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Double Duty: First Record of Double Brooding in Snow Buntings in the Canadian Arctic

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ABSTRACT. Urbanization is increasing worldwide, leading to changes in urban animal behaviour, physiology, fitness, and reproductive outcomes. As climate change effects in northern regions generate earlier spring melt and later fall freeze-up, some Arctic-breeding songbird species previously limited to single breeding attempts per season may now have the opportunity to produce multiple broods a year. Climate change effects may be further accelerated for species breeding in urban environments. Here, we report the first known case from the North American Arctic of Snow Buntings (*Plectrophenax nivalis*) fledging two successful broods within a single breeding season. We documented two female Snow Buntings nesting in Iqaluit, Nunavut, Canada, that, after successfully fledging their first broods, initiated a second clutch and successfully hatched or fledged nestlings from that second attempt. These females attempting a second brood were some of the earliest nesting birds and represent 2.7% (2 of 73) of females found nesting in Iqaluit during the 2024 field season. These findings demonstrate flexibility in the breeding decisions of Snow Buntings and could provide an early insight into how birds may be able to respond to future effects of climate change.

Keywords: Arctic; songbird; Snow Bunting; *Plectrophenax nivalis*; life history traits; second brood; climate change; Iqaluit; Nunavut

RÉSUMÉ. Le phénomène de l'urbanisation mondiale s'accélère, entraînant ainsi une modification du comportement, de la physiologie, de la forme physique et de la reproduction des animaux. Alors que les conséquences du réchauffement climatique dans les régions nordiques se manifestent par une débâcle printanière précoce et une prise des glaces tardive à l'automne, certaines espèces d'oiseaux chanteurs nichant dans l'Arctique qui ne faisaient auparavant qu'une seule tentative de reproduction par saison pourraient maintenant avoir la possibilité d'en faire plusieurs par an. Les conséquences du réchauffement climatique pourraient être exacerbées chez les espèces se reproduisant en milieu urbain. Dans cette étude, nous présentons le premier cas connu de plectrophanes des neiges de l'Arctique nord-américain (*Plectrophenax nivalis*) ayant réussi à produire deux couvées au cours d'une seule saison de reproduction. Nous avons documenté deux plectrophanes des neiges femelles nichant à Iqaluit, au Nunavut, au Canada, qui ont réussi à produire ou à élever une seconde couvée après leur première ponte. Ces femelles faisaient partie des premières nicheuses et comptaient pour 2,7 % (2 sur 73) des nicheuses recensées lors de la saison de terrain à Iqaluit en 2024. Ces constatations illustrent la flexibilité des décisions de reproduction des plectrophanes des neiges. Elles pourraient nous fournir les premiers indices sur la manière dont les oiseaux pourraient être en mesure de réagir aux effets futurs du changement climatique.

Mots-clés : Arctique; oiseau chanteur; plectrophane des neiges; *Plectrophenax nivalis*; caractéristiques du cycle biologique; deuxième couvée; changement climatique; Iqaluit; Nunavut

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INTRODUCTION

Arctic-breeding birds, specifically passerines, shorebirds, waterfowl, and raptors, are usually limited to a single successful reproductive attempt per year because of the short summer breeding season (Lack, 1954; Hussell, 1972). Generally, Arctic-breeding birds within the same species have significantly shorter incubation periods than their temperate breeding counterparts (e.g., American Robin *Turdus migratorius*) (Turner et al., 2017). Second broods have occasionally been recorded in Arctic passerine species, for example, Northern Wheatear (*Oenanthe*

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oenanthe) in Nunavut, Canada (Hussell et al., 2014), and Redpoll (*Acanthis flammea*) in Alaska, USA (Troy and Shields, 1979) and the Yamal Peninsula, Russia (Ryzhanovskiy and Ryabitsev, 2021).

