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Breeding Bird Surveys at Alexandra Fiord, Ellesmere Island, Nunavut (1980 – 2008)

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ABSTRACT. Long-term monitoring of bird populations in the Arctic is of considerable interest as this area is experiencing rapid climate warming; however, multi-decadal studies in the Canadian High Arctic are rare. Over five summers between 1980 and 2008, we conducted breeding bird surveys by walking transects and mapping territories in a periglacial lowland on east-central Ellesmere Island, Nunavut. In all survey years, snow bunting (*Plectrophenax nivalis*), Lapland longspur (*Calcarius lapponicus*), and Baird's sandpiper (*Calidris bairdii*) were the most abundant species. Over the study period, the assemblage of breeding bird species appears to have changed little, except for an increase in Lapland longspur. In the summer of 2008, we also compared two techniques for censusing territories. We found that spot-mapping, a simple and cost-effective method, produced similar results to the more labour-intensive active-flushing. Spot-mapping is therefore suitable for conducting bird surveys in northern locations where the vegetation is short, the terrain is flat, and the visibility is extensive. In the coming years, it will be important to continue monitoring Arctic birds to determine how climate change is affecting their breeding populations.

Key words: active-flushing, Arctic, climate change, Ellesmere Island, High Arctic, monitoring, rope-drag, spot-mapping, survey

RÉSUMÉ. La surveillance à long terme des populations d'oiseaux de l'Arctique revêt un intérêt considérable à la lumière du changement climatique rapide que connaît cette région. Cela dit, il faut remarquer que peu d'études échelonnées sur plusieurs décennies ont été réalisées dans l'Extrême-Arctique canadien. Au cours de cinq étés répartis entre 1980 et 2008, nous avons effectué le dénombrement d'oiseaux nicheurs en traversant des transects et en cartographiant des territoires situés sur les basses terres périglaciaires de l'île d'Ellesmere, au Nunavut. Au cours de toutes les années visées par le dénombrement, le bruant des neiges (*Plectrophenax nivalis*), le bruant lapon (*Calcarius lapponicus*) et le bécasseau de Baird (*Calidris bairdii*) se sont avérés les espèces les plus abondantes. Au cours de la période visée par l'étude, l'assemblage d'espèces d'oiseaux nicheurs semble avoir peu changé, sauf pour ce qui est d'une augmentation de bruants lapons. À l'été 2008, nous avons également comparé deux techniques de recensement des territoires. Nous avons effectivement constaté que la méthode des plans quadrillés, une méthode simple et abordable, donnait des résultats semblables à la méthode de dispersion active qui demande beaucoup plus de travail. Par conséquent, la méthode des plans quadrillés convient bien à la réalisation de recensements d'oiseaux dans les emplacements nordiques où la végétation est courte, où le terrain est plat et où la visibilité est vaste. Au cours des années à venir, il sera important de continuer à surveiller les oiseaux de l'Arctique afin de déterminer quelles sont les incidences du changement climatique sur les populations d'oiseaux nicheurs.

Mots clés : dispersion active (active-flushing), Arctique, changement climatique, île d'Ellesmere, Extrême-Arctique, surveillance, tirage de corde, méthode des plans quadrillés, dénombrement

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INTRODUCTION

Long-term monitoring of breeding bird densities in the Arctic is important for identifying avian responses to climate change, as well as other stressors (Callaghan et al., 2005; Andres, 2006). Many birds, particularly shorebirds, appear to be declining in abundance (e.g., Morrison et al., 2001, 2006; Stroud et al., 2004; Gilchrist and Mallory, 2005), and models predict further reductions; however, some birds, particularly geese, appear to be increasing (e.g., Ankney, 1996; Zöckler et al., 2003; Chaulk et al., 2005; Morrison et al., 2006; Mallory et al., 2009). Such temporal-trend studies require long-term observations, but multi-decadal monitoring of Arctic bird populations in Canada is rare (Table 1).

