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Nesting by Canada Geese on Baffin Island, Nunavut

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ABSTRACT. Outside of northern Quebec, there is little evidence to confirm reports of nesting by Canada Geese in Arctic habitats of North America, but they nest regularly in the Arctic tundra of West Greenland, from about 62˚ N to as far north as 76.96˚ N, 71.11˚ W. In 2013, we documented successful nesting by a pair of Canada Geese on northern Baffin Island (71.36˚ N, 79.59˚ W), approximately 1200 km north of the nearest known site of regular nesting by this species in northern Quebec. Photographs, egg measurements, and mitochondrial DNA evidence confirmed that these were Canada Geese. Egg laying began around 17 June, the nest of five eggs hatched on 18 July, and we determined that fledging should have occurred around 20 September. Daily mean temperatures on northern Baffin Island fell below freezing after 5 September 2013, and we suspect that the probability of recruitment for this brood was very low. Climate warming in the Arctic is likely to favor northward range expansion by Canada Geese.

Key words: Arctic; *Branta canadensis*; breeding range; Canada Goose; egg size; genetics; nesting; Nunavut

RÉSUMÉ. En dehors du nord du Québec, il existe peu de preuves permettant de confirmer des rapports selon lesquels la bernache du Canada nidifierait dans les habitats arctiques de l'Amérique du Nord. Cela dit, la bernache du Canada nidifie régulièrement dans la toundra arctique de l'ouest du Groenland, à partir d'environ 62˚ N et aussi loin qu'à 76,96˚ N, 71,11˚ O. En 2013, nous avons documenté la nidification réussie d'une paire de bernaches du Canada dans le nord de l'île de Baffin (71,36˚ N, 79,59˚ O), à environ 1 200 km au nord du site le plus près de nidification habituel connu de cette espèce dans le nord du Québec. Des photographies, la mesure des œufs et des échantillons d'ADN mitochondrial ont permis de confirmer qu'il s'agissait effectivement de bernaches du Canada. La ponte a commencé vers le 17 juin, puis la couvée de cinq œufs a éclos le 18 juillet. Nous avons ensuite déterminé que la prise des ailes aurait eu lieu vers le 20 septembre. Dans le nord de l'île de Baffin, les températures moyennes quotidiennes sont tombées sous le point de congélation après le 5 septembre 2013, si bien que nous estimons que pour cette nichée, la probabilité de recrutement était très faible. Le réchauffement climatique dans l'Arctique favorisera vraisemblablement l'expansion du parcours naturel de la bernache du Canada vers le nord.

Mots clés : Arctique; *Branta canadensis*; zone de reproduction; bernache du Canada; taille des œufs; génétique; nidification; Nunavut

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INTRODUCTION

In 2004, the American Ornithologists' Union (AOU) split North American white-cheeked geese into two species (Banks et al., 2004). The Cackling Goose, *Branta hutchinsii*, is a small-bodied species that nests in Arctic tundra habitats of northern Canada and Alaska, while the Canada Goose, *Branta canadensis*, is a large-bodied species that nests mainly in sub-Arctic and temperate regions of North America (Mowbray et al., 2002). The two species overlap extensively on migration and wintering areas outside of the breeding season, and yearlings and failed nesters from many Canada Goose populations undertake northward molt migrations in late May to June that can result in overlap with Cackling Geese in the Arctic during wing molt (e.g., Luukkonen et al., 2008). For the most part, the breeding ranges of the two species do not overlap (but see Norment et al., 1999 and Leafloor et al., 2013). To our knowledge, Cackling Geese do not nest outside of Arctic tundra habitats (i.e., below or within the tree line). Canada Geese nest mostly in suitable habitats south of the tree line, which extends above the Arctic Circle in western North America and to about 59˚ N latitude in eastern North America (Fig. 1). Regular nesting by Canada Geese is known to occur in Arctic habitats above the tree line in northern Quebec (Cotter et al., 2013), but despite

