the Brodeur Peninsula (where data were pooled in previous studies), no ivory gulls were observed in either year of surveys at the 10 known colony locations that previously supported 575 birds. Despite the loss of sample size due to pooling, there was a significant decline in the number of ivory gulls present across all colonies in both 2002 and 2003 when compared to historical data (1980s–2002, $t_{17} = -2.8$, $P = 0.01$; 1980s–2003, $t_{16} = -2.8$, $P = 0.01$).

3.2. New colonies

Despite comprehensive survey coverage on Ellesmere and Devon Islands in both years, we only located nine new colonies in 2002 and one new colony in 2003 (Table 2). Whether these colonies reflect new nesting locations or were missed in the original surveys is unknown. However,

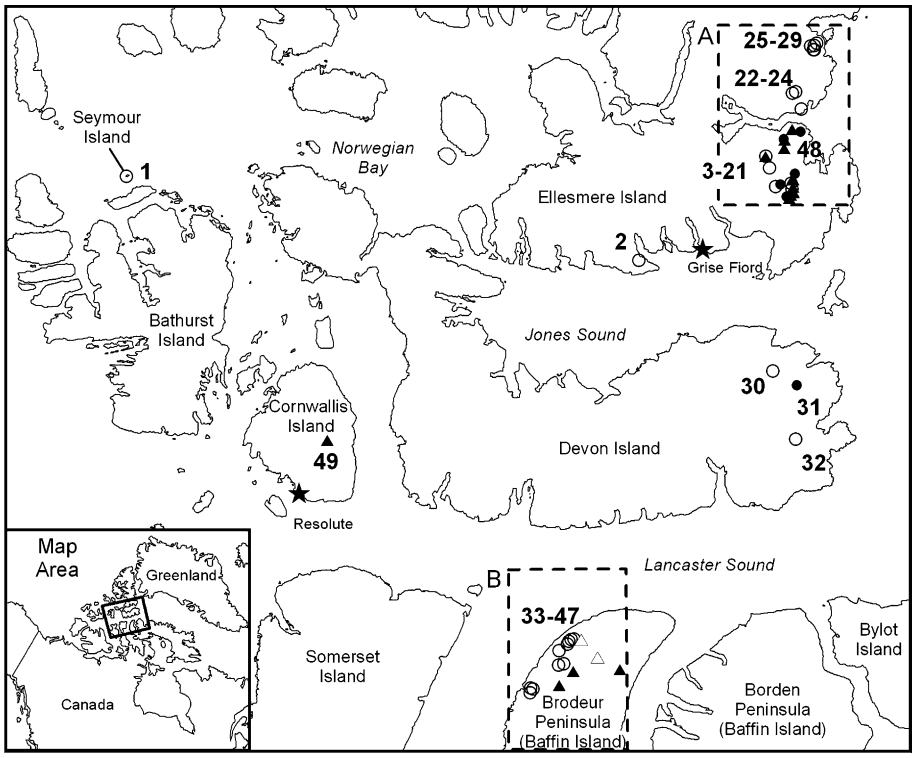

Fig. 1. Eastern high Arctic Canada, showing the locations of ivory gull survey regions. Numbers correspond to colonies listed in Tables 1 and 2. Closed circles represent previously known colonies with birds; open circles represent previously known colonies without birds; triangles represent new colonies discovered for the first time.