Our High Arctic site is ideal for long-term monitoring of bird populations. First, the site is a large, well-vegetated lowland that supports a diverse array of plants, insects, and birds compared to its surrounding region (Freedman et al., 1994). Second, the local climate and vegetation have been intensively studied since 1980 (e.g., Muc et al., 1989; Freedman et al., 1994; Hudson and Henry, 2009). In addition, breeding birds were first surveyed at the site in 1980, and direct human disturbance is minor. In this study, we compare breeding bird surveys conducted by spot-mapping in

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TABLE 1. Summary of published (peer-reviewed or grey literature) multi-decadal, multi-species breeding bird surveys at northern Canadian sites.

Site	Location	Years	Sources
High Arctic			
Alexandra Fiord, Ellesmere Island, NU	(79˚ N, 75˚ W)	1980–81	Freedman and Svoboda, 1982
		1980–82	Freedman, 1994
		1980–82, 2003, 2008	this study
Prince Charles and Air Force Islands, NU	(67˚ N, 76˚ W)	1984, 1989, 1996, 1997	Johnston and Pepper, 2009
Qarlikturvik Valley, Bylot Island, NU	(73˚ N, 80˚ W)	1992–97	Lepage et al., 1998
		1993–2007	Cadieux et al., 2008
Truelove Lowland, Devon Island, NU	(75˚ N, 84˚ W)	1970–73, 1978–89	Pattie, 1990
Low Arctic			
Cape Churchill, MB	(59˚ N, 93˚ W)	1984, 1999, 2000	Sammler et al., 2008
Coats Island, NU	(63˚ N, 83˚ W)	1975–96	Gaston and Ouellet, 1997
Daring Lake, NT	(64˚ N, 111˚ W)	1998–2007	Obst, 2008
Rasmussen Lowlands, NT	(69˚ N, 95˚ W)	1975–76, 1994–95	Gratto-Trevor et al., 1998

the 1980s (1980, 1981, 1982) to more recent surveys (2003 and 2008). Our objectives were to estimate densities of local breeding bird populations, compare densities in the 1980s to the 2000s, and estimate the accuracy of spot-mapping by comparing it to the more intensive technique of active-flushing.

METHODS

Study Site

Breeding bird surveys were conducted in a relatively flat, periglacial lowland and the surrounding talus slopes (12 km^2). The site is adjacent to Alexandra Fiord (78˚53′ N, 75˚47′ W) on the east-central coast of Ellesmere Island, Nunavut (Fig. 1). The lowland is bound by the fiord to the north, two glacial tongues to the south, and cliffs and talus slopes about 500 m high to both the east and the west. There are four glacial rivers and streams in the lowland, as well as several small, shallow freshwater ponds near the coast. The lowland receives a greater accumulation of snow and has a warmer climate and a longer growing season than its surrounding region; therefore, it is considered a "polar oasis" (Freedman et al., 1994). The lowland has a mean annual temperature of -15˚C and becomes snow-free in June (Hudson and Henry, 2010). Over the last few decades, mean annual temperature has increased and snow-free dates have advanced (Hudson and Henry, 2009). Since 1981, July air temperature has been measured at the lowland's automatic meteorological station, which is next to the camp buildings and inside the study area (1.5 m aboveground, Model 207 temperature probe connected to a CR10 data logger, Campbell Scientific Canada Corp., Edmonton, Alberta). The vegetation is relatively productive and diverse compared to that of the surrounding uplands, and plant communities are stratified along a moisture gradient (Muc et al., 1989). Wet communities are dominated by sedges, moist communities by dwarf shrubs, and dry rocky outcrop communities by lichens (Muc et al., 1989). Vascular plant cover in most vegetation types is usually more than 60%, which is relatively high for this region of the High Arctic (Muc et al., 1989). Plants are typically 5–15 cm tall (Hudson and Henry, 2009). The site is described in detail in Freedman et al. (1994).