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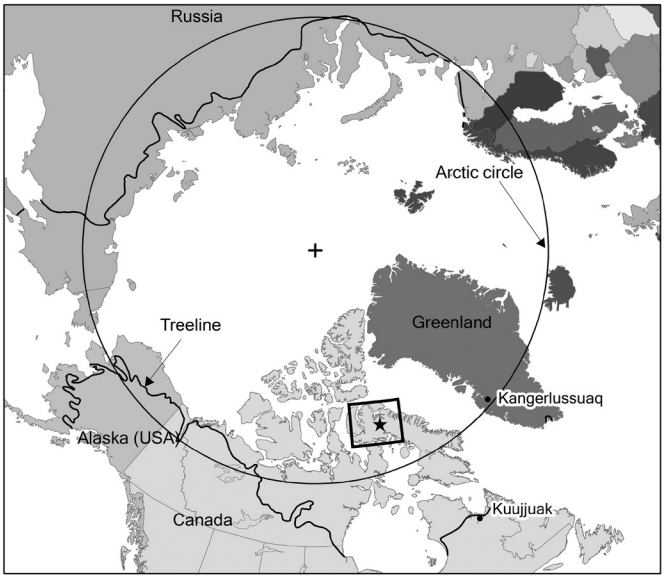

FIG. 1. Map of northern Baffin Island, with the nest site location denoted by a star. Most Canada Geese nest in sub-Arctic and temperate regions below the tree line indicated on the map (see text for exceptions), while Cackling Geese nest exclusively north of the tree line.

many anecdotal reports, evidence of nesting by Canada Geese elsewhere in the Arctic tundra of North America is still relatively scarce (see below).

Long before Cackling Geese were officially recognized as a species, there were reports of large-bodied Canada Geese nesting in the Arctic tundra, sometimes in close proximity to morphologically similar small-bodied geese. Sutton (1932) reported such observations by Inuit residents of Southampton Island, including a description of eggs laid by large Canada Geese that were initially thought to be swan eggs because of their large size. However, no measurements of the eggs were obtained, and no nesting specimens of large-bodied Canada Geese were collected during Sutton's (1932) exploration of the island in 1929–30. Soper (1946:16) reported that the large-bodied form of Canada Goose "breeds very sparingly along the southern coast of Foxe Peninsula" and that it was absent as a breeder from western Baffin Island, but he did not observe or collect any gosling specimens from large-bodied geese during his explorations of southwestern Baffin Island from 1928 to 1931. Sutton and Parmelee (1955) described flightless large-bodied Canada Geese (*B. c. interior*) accompanied by goslings on southeastern Baffin Island and included measurements of a single adult female that was shot from the flock, but there was no way to verify that this adult female was a parent to any of the goslings. Cooch (1977) reported observations of an intermediate-sized form (*B. c. interior*) and a small form (*B. c. hutchinsii*) of Canada Goose that were accompanied by young on the West Foxe Islands (64.23˚ N, 76.22˚ W) near Cape Dorset, Nunavut, but did not provide data to corroborate the size of the birds. Brandt (1943) described the nest of what he called a Lesser Canada Goose, a pale-colored goose that had larger eggs than the small Cackling Geese that predominated around Hooper Bay, Alaska, but no egg measurements were taken. Lepage et al. (1998) reported that both large-bodied and small-bodied forms of Canada Geese were observed on Bylot Island, Nunavut, between 1979 and 1997, but it was unclear which species was accompanied by the goslings that they observed during aerial surveys. Norment et al. (1999) reported observations of Canada Geese accompanied by goslings in the forest-tundra transition between 62.4˚ N, 104.8˚ W and 64.6˚ N, 100.5˚ W and mentioned separately that a small subspecies nested in this area on cliffs along the Clarke River, but they did not provide any other information. Mallory et al. (2005) reported anecdotal evidence of nesting (large-bodied) Canada Geese from several locations on Baffin Island that was based on observations by Inuit hunters, wildlife officers, and scientific investigators. Despite numerous observations, there was no conclusive scientific evidence (e.g., photographs, measurements of adult geese or their eggs, genetic materials collected from eggs, nests, or pre-fledging goslings) to verify that Canada Geese, and not Cackling Geese, had nested in any of these cases.