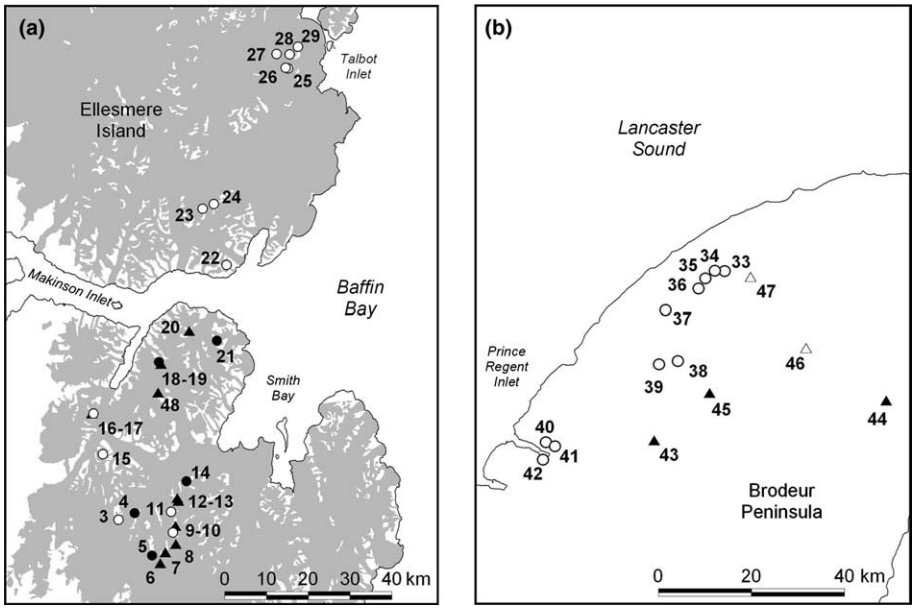

Fig. 2. The detailed locations of colonies on (a) southeastern Ellesmere Island and (b) the Brodeur Peninsula, northern Baffin Island. Numbers correspond to colonies listed in Tables 1 and 2. Closed circles represent previously known colonies with birds; open circles represent previously known colonies without birds; triangles represent new colonies discovered for the first time.

the number of birds present at colonies was small, totalling 61 and 6 individuals in 2002 and 2003, respectively (2002 Mean $= 6.6 \pm 7.6$ gulls; 2003 Mean $= 2 \pm 1$ gulls).

On the Brodeur Peninsula in both 2002 and 2003, we found no new nesting locations while surveying in the vicinity of previously known colonies, but further inland

we found three new colonies that supported 55, 26, and 7 birds, respectively (Table 2, Fig. 2(b)). It is unknown whether these colonies existed in 1985, because they were located outside of the original survey coverage (Thomas and MacDonald, 1987).

We found no ivory gulls on any of the islands near Seymour Island in 2002 or 2003 (Mallory and Gilchrist, 2003). However, in 2003 we found seven gulls nesting at a new colony on the interior of Cornwallis Island in similar habitat to those found on the Brodeur Peninsula (i.e., limestone gravel) (Table 2).

Collectively, 42 colony locations were visited on Ellesmere, Devon, Baffin, Cornwallis, and Seymour Islands (Figs. 1 and 2), 14 of which are new discoveries (Table 2). Despite this survey coverage and including colonies found for the first time, only 83 and 306 individuals were found in 2002 and 2003, respectively. This is in contrast to 1822 gulls detected by less comprehensive surveys in the 1980s (Table 1). The greater number found in 2003 reflects more extensive survey coverage on the Brodeur Peninsula, and that some ivory gulls returned to nest on Seymour Island in 2003 where they had been entirely absent in 2002 (Table 1).

3.3. Colony occupation

We observed no gulls at Seymour Island in 2002, but at least 200 ivory gulls on the Island in 2003. Similarly, 11 colonies in southeastern Ellesmere and Devon Islands that supported nesting ivory gulls in 2002 had no gulls in 2003 (Tables 1 and 2). In contrast, 1 colony that was uninhabited in 2002 supported nesting gulls in 2003 (Tables 1 and 2). These data suggest that colony occupation by ivory gulls may be intermittent, due either to years of skipped breeding, movements among colonies, or both.

4. Discussion

4.1. Survey results

The Canadian breeding population of ivory gulls was estimated at 2400 individuals in the early 1980s (Thomas and MacDonald, 1987). Data from recent surveys suggest that the population has declined by approximately 80% since that time, and that declines have occurred across the known breeding range in all three known nesting habitat types (Tables 1 and 2, Fig. 2). These results support the observations made by Inuit residents, who report observing fewer ivory gulls during spring and fall in the eastern Canadian Arctic in recent years (Mallory et al., 2003).