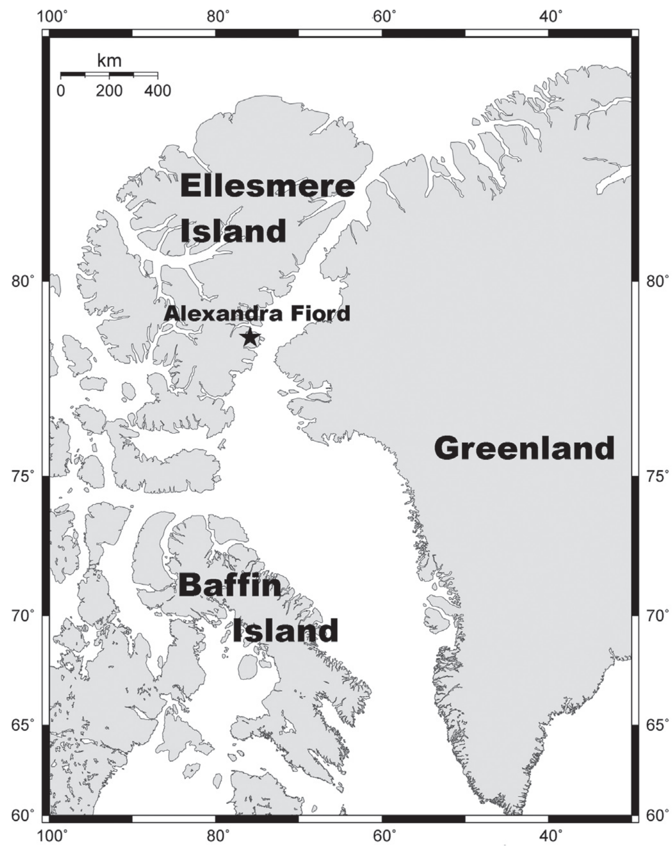

FIG. 1. Location of Alexandra Fiord (*) on the east coast of Ellesmere Island in the Canadian High Arctic.

Spot-mapping

Between late June and late July in 1980–82, 2003, and 2008, the entire lowland area was surveyed for breeding birds using an adaptation of the spot-mapping technique (Williams, 1936; IBCC, 1970). The lowland was divided into sections that could each be walked systematically in a day, usually by two (rarely three) observers spaced approximately 30–40 m apart. These sections differed between years because the waterways, which were often difficult to cross, changed over the study period. All sections of the lowland were surveyed at least three times, and high-density areas were surveyed up to six times.

Observers with extensive training conducted the surveys following detailed, standardized instructions. Surveys were conducted only on fair weather days (i.e., low winds and good visibility), usually between 07:00 and 19:00 local time.

The spot-mapping technique for these transect surveys involved recording every bird contact (visual or acoustic or both) and noting behaviour on a visit map. Breeding territories were determined by comparing visit maps. Confirmed territories were based on nest locations or observations of broods, while probable territories were based on clusters of at least two observations, particularly of birds demonstrating territorial or breeding behaviour such as singing or displaying (IBCC, 1970). Although the spot-mapping technique is subject to variation in factors such as weather, seasonal variability, bird detectability, and observer competence (Williams, 1936; Verner, 1985; Verner and Milne, 1990), it is considered to be a reliable tool for obtaining estimates of bird densities (Baillie, 1991; Bibby et al., 2000).

Active-flushing

In 2008, to determine the effectiveness of the spot-mapping technique, we conducted labour-intensive surveys (total time = 37 person-hours) using an active-flushing (rope-drag) technique in five 300 × 300 m plots. These plots were located inside the spot-mapping survey area. Plot locations were selected prior to spring snowmelt. We tried to achieve representative coverage of dry, moist, and wet vegetation types, basing our selection on a map of the lowland in Muc et al. (1989). Plot locations were staked, recorded with a handheld GPS, and then drawn onto high-resolution aerial maps that were subsequently used during the spot-mapping surveys.