Leafloor et al. (2013) described a narrow hybrid zone on the west coast of Hudson Bay where Canada Geese and Cackling Geese overlapped on nesting areas. Species identification was based on morphological and genetic data, and hybrids were identified as those birds that had phenotypic mismatches with their mtDNA (i.e., a large-bodied goose with the mtDNA of a Cackling Goose, or vice versa). The area of overlap coincided with the tree line on the west coast of Hudson Bay, at the transition zone between boreal taiga and Arctic tundra habitats (around 60˚ N latitude). The hybrid zone was hypothesized to be a tension zone, where northward effective dispersal by Canada Geese and southward effective dispersal by Cackling Geese were limited by ecological and behavioral factors. The short growing season in the Arctic was one factor thought to limit the northward extent of nesting by Canada Geese (Leafloor et al., 2013).

Despite the dearth of physical evidence in North America, there is no doubt that large-bodied Canada Geese are capable of nesting in the Arctic and no reason to believe that any of the aforementioned accounts were mistaken in their identification of large-bodied Canada Geese, as opposed to the small-bodied birds now known as Cackling Geese. On the west coast of Greenland, nesting by Canada Geese has been documented from about 62˚ N to as far north as 76.96˚ N, 71.11˚ W (Fox et al., 2012; A.D. Fox, pers. comm. 2013). Nesting by Canada Geese on Greenland appears to be a recent phenomenon, and numbers have greatly increased there since the late 1980s (Fox et al., 2011). Species identification has been verified by morphological and egg measurements (Fox et al., 1996, 2012) and genetic data (Scribner et al., 2003b). Banding and telemetry data have also confirmed that the Canada Geese nesting on Greenland winter on the east coast of North America (Kristiansen et al., 1999; Scribner et al., 2003b), where Cackling Geese are relatively uncommon. In this paper we document nesting by a pair of Canada Geese on northern Baffin Island in 2013.

FIG. 2. A nesting pair of Canada Geese on northern Baffin Island: (a) the gander, (b) incubating female, (c) the nest with five eggs, showing habitat around the nest site dominated by the sedge, *Carex aquatilis*, and (d) pair of Canada Geese and their brood of five goslings leaving the nest site on 18 July 2013.

METHODS AND RESULTS

A pair of Canada Geese was observed and photographed by A. MacLeod and J. Jantunen at a nest site on northern Baffin Island, Nunavut, on 26 June 2013 (Figs. 2a–c). The nest site was found in the interior region of northern Baffin Island, about 75 km southeast of Milne Inlet and 100 km north of Steensby Inlet, at 71.36˚ N, 79.59˚ W (Fig. 1). The nest was located in sedge (*Carex aquatilis*) meadow habitat at the edge of a pond, with a larger lake (approximately 2.7 km^2) located 200–300 m away.

The nest contained five eggs when it was found on 26 June; maximum length and width of the eggs (± SD) averaged 85.0 (± 0.70) × 56.2 (± 0.83) mm. Egg dimensions were similar to those of Canada Geese that nest in coastal and boreal regions around James Bay and Hudson Bay (*B. c. interior*), but were smaller than those of temperate-nesting Canada Geese (*B. c. maxima*), and larger than those of Cackling Geese (Table 1). The female was incubating the eggs when the nest was re-visited on 13 July, but on 18 July, a pair of Canada Geese with five recently hatched goslings, presumably the pair from this nest, was photographed walking away from the nest site at 2:35 p.m. (Fig. 2d). Eggshells and membranes from hatched eggs were collected from the nest site and stored in a paper envelope until they were shipped to K.T. Scribner for genetic analysis.

DNA was extracted from regions of vascularization on the eggshell membrane of individual eggs using DNeasy extraction kits (Qiagen Inc., CA). A 143 bp fragment of the 5’ end of the mitochondrial DNA control region flanking the hypervariable portion of the control region (3’ end of domain; Baker and Marshall, 1997) was sequenced using primers and conditions described in Pierson et al. (2000) and Pearce et al. (2000). The sample’s mtDNA sequence was characterized as A haplotype (GenBank Accession number AF175473), which is the most common haplotype found in Canada Geese but is not found in Cackling Geese sampled across the species’ range (see methods and results in Scribner et al., 2003a, b).

TABLE 1. Mean length and width (± SD) of Canada Goose and Cackling Goose eggs from various taxa and locations compared to those measured in this study.