Snow Buntings (*Plectrophenax nivalis*) are heralded as one of the earliest arrivals to the North in spring (Meltofte, 1983). Non-migratory populations of Snow Buntings regularly raise second broods in the mountains of Scotland (Watson, 1996) at the southern edge of their breeding range (57°N), and occasional second broods have been documented in migratory Arctic-breeding populations in Svalbard (78°N; Epsmark, 2016). Currently, there is no concrete evidence for double brooding in Snow Buntings in the North American Arctic despite their early arrival and long-term reproductive studies at multiple locations (Hussell, 1972; Meltofte, 1983; Montgomerie et al. 1983; Romero, 1998; Baldo et al., 2014). However, with the impacts of climate change providing a longer breeding season (Callaghan et al., 2011), species such as the Snow Bunting may begin to opportunistically initiate and even fledge young from second clutches following successful fledging of first broods. Snow Buntings and other Arctic songbirds are also increasingly associated with growing urban centres in the North (Sullivan et al., 2009; Simard-Provençal et al., 2025): warmer urban microclimates with earlier snowmelt and earlier emergence of invertebrate prey (Belitz, 2023) may act along with climate change to facilitate second clutches and successful second broods.

Here, we confirm for the first time (to the best of our knowledge) that Snow Buntings in the North American Arctic can successfully raise two broods to fledging in one breeding season, with observations of nests in and around the urban center of Iqaluit, Nunavut. Specifically, we documented two separate females raising a first full brood and either hatching or fledging nestlings in a second brood, all within a single breeding season at this location. These novel and successful second breeding attempts not only demonstrate potential advantages for urban-nesting birds, but importantly, shed light on the significant flexibility in the breeding decisions of Snow Buntings, demonstrating the potential for this species to respond more generally to the ongoing effects of climate change.

METHODS

Study System and Species

In North America, Snow Buntings winter in southern Canada and the northern US (Macdonald et al. 2012, 2016). Depending on the breeding location, males arrive on breeding grounds from the end of April to late May (McKinnon et al., 2016; Montgomerie and Lyon, 2020), several weeks to days before females (McKinnon et al., 2016), establishing territories and competing for limited breeding cavities (Tinbergen, 1939; Meltofte, 1983; Macdonald et al., 2012). Females typically build nests in rock cavities, but they have also been found to use anthropogenic structures, such as nest boxes and buildings when available (Montgomerie and Lyon, 2020; Simard-Provençal et al., 2025). Females typically produce a clutch containing five to seven eggs and rely on the resources they gain from breeding grounds for egg production (Hussell, 1972; Meltofte et al., 2007; Montgomerie and Lyon, 2020). Both parents feed nestlings arthropods for up to two weeks after fledging (Parmelee, 1968; Montgomerie and Lyon, 2020). The adults then need to perform an energetically costly moult before migration in mid-September to early October (Montgomerie and Lyon, 2020).

This research was conducted in 2024 in the City of Iqaluit ᐃᖃᓗᐃᑦ, Nunavut, Canada (63.74°N, −68.52°W), in the adjacent community of Apex (Niaqunngut), Nunavut, Canada (63.72° N, −68.44° W), and in the surrounding land, water, and ice covered by the Nunavut Agreement and within the Inuit Nunangat. Research on Snow Bunting breeding ecology began in Iqaluit in 2022 to quantify the impact of urbanization-associated changes on species distribution, life history, and fitness.

Adult Snow Buntings were caught using previously validated techniques, such as baited ground traps and mist nets pulled over incubating or feeding adults as they visited the nest (under Nunavut Wildlife Research Permit 2023-048 and with University of Windsor Animal Care Committee approval AUPP 22-04). Birds were banded with uniquely numbered U.S. Fish and Wildlife lightweight aluminum alloy butt-end bands and three colour bands for individual identification. The research team aged and sexed birds based on plumage (Pyle, 1997) and took morphometric measurements, such as unflattened wing chord (± 0.1 mm) and tarsus length (± 0.1 mm). As part of a separate study, most birds were also equipped with Biotherm 13 Passive Integrated Responder PIT tags to monitor nest visitation and provisioning behaviours of individuals and pairs. The radio frequency identification (RFID) data collected were used to supplement in-person nest monitoring for validation of hatch and fledge dates, and successful nest fledgling was confirmed via nest monitoring and nestling banding.