In each plot, a pair of observers walked in parallel, approximately 10 m apart, with a 13.5 m rope-drag strung between them and attached to their belts with carabiners (Fig. 2). At 0.5 m intervals along the rope-drag, 1 m of heavy, brightly coloured rope with pieces of 10 cm long, pink flagging tape at the trailing end dragged along the ground between the observers as they walked. One observer placed flag stakes every 50 m along the inner edge of the plot to ensure that walked lines were straight. Both observers watched continuously for birds being flushed, and both birds and their behaviours were recorded on grid paper. We believe that we detected all territories in these plots (Verner, 1985; Fletcher et al., 2004), given the short vegetation and flat topography at the site. All spot-mapping surveys within the plots were conducted prior to the active-flushing surveys to prevent observer knowledge-bias of nest locations.

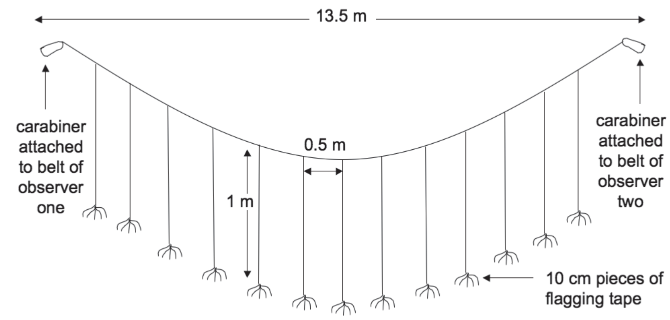

FIG. 2. Schematic of rope-drag used in five plots during the 2008 active-flushing surveys (not to scale).

By conducting the labour-intensive active-flushing surveys, we were able to estimate the effectiveness of the less intensive spot-mapping technique at detecting breeding birds. Our approach followed Bart and Earnst (2002), who suggest that researchers should employ a rapid method over a large area and an intensive method over a smaller area to determine actual densities.

Statistical Analyses

We conducted two-sided t-tests to compare the data from the 1980s (1980, 1981, and 1982) to the 2000s data (2003 and 2008). While we recognize the limitations of statistically analyzing our dataset, a basic statistical test can provide more rigorous support for trends that are detected by visual inspection of the data.

We analyzed the 1981–2008 July temperature data with a simple linear regression. Two years (1988 and 2005) were excluded from the analysis because of missing data.

RESULTS

Spot-mapping

Confirmed and probable territories were grouped for analysis because nest-searching effort varied across years, and therefore the ratio of confirmed to probable territories fluctuated over the study period. A preliminary analysis indicated that the data from confirmed and probable territories, when analyzed separately, produced similar results.

Total breeding bird densities were similar in 1980, 1981, 1982, and 2008, but higher in 2003 (Table 2). Snow bunting (*Plectrophenax nivalis*) was the most abundant species in all five survey years, followed by Lapland longspur (*Calcarius lapponicus*) and Baird's sandpiper (*Calidris bairdii*) (Fig. 3). Not included in Figure 3 are several species that were present only sporadically: three snow goose (*Chen caerulescens*) territories in 1980, five common eider (*Somateria mollissima*) territories in 2003, and three red knot (*Calidris canutus*) territories, one in 1981 and two in 2003. Three species, arctic tern (*Sterna paradisaea*), snow goose, and rock ptarmigan (*Lagopus mutus*), were observed breeding

TABLE 2. Survey efforts, temperature, and densities (pairs per km^2) during monitoring periods between 1980 and 2008. Monitoring began soon after the study site became snow-free. Number of person-hours in 2008 excludes time spent conducting active-flushing surveys.

Year	Monitoring Period	# of Person-hours	Mean July Temperature (˚C)	Pairs per km^2	Source
1980	30 June – 12 July	125	no data	12.8	Freedman and Svoboda, 1982
1981	20 June – 20 July	169	5.2	13.7	Freedman and Svoboda, 1982
1982	26 June – 6 July	125	4.7	13.2	Freedman, 1994
2003	27 June – 8 July	125	5.9	19.0	this study
2008	17 June – 8 July	180	6.8	13.6	this study

in the 1980s but not in 2008. However, we observed all three species breeding in nearby habitat outside the study area in 2007 and 2008.