Taxon	Location	Width (mm)	Length (mm)	n	Source
B. h. hutchinsii	Karrak Lake, Nunavut	49.7 (3.8)	73 (9.6)	640	R. Alisauskas and D. Kellett, unpubl. data
	Southampton Island, Nunavut	53.4	78.5	77	MacInnes and Dunn, 1988
B. c. interior	Ungava, Quebec	56.3 (1.4)	83.4 (4.1)	18 992	Cotter et al., 2013
	Quebec, Ontario	56.6 (1.0)	83.9 (2.2)	334	Manning, 1978
	Cape Churchill, Manitoba	56.9 (2.0)	83.4 (3.5)	6769	D. Andersen, unpubl. data
	Akimiski Island, Nunavut	57.2 (1.8)	84.7 (3.6)	15 942	J. Leafloor and R. Brook, unpubl. data
	South Hudson Bay, Ontario	57.6 (1.8)	85.1 (3.6)	1907	K. Abraham and R. Brook, unpubl. data
	Kinoje Lake, Ontario	58.0	85.1	74	Raveling and Lumsden, 1977
B. c. maxima	Marshy Point, Manitoba 1970	59 (1.5)	86.6 (3.6)	866	Cooper, 1978
	Columbia, Missouri	59.2 (5.2)	87.6 (8.2)	945	J. Coluccy, unpubl. data
	Fargo, North Dakota	59.8 (1.9)	86.3 (3.1)	1126	M. Clark, unpubl. data
	Marshy Point, Manitoba 1971	59.9 (1.9)	87.1 (3.2)	876	Cooper, 1978
B. canadensis ssp.	Baffin Island, Nunavut	56.2 (0.7)	85 (0.8)	5	This study

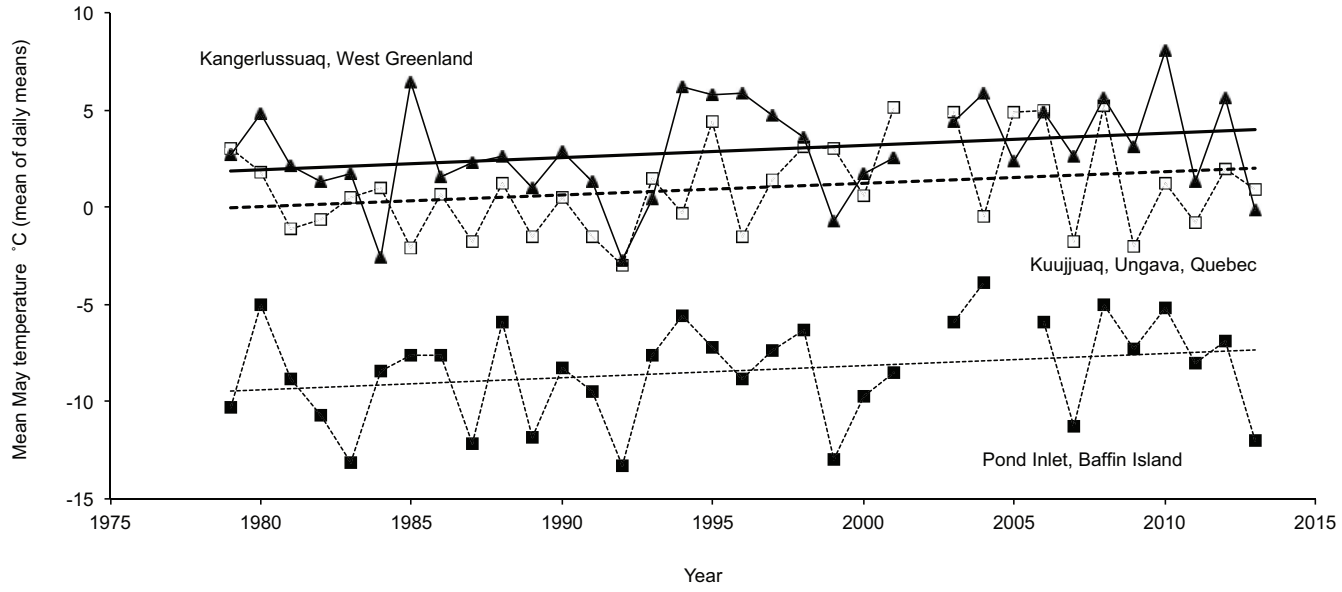

FIG. 3. Comparison of mean May temperatures at Kangerlussuaq, West Greenland (67.02˚ N, 50.70˚ W), Kuujjuak, Ungava, Quebec (58.10˚ N, 68.68˚W), and Pond Inlet, Baffin Island, Nunavut (72.70˚ N, 77.96˚ W), 1979–2013 (climate data from TuTiempo Network, 2015).