Nest Searching and Monitoring

Nest searching was conducted throughout the Snow Bunting breeding season from 1 June to 30 July 2024. A core team of five individuals searched for Snow Bunting nests in Iqaluit from approximately 7:00 – 15:00 each day. Searchers primarily focused on male bunting vocalizations to indicate proximity to a potential nest. When a male was spotted, the nest searcher monitored the area for the presence of a female bunting. If a female was located, her behaviour (e.g., carrying nesting materials, such as grass, moss, or down) was documented to provide insights into the stage of nest construction. When a potential nest site was identified and the female was no longer near the nest, the site was examined to determine the status of nest construction (e.g., cup formation and material quantity).

FIG. 1. Photos of the two double-brooding female Snow Buntings (*Plectrophenax nivalis*) documented in Iqaluit, Nunavut, Canada, in 2024. Female A second brood. A) Male feeding chicks on 23 July 23 2024, B) Male removing fecal sac on 26 July 2024, C) Female leaving nest on 26 July 2024, D) Female feeding fledgling on 31 July 2024. Photo credits: Wren Coxson.

GPS coordinates for the nests were recorded on Gaia GPS (Outside Inc. and Trailbehind Inc.), and distances between nesting locations for each female were calculated using coordinates recorded at each nest site.

Ongoing nest monitoring occurred every three to four days to assess nest development, lay date, clutch size, duration of incubation, hatch date, nest/nestling success, and nestling growth. Upon arriving at nest locations, nest monitors documented the presence of male and female buntings. In the absence of the breeding pairs, the nest monitors inspected nest progress using a dentist's mirror and a headlamp, or a cable digital inspection camera (Mastercraft Inc.).

When the timing of clutch initiation was unknown, we estimated it by back calculating from the fledging, hatch (first observation of adults carrying food), or lay date, or from the estimated age of the nestlings during the growth stage. Based on previous long-term monitoring at other sites in the Canadian Arctic (Hussell, 1972; Marier, 2015; Riquier, 2024), we assumed that one egg was laid per day and that the incubation period (interval between the last egg being laid until the beginning of hatching) was 10 days. Once hatched, fledgling occurred approximately 15 days after hatching.

Assessing Fledgling Quality and Success

Nests were visited to band, weigh, and measure nestlings when they were approximately 7–11 days of age. Nestlings were banded with uniquely numbered U.S. Fish and Wildlife lightweight aluminum alloy butt-end bands in addition to a single year-specific colour band for post-fledging and inter-annual identification. Nestlings were weighed to the nearest 0.01 g and we took morphometric measurements, including unflattened wing chord (± 0.1 mm) and tarsus length (± 0.1 mm), to track nestling growth. The number of nestlings was recorded to estimate fledging success. Second broods were confirmed to have occurred where the nesting female or both parents were colour banded and their first brood was known to have fledged successfully.