The abundance of most species did not change between the two monitoring periods (two-sided t-tests, $p > 0.05$). Only Lapland longspur appears to have increased in the 2000s relative to the 1980s (two-sided t-test, df = 3, $p = 0.002$). Analyzed another way, Lapland longspur densities in the 1980s were 0.3 – 0.5 pairs/km^2 (95% confidence interval), and the densities for 2003 (1.9 pairs/km^2) and 2008 (1.6 pairs/km^2) fall outside this interval.

Comparison of Survey Techniques

The spot-mapping and active-flushing techniques provided similar results in all five labour-intensive plot surveys. Overall, spot-mapping surveys located 93% (13 of 14) of the pairs detected in the more intensive active-flushing surveys. Because of the similarities in the performance of the two techniques, no correction factor was calculated for the spot-mapping method.

Climate Data

Mean July temperature at the site increased by about 2˚C over the 1981 – 2008 period (simple linear regression, Temperature = 0.08 × Year – 149.38, df = 24, $r^2 = 0.35$, $p = 0.002$).

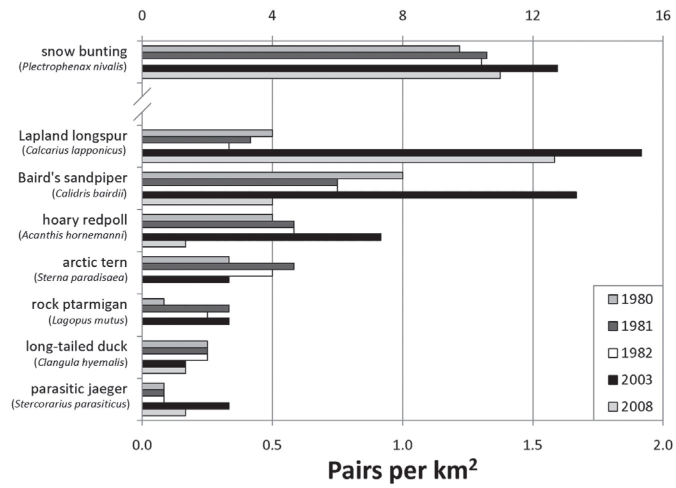

FIG. 3. Breeding bird densities at Alexandra Fiord, Ellesmere Island (78˚53′ N, 75˚47′ W) based on spot-mapping surveys. Probable and confirmed territories are combined. Note that two density scales are used: snow bunting densities correspond to the upper horizontal scale, and all others to the lower scale.

DISCUSSION

Density Estimates

When compared to estimates from other Canadian High Arctic sites (Table 1, Bliss et al., 1973; Freedman and Svoboda, 1982), breeding bird densities of 14.5 pairs/km^2 at Alexandra Fiord are intermediate. High Arctic breeding bird densities correlate with mean annual temperature (Freedman and Svoboda, 1982), and temperatures at our site are mid-range for the Canadian Arctic Archipelago. Similarly, owing in part to their warmer temperatures, Low Arctic sites typically have much higher densities of breeding birds than High Arctic sites. Warmer summers and longer growing seasons can support more productive plant and insect communities and greater numbers of breeding birds (Bliss et al., 1973).

Snow bunting densities were high at our site and were higher only on Devon Island (Pattie, 1990; Falconer et al., 2008). Snow bunting was the most abundant passerine at our site, whereas Lapland longspur is the most abundant in many other northern studies, such as those carried out in Aulavik National Park, Banks Island (Henry and Mico, 2002); Creswell Bay, Somerset Island (Latour et al., 2005); northwestern Ungava Peninsula, Quebec (Andres, 2006); and Daring Lake, Northwest Territories (Obst, 2008). The talus slopes that border the east and west sides of the lowland at Alexandra Fiord provide nest sites that are well suited for snow bunting.