DISCUSSION

This account provides conclusive evidence to support earlier observations of nesting by Canada Geese in the eastern Arctic of North America (e.g., Sutton, 1932; Soper, 1946; Cooch, 1977; Mallory et al., 2005). As far as we know, this is the northernmost confirmed nesting record for Canada Geese in North America. If we assume a six-day egg-laying period and a 28-day incubation period (Mowbray et al., 2002), then egg laying began on approximately 17 June. By contrast, the average nest initiation date in West Greenland in 2010 was 27 May (Fox et al., 2011). At the nearest known site of regular nesting by Canada Geese in Canada (1200 km south of the northern Baffin nest site in northern Quebec), the average date of nest initiation from 1996 to 2005 was also 27 May (Cotter et al., 2013). The latest nest initiation observed in northern Quebec occurred on 20 June 2002, and no nests were initiated after 10 June in any other year of the study (Fig. 2 in Cotter et al., 2013). If we further assume a pre-fledging period of approximately 63 days after hatching (Mowbray et al., 2002), then the goslings on northern Baffin should have fledged around 20 September.

Until recently, accounts of nesting by large-bodied Canada Geese in the Arctic (especially above ~62˚ N latitude) appeared to be relatively rare. Though Fox et al. (2012) reported that a pair of large-bodied Canada Geese probably bred in West Greenland at least as early as 1864, evidence of annual nesting has been found only within the past few decades and may be associated with a warmer climate there. May temperatures in West Greenland averaged 2˚C warmer than in northern Quebec, Canada, between 1979 and 2010, and Canada Geese initiated nests at the same time in both places in 2010, even though Greenland birds traveled ~1300 km farther north before nesting (Fox et al., 2011). This correspondence of timing suggests that even relatively small changes in temperature could have profound effects on the suitability of Arctic habitats for nesting by

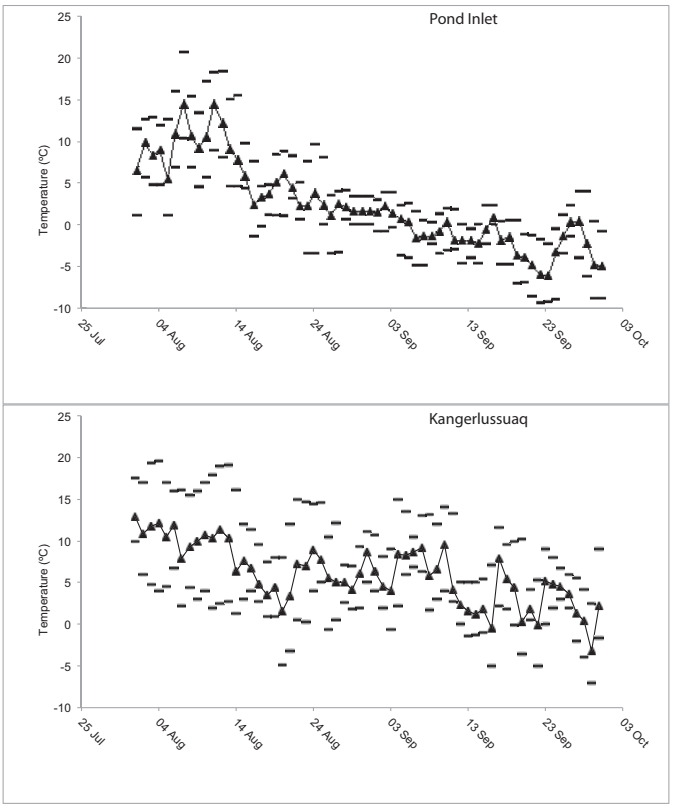

FIG. 4. Daily mean, minimum, and maximum temperatures (°C) from 1 August to 30 September 2013 at Pond Inlet on northern Baffin Island and at Kangerlussuaq in West Greenland. Triangles represent daily mean temperatures, and dashes represent daily minimum and maximum temperatures.