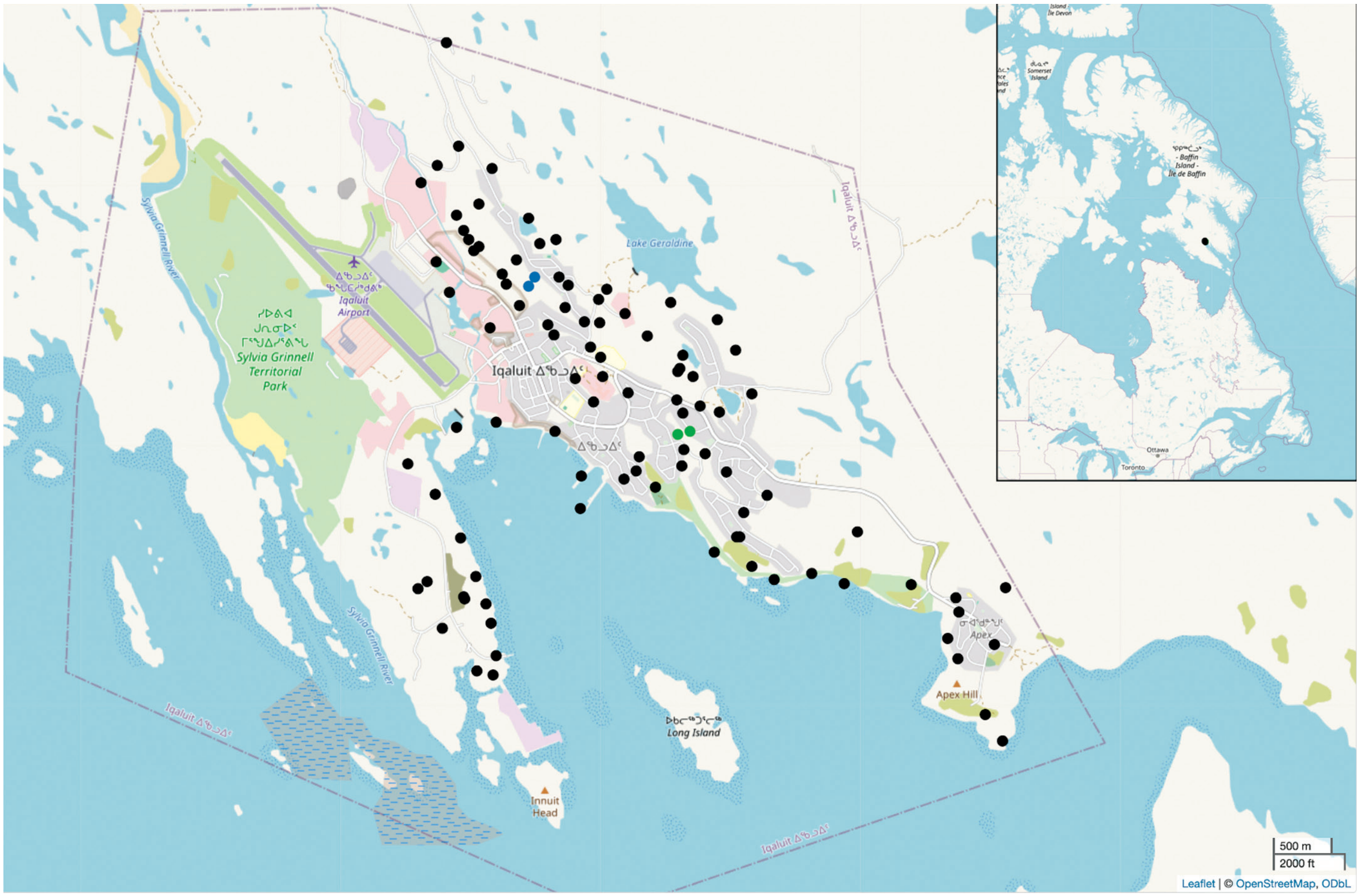

FIG. 2. Map of Snow Bunting (*Plectrophenax nivalis*) nesting locations in Iqaluit, Nunavut, 2024. Single brood nests are shown in black, Female A nests in blue and Female B nests in green.

RESULTS

During the 2024 research season in Iqaluit, a total of 102 Snow Bunting nests were found and monitored (Fig. 1). Clutch initiation dates were confirmed or estimated for 75 of 102 nests. Two of the 75 nests with confirmed or estimated clutch initiation dates were confirmed to be second broods of females individually identifiable by their colour bands. These two females are designated Female A and Female B, and nest observations for their first and second broods are summarized in Appendix Table S1.

Female A successfully fledged two broods, with her first brood fledging on 2 July and her second brood fledging on 31 July. Her second nest was located 82 m from her first nest site (Fig. 2). Her mate was not colour banded for these two broods, and therefore it is not known whether she was socially paired to the same male for both broods. Female B fledged nestlings from her first brood on 27 June and initiated a second nest 108 m from the first nest site (Fig. 2), resulting in hatched nestlings. However, this second nest was depredated on 16 July when the nestlings were two to three days old. Female B did not pair with the same male from her first brood. Her partner from the first brood was individually colour banded, and her second brood was raised with a new, unbanded male.