Temporal Trends

Lapland longspur abundance was greater during the surveys conducted in the 2000s than in the 1980s. We can cautiously speculate that the increase may be due to increased plant productivity at the site over the period. Tall graminoids, which provide the preferred nesting habitat for longspur at Alexandra Fiord, have increased since the early 1980s (Hill and Henry, 2010). It is noteworthy that Lapland longspur increased in our study, while snow bunting did not, because these species share similar summer diets of seeds and invertebrates, with young being fed mainly invertebrates (snow bunting) and arthropods (Lapland longspur) (Lyon and Montgomerie, 1995; Hussell and

Montgomerie, 2002). At Truelove Lowland, Devon Island, Lapland longspur and snow bunting abundances fluctuated synchronously over a 16-year period (Pattie, 1990). Reports on temporal changes in Lapland longspur abundance are mixed. Boal and Anderson (2005) documented a decrease at Cape Churchill since the 1930s, likely due to habitat alteration through overgrazing by snow geese. In contrast, Cadieux et al. (2008) reported higher abundance in 2005–07 than in 1995–2004, though that increase may reflect variation in sampling effort (Gilles Gauthier, pers. comm. 2009).

No other species differed between the two periods. This fact is important, given that several Arctic bird studies have detected substantial temporal shifts, especially species declines (e.g., Morrison et al., 2001, 2006; Zöckler et al., 2003; Stroud et al., 2004). However, there appears to be interannual variation in the abundance of some species (see Fig. 3). This year-to-year variation may be attributed to a variety of physical and biological factors. Physical factors important to Arctic birds are often weather-related (e.g., winter snow depth, timing of snowmelt, temperature, precipitation, and extreme events) and have been variable at our site over the last several decades (Hudson and Henry, 2009). Important biological factors include resource availability (e.g., nest and food), interspecific competition, predation, and parasites (Newton, 1998). Conditions on both the wintering grounds and the migratory routes, such as weather and food availability, may also influence Arctic breeding bird populations. Owing to our limited understanding of many of the factors listed above, we cannot speculate on why our site had a higher total density of breeding birds in 2003 (more snow bunting, Lapland longspur, Baird's sandpiper, hoary redpoll, and parasitic jaeger) than in other years. Temperature and precipitation data collected by the authors since 1981 indicate that the weather and timing of snowmelt at Alexandra Fiord in 2003 were average (G.H.R. Henry, unpubl. data). Although Dickey et al. (2008) identified temperature as a critical variable for predicting snow goose nest density on Bylot Island, long-term, multi-species studies have been unable to identify key factors (e.g., Pattie, 1990; Cadieux et al., 2008; Obst, 2008). Year-to-year variation remains a poorly understood component of Arctic breeding bird monitoring.

While knowledge of interannual variation is certainly important, it is difficult to ignore the potential impacts of a warming Arctic on breeding birds over time. From 1981 to 2008, July temperature increased by about 2˚C at our lowland site. This warming is affecting many variables, including timing of snowmelt and food availability (Hudson and Henry, 2009). Long-term bird monitoring studies have detected changes to some of the physical and biological factors described above (e.g., Dickey et al., 2008); however, relating temporal trends to climate change in Arctic bird monitoring studies such as ours will remain challenging until we develop stronger associations between bird abundance and environmental variability.

Spot-mapping vs. Active-flushing

We found that the spot-mapping technique compared well to the active-flushing method. Spot-mapping is therefore a simple, cost-effective, and accurate method for surveying breeding bird territories in open tundra ecosystems. This technique is appropriate in open habitats, where visibility is good and birds are easily detected (Freedman and Svoboda, 1982).

Since we began monitoring breeding bird densities with the spot-mapping technique in 1980, more advanced survey techniques have been developed. While newer methods have merit, it was necessary for us to maintain a constant survey technique in our monitoring effort. The recent advances in bird survey techniques may improve the feasibility of surveying new and larger areas of the Arctic because they may be faster or better represent actual densities, or both (e.g., Brown et al., 2007).

Few studies have monitored breeding bird populations in the Canadian Arctic for temporal trends (Table 1). To evaluate the state of Arctic bird populations, a considerable increase in the number and geographic coverage of study sites is needed. Multi-decadal, standardized monitoring studies such as this one establish baseline breeding bird densities and, just as importantly, provide insight into how Arctic bird populations are responding to climate change, as well as to other factors.

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