Canada Geese (see also Jensen et al., 2008). However, May temperatures at Pond Inlet, Nunavut, averaged about 9 to 11°C colder over the same period, suggesting a substantial delay in spring thaw and plant growth on northern Baffin Island compared to both northern Quebec and West Greenland (Fig. 3).

Successful nesting by geese in the Arctic depends on suitable spring temperatures, absence of snow cover, availability of suitable forage, and a snow-free period that is long enough to allow goslings to fledge before the onset of migration (e.g., Dickey et al., 2008; Jensen et al., 2008). The Canada Geese that we observed hatched on 18 July, which suggests that goslings would not have fledged until around 20 September, assuming a 63-day fledging period (captive Canada Geese fed high-quality diets ad libitum required 70 days to complete growth of primaries; Richman et al., 2015). Ground frosts began on northern Baffin Island in mid-August, and daily mean temperatures fell below freezing after 5 September 2013 (Fig. 4a), which would have inhibited plant growth and elevated thermoregulatory demands during pre-migration fueling. Thus, we expect that the probability of recruitment would be very low for this brood of Canada Geese. In contrast, Canada Goose goslings in West Greenland would have fledged around 20 days earlier (i.e., in late August), and mean daily temperatures there did not consistently fall below freezing before the end of September (Fig. 4b).

For Arctic-nesting geese, the narrow window of time available to lay and incubate eggs and raise young to fledging is a major determinant of the northern limit of the breeding range (Jensen et al., 2008). Species of geese that nest regularly on Baffin Island include Ross's Geese (*Chen rossii*), Brant (*Branta bernicla*), Snow Geese (*Chen caerulescens*), and Cackling Geese, all of which have shorter incubation periods and shorter fledging times than Canada Geese (Table 2). Tundra Swans (*Cygnus columbianus*), which are larger and have longer reproductive cycles than do Canada Geese (Table 2), do not nest on northern Baffin Island and are uncommon breeders on southern and western Baffin Island (Soper, 1946; J. Leafloor and F. Roetker, unpubl. data). Climate warming in the Arctic is expected to result in earlier springs and delayed onset of winter conditions that will affect plant phenology (e.g., Schwartz et al., 2006; Prowse et al., 2009), and these changes are likely to favor northward range expansion by Canada Geese.

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TABLE 2. Approximate number of days of egg laying, incubation, and gosling growth to fledging for large-bodied herbivorous waterfowl species that nest in the Arctic.

Species	Egg laying	Incubation	Fledging	Total	Source
Ross's Goose	4–6	19–25	40–43	63–74	Jonsson et al., 2013
Brant	5	24	40–45	69–74	Lewis et al., 2013
Lesser Snow Goose	5–7	24	40–43	69–74	Mowbray et al., 2000
Greater Snow Goose	5–7	24	43	72–74	Mowbray et al., 2000
Greater White-fronted Goose	5–7	25	42–49	73–81	Ely and Dzubin, 1994
Cackling Goose	5–7	26–27	42–49	73–83	Mowbray et al., 2002
Canada Goose	5–7	27–28	63	95–98	Mowbray et al., 2002
Tundra Swan	6–10	31–32	65	102–107	Limpert and Earnst, 1994

comparisons in Figures 3 and 4. M. Oldham identified the species of sedge from samples obtained at the nest site, and J. Kanefsky assisted with the sequencing analysis. We thank K.F. Abraham, R.T. Alisauskas, F.B. Baldwin, A.D. Fox, M.L. Mallory and three anonymous reviewers for reviewing this note.

REFERENCES

Baker, A.J., and Marshall, H.D. 1997. Mitochondrial control region sequences as tools for understanding evolution. In: Mindell, D.P., ed. Avian molecular evolution and systematics. New York: Academic Press. 51–82. http://dx.doi.org/10.1016/B978-012498315-1/50005-4

Banks, R.C., Cicero, C., Dunn, J.L., Kratter, A.W., Rasmussen, P.C., Remsen, J.V., Jr., Rising, J.D., and Stotz, D.F. 2004. Forty-fifth supplement to the American Ornithologists' Union check-list of North American birds. The Auk 121(3):985–995.