One possible explanation for our survey results is that gulls had simply abandoned the known colonies to nest elsewhere in Arctic Canada. This explanation is unlikely for several reasons. Although ivory gulls may occasionally change colony locations (Bateson and Plowright, 1959), they rarely move more than 1–2 km, and those nesting on cliffs rarely move at all (Volkov and De Korte, 1996). We surveyed extensive areas of apparently suitable habitat in both years, and found only 14 new colonies, mostly within 5 km of old colony locations. Ivory gull colonies are obvious under good survey conditions, so we also do not believe that we missed sites during our coverage.

If ivory gulls have moved, they appear to have moved completely out of the eastern Canadian Arctic, as they are no longer observed either at local community garbage dumps where they were common 15–20 years ago, or along ice edges travelled by Inuit hunters (Mallory et al., 2003). Garbage and marine mammal carcass disposal have changed little over time, and communities continue to provide easy food sources for avian scavengers such as glaucous (*Larus hyperboreus*) and iceland gulls (*Larus glaucoides*). We also encountered few ivory gulls in transit, along ice edges or open water, and only 17 were observed by biologists in a circumnavigation of Devon Island by ship in 2002; effectively through the prime feeding habitat for this species (A.J. Fontaine, unpublished data). Even if gulls had moved elsewhere in the eastern Arctic to nest, their migration routes and occurrence at ice edges and communities should not change because of their reliance on marine open water and associated ice edges to feed. Thus, we believe that the decline in the number of ivory gulls detected by these colony surveys is supported by the absence of ivory gulls now observed during migration.

4.2. Colony occupation

Variation in colony occupation was observed at ivory gull colonies in Russia (Volkov and De Korte, 1996), suggesting that colony occupation can apparently change among years, although specific sites are used regularly through time. We also detected differences in colony occupation across only two years at some sites, despite overall low numbers of birds. These intermittent breaks in specific site attendance within a region suggest that surveys must be conducted annually to monitor breeding population size of ivory gulls in Canada.

4.3. Possible causes of the decline

If population declines of ivory gulls have occurred, there are a number of possible explanations. Hunting of gulls may be a contributing factor. Most band returns of ivory gulls banded in Arctic Canada during the 1970s and 1980s came from birds shot in northwest Greenland during spring and fall migration, while a few birds were shot in Canada (Stenhouse et al., 2004). Recovery rates for ivory gulls are relatively high (0.02–0.03; Stenhouse

et al., 2004) and comparable to other harvested seabirds in west Greenland. Hence, harvest may have affected Canadian ivory gull subpopulations that migrate along the west coast of Greenland.

Another possible mechanism is that an ecological change may have occurred on the wintering grounds. This would be consistent with our observation of declines across all locations and breeding habitats in the Canadian Arctic, and may be the most parsimonious explanation. For example, survival of auklets and thick-billed murres (*Uria lomvia*) is reduced following winters with more severe weather (Gaston, 2003; Jones et al., 2002). Given that sea ice distribution and thickness are changing in the Northwest Atlantic (Stern and Heide-Jørgensen, 2003; Vinnikov et al., 1999), we speculate that observed changes in marine conditions may have altered the wintering habitat for ivory gulls, although the exact mechanisms of change remain unknown.

4.4. Implications for conservation and management

Evidence from local ecological knowledge (Mallory et al., 2003), at-sea surveys (A.J. Fontaine, unpublished data) and breeding colony surveys (this study) suggest that populations of ivory gulls in the Canadian Arctic have declined. This is the first published regional population trend data for this species in the world, and is alarming because this species breeds and winters in remote and inhospitable areas where habitat change and human disturbance are rarely considered.

The causes of the population decline of ivory gulls breeding in Canada remain unknown, but changes in the wintering or migration grounds are suspected and could be influencing the breeding populations of other circumpolar countries (Kalyakin, 1989; Vinje, 1979). Also, given the high trophic position of the ivory gull in the Arctic marine environment, ivory gull declines may be a harbinger of trophic web conditions across the high Arctic. We recommend that international efforts now be directed at assessing population status and trends of this species in other circumpolar countries. This project also illustrates the conservation value of monitoring bird species associated with polar marine environments; a region that is predicted to be strongly affected by current climate change scenarios (Etkin, 1990; Roots, 1989; Vinnikov et al., 1999).

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