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Avifauna of Hornsund area, SW Spitsbergen: present state and recent changes

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Abstract: The purpose of this study was to present the current state of avifauna in the vicinity of Polish Polar Station, at Hornsund (SW Spitsbergen). During four seasons (2003–2006) ten bird species were recorded as breeding there. Among them colonial little auk and Arctic tern were most abundant. Six additional species were noted during the breeding season but none of them bred there and their visits in the study plots were a consequence of their nesting nearby study area. Remaining 11 species were recorded during migration. The most pronounced changes over the last 35 years has been a considerable increase in number of barnacle geese exploiting the tundra as their foraging and resting area.

Key words: Arctic, Spitsbergen, Hornsund fjord, avifauna.

Introduction

The structure of the High Arctic ecosystems is believed to be simple, with relatively small number of elements (Remmert 1985; Woodin and Marquiss 1997). Therefore shifts in population numbers of any species could have cascading effects on the whole ecosystem. Many Arctic bird species being top predators, are excellent indicators of changes in the environment (Stempniewicz *et al*. 2007). Changes in their population dynamics may reflect changes in the lower trophic levels at an early stage, therefore birds may be a good tool for monitoring the whole ecosystem.

The Arctic environment is undergoing dramatic climate changes, and this trend is expected to continue (Kattsov *et al*. 2005; IPCC 2007; Przybylak 2007). Many Arctic birds respond to climate variability in terms of energetic costs, timing of breeding, reproductive output and mortality rates (*e.g*. Järvinen 1994; McCleery and Perrins 1998; Durant *et al*. 2004; Gjerdrum *et al.* 2003; Madsen *et al*. 2007). In addi-

tion, there are new potential threats such as industrial fisheries, environmental contaminants, oil exploration, tourism and other types of disturbance that influence bird populations and potentially, the structure of the whole ecosystem. Consequently, there is a need to assess the current status of particular bird species populations in order to have the possibility of tracking future changes.

This paper aims to present updated information on the composition, number, and local distribution of bird species breeding and resting in the vicinity of the Polish Polar Station, in Hornsund fjord (South-Western Spitsbergen). Ornithological investigations in Hornsund area have a long history (*e.g.* Norderhaug 1968; Stempniewicz 1980, 1981; Konarzewski *et al*. 1993; Karnovsky *et al.* 2003; Harding *et al*. 2004; Wojczulanis *et al*. 2005; Jakubas *et al.* 2007). However, only a few studies have focused on the composition of the entire avifauna, which were done a long time ago (Ferens 1958, 1968; Jakubiec 1982) thus this is the first quantitative analysis of local avifauna at Hornsund since 1973.

Presented results pertain to relatively small but important area. The species composition and abundance of birds in the study area seem to be rather representative for Spitsbergen, so any general change in Spitsbergen avifauna, for instance related to the climate change, should be reflected also in bird community from the Hornsund area. Additionally, the neighborhood of Polish Polar Station provides continuous presence of ornithologists what makes possible that potential future changes in avifauna will be recorded. Moreover, recent rapid growth of tourism as well as scientific activity in Hornsund area (own data) may potentially affect negatively birds breeding there. Several studies report adverse effects of human disturbance on birds nesting in polar regions (*e.g.* McClung *et al.* 2004; Culik *et al.* 1990; Wilson *et al.* 1990, 1991; Giese 1996, 1998; Giese and Riddle 1999; Woehler *et al.* 1994). Thus it is worth to monitor the local avifauna in order to undertake appropriate steps in case of occurrence of any anthropogenic changes. The present study may also serve as a background for subsequent ecological studies carried out in the area.

Study area, materials and methods

This study was carried out in the northern part of the Hornsund area in the vicinity of the Polish Polar Station (77˚00'N 15˚33'E) during four seasons: 2003 (27 July – 30 September), 2004 (14 July – 14 August), 2005 (24 May – 31 July) and 2006 (16 May – 7 August). The study area comprised flat tundra between the fjord coast and the Ariekammen mountain as well as northern slopes of the mountain (in total ca 2 km^2; Fig. 1). The flat tundra was naturally divided by a permanent stream into two plots with the surface of *ca* 0.75 km^2 each. The habitats of the first plot (T