Brandt, H.W. 1943. Alaska bird trails: Adventures of an expedition by dog sled to the delta of the Yukon River at Hooper Bay. Cleveland, Ohio: Bird Research Foundation. 271–281.

Cooch, F.G. 1977. Changes in the avifauna of the West Foxe Islands, Northwest Territories, 1956–1976. Canadian Field-Naturalist 91:314–317.

Cooper, J.A. 1978. The history and breeding biology of the Canada Geese of Marshy Point, Manitoba. Wildlife Monographs 61. 87 p.

Cotter, R.C., Hughes, R.J., May, P., Novalinga, P., Johannes, J., Hindman, L.J., and Padding, P.I. 2013. Breeding biology of Atlantic population Canada Geese in Nunavik, northern Québec. Arctic 66(3):301–311. http://dx.doi.org/10.14430/arctic4309

Dickey, M.-H., Gauthier, G., and Cadieux, M.-C. 2008. Climatic effects on the breeding phenology and reproductive success of an Arctic-nesting goose species. Global Change Biology 14(9):1973–1985. http://dx.doi.org/10.1111/j.1365-2486.2008.01622.x

Ely, C.R., and Dzubin, A.X. 1994. Greater White-fronted Goose (*Anser albifrons*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/131

Fox, A.D., Glahder, C., Mitchell, C.R., Stroud, D.A., Boyd, H., and Frikke, J. 1996. North American Canada Geese (*Branta canadensis*) in West Greenland. The Auk 113(1):231–233. http://dx.doi.org/10.2307/4088952

Fox, A.D., Mitchell, C., Weegman, M.D., Griffin, L.R., Thomas, H., Stroud, D.A., and Francis, I.S. 2011. Potential factors influencing increasing numbers of Canada Geese *Branta canadensis* in West Greenland. Wildfowl 61:30–44.

Fox, A.D., Sinnett, D., Baroch, J., Stroud, D.A., Kampp, K., Egevang, C., and Boertmann, D. 2012. The status of Canada Goose *Branta canadensis* subspecies in Greenland. Dansk Ornitologisk Forenings Tidsskrift 106:87–92.

Jensen, R.A., Madsen, J., O'Connell, M., Wisz, M.S., Tommervik, H., and Mehlum, F. 2008. Prediction of the distribution of Arctic-nesting Pink-footed Geese under a warmer climate scenario. Global Change Biology 14(1):1–10. http://dx.doi.org/10.1111/j.1365-2486.2007.01461.x

Jonsson, J.E., Ryder, J.P., and Alisauskas, R.T. 2013. Ross's Goose (*Chen rossii*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/162

Kristiansen, J.N., Fox, A.D., and Jarrett, N.S. 1999. Resightings and recoveries of Canada Geese *Branta canadensis* ringed in West Greenland. Wildfowl 50:199–203.

Leafloor, J.O., Moore, J.A., and Scribner, K.T. 2013. A hybrid zone between Canada Geese (*Branta canadensis*) and Cackling Geese (*Branta hutchinsii*). The Auk 130(3):487–500. http://dx.doi.org/10.1525/auk.2013.12196

Lepage, D., Nettleship, D.N., and Reed, A. 1998. Birds of Bylot Island and adjacent Baffin Island, Northwest Territories, Canada, 1979 to 1997. Arctic 51(2):125–141. http://dx.doi.org/10.14430/arctic1054

Lewis, T.L., Ward, D.H., Sedinger, J.S., Reed, A., and Derksen, D.V. 2013. Brant (*Branta bernicla*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/337

Limpert, R.J., and Earnst, S.L. 1994. Tundra Swan (*Cygnus columbianus*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/089

Luukkonen, D.R., Prince, H.H., and Mykut, R.C. 2008. Movements and survival of molt migrant Canada Geese from southern Michigan. Journal of Wildlife Management 72(2):449–462. http://dx.doi.org/10.2193/2007-029

MacInnes, C.D., and Dunn, E.H. 1988. Components of clutch size variation in Arctic-nesting Canada Geese. Condor 90(1):83–89. http://dx.doi.org/10.2307/1368436

Mallory, M.L., Fontaine, A., and Boyd, H. 2005. Breeding and non-breeding range of Canada, *Branta canadensis*, and Cackling Geese, *Branta hutchinsii*, in the eastern Canadian Arctic. Canadian Field-Naturalist 119(4):483–489.