The mean clutch initiation date for Snow Buntings around Iqaluit in 2024 was 14 June ± 9 days (n = 75). Among the 75 nests whose clutch initiation dates could be determined, 58 (77%) were initiated between 5–23 June. Seven females had early clutch initiation dates between 29 May and 4 June, and 10 females had late clutch initiation dates between 24 June and 14 July. Two of these late clutch initiations were confirmed to be second clutches (Female A and Female B); the other eight late clutch initiations may have been due to late first broods, second attempts after earlier failure, or second broods. The first clutch initiation dates (day the first egg was laid) for Females A and B, that attempted second broods, were estimated as 30 May and 31 May, respectively. One nest was found with an even earlier estimated clutch initiation date of 29 May, but it is not known whether that female initiated a second brood.

The first broods of the two double-brooded females were estimated to have fledged on 2 July (Female A) and 27 June (Female B). These females were estimated to have initiated their second clutches on 1 July (Female A) and 2 July (Female B), indicating that the interval between fledging the first clutch and starting the second clutch was one day before and five days after the nestlings fledged. Only three bunting pairs initiated clutches later than the second nests of the two double-brooded females in this population in the study year. One of those three nests fledged successfully, and the other two were still active on 31 July, at the conclusion of the field season.

Even in the unlikely event that all 10 late clutches (initiated 24 June or later) were genuine second broods, no more than 13.7% (10/73) of females observed attempted second broods. The two confirmed second broods in the current study year provide a minimum estimate of 2.7% (2/73) occurrence in the breeding population. This estimate suggests the proportion of females attempting a second brood within our population may therefore lie between 2.7% and 13.7%.

DISCUSSION

Previous studies have confirmed double broods in populations of Snow Buntings in Scotland (Watson, 1996) and Svalbard (Epsmark, 2016), but this is the first documentation of double brooding in a North American population of Snow Buntings. Results from this study suggest that the proportion of females raising second broods closely mirrors results from the long-term study in Svalbard (Epsmark, 2016) where 2.3% of recorded breeding cases from 1998–2005 were second broods. The Svalbard study found that double broods were only recorded in years with early initiation of egg-laying (Hoset et al, 2009; Epsmark, 2016). Similarly, this first observation of double broods in Iqaluit occurred for the females initiating earlier clutches in 2024.

Recent empirical studies of Snow Buntings have confirmed that population lay dates are earlier in warmer springs: this species uses temperature cues four to five days before recruiting follicles to determine when to time laying, and that some individuals are more responsive to these temperatures (Riquier, 2024). Moreover, weather plays a role in determining the length of the Arctic breeding season by influencing food availability, since Arctic passerines rely on a diversity of invertebrates to feed nestlings (Eeva et al., 2000; Leung et al., 2018). Clutch initiation is later in Arctic-breeding birds than those breeding at lower latitudes, likely related to invertebrate emergence in the Arctic being later than temperate habitats (Maclean and Pitelka, 1971; Hussell, 1972; Strathdee and Bale, 1998).

Weather also significantly influences the availability of nest cavities, since ice and snow cover can limit access to nesting locations, directly impacting the length of the Arctic breeding season. Most Snow Bunting nests around Iqaluit are at ground level, requiring snow-free ground before clutch initiation. This results in later clutch initiation for Arctic ground-nesting birds in comparison to their counterparts in temperate regions. However, warmer urban microclimates could accelerate spring snow melt around rock cavities and anthropogenic cavities, providing "early bird" nesting spots. The double-brooding results we report on here suggest that Snow Buntings exhibit significant nesting flexibility in Iqaluit, potentially taking advantage of opportunities within the city to initiate nesting earlier and attempting second broods later in the season.

Longer breeding seasons and double broods could result in more offspring produced within a season, but this added workload and extension of the breeding season can also affect the amount of time adults have to moult and prepare for migration (Bonier et al., 2007). Previous work has shown that adult female Snow Buntings tend to leave later on fall migration than adult males and juvenile birds (McKinnon et al., 2016), delays which could be due to the increased level of investment in breeding by females. If double-brooding females began moulting later in the season than single-brooding females, it would be energetically costly and could reduce their survival. As such, the costs and benefits of the two strategies may include trade-offs between the survival of the first and second broods, and between parental survival and the probability of future reproductive output. These warrant further investigation.

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