Manning, T.H. 1978. Measurements and weights of eggs of the Canada Goose, *Branta canadensis*, analyzed and compared with those of other species. Canadian Journal of Zoology 56(4):676–687. http://dx.doi.org/10.1139/z78-095

Mowbray, T.B., Cooke, F., and Ganter, B. 2000. Snow Goose (*Chen caerulescens*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/514,doi:10.2173/bna.514

Mowbray, T.B., Ely, C.R., Sedinger, J.S., and Trost, R.E. 2002. Canada Goose (*Branta canadensis*). In: Poole, A., ed. The birds of North America Online. Ithaca: Cornell Lab of Ornithology. http://bna.birds.cornell.edu/bna/species/682

Norment, C.J., Hall, A., and Hendricks, P. 1999. Important bird and mammal records in the Thelon River Valley, Northwest Territories: Range expansions and possible causes. Canadian Field-Naturalist 113:375–385.

Pearce, J.M., Pierson, B.J., Talbot, S.L., Derksen, D.V., Kraege, D., and Scribner, K.T. 2000. A genetic evaluation of morphology used to identify hunter-harvested Canada Geese. Journal of Wildlife Management 64(3):863–874. http://dx.doi.org/10.2307/3802757

Pierson, B.J., Pearce, J.M., Talbot, S.L., Shields, G.F., and Scribner, K.T. 2000. Molecular genetic status of Aleutian Canada Geese from Buldir and the Semidi Islands, Alaska. The Condor 102(1):172–180. http://dx.doi.org/10.1650/0010-5422(2000)102[0172:MGSOAC]2.0.CO;2

Prowse, T.D., Furgal, C., Bonsal, B.R., and Edwards, T.W.D. 2009. Climatic conditions in northern Canada: Past and future. Ambio 38(5):257–265. http://dx.doi.org/10.1579/0044-7447-38.5.257

Raveling, D.G., and Lumsden, H.G. 1977. Nesting ecology of Canada Geese in the Hudson Bay Lowlands of Ontario: Evolution and population regulation. Ontario Ministry of Natural Resources Fish and Wildlife Research Report No. 98. 77 p.

Richman, S.E., Leafloor, J.O., Karasov, W.H., and McWilliams, S.R. 2015. Ecological implications of reduced forage quality on growth and survival of sympatric geese. Journal of Animal Ecology 84(1):284–298. http://dx.doi.org/10.1111/1365-2656.12270

Schwartz, M.D., Ahas, R., and Aasa, A. 2006. Onset of spring starting earlier across the Northern Hemisphere. Global Change Biology 12(2):343–351. http://dx.doi.org/10.1111/j.1365-2486.2005.01097.x

Scribner, K.T., Malecki, R.A., Batt, B.D.J., Inman, R.L., Libants, S., and Prince, H.H. 2003a. Identification of source population for Greenland Canada Geese: Genetic assessment of a recent colonization. The Condor 105(4):771–782. http://dx.doi.org/10.1650/7331

Scribner, K.T., Talbot, S.L., Pearce, J.M., Pierson, B.J., Bollinger, K.S., and Dirksen, D.V. 2003b. Phylogeography of Canada Geese (*Branta canadensis*) in western North America. The Auk 120(3):889–907. http://dx.doi.org/10.1642/0004-8038(2003)120[0889:POCGBC]2.0.CO;2

Soper, J.D. 1946. Ornithological results of the Baffin Island Expeditions of 1928–1929 and 1930–1931, together with more recent records. The Auk 63(1):1–24. http://dx.doi.org/10.2307/4079904

Sutton, G.M. 1932. The exploration of Southampton Island, Hudson Bay. Part II, Zoology. Section 2: The birds of Southampton Island. Memoirs of the Carnegie Museum, Vol. 12. Pittsburgh: Carnegie Museum.

Sutton, G.M., and Parmelee, D.F. 1955. On certain anatids of Frobisher Bay, Baffin Island. Arctic 8(3):138–147. http://dx.doi.org/10.14430/arctic3813

TuTiempo Network. 2015. Climate data: 1941–2015. http://en.tutiempo.net/climate/north-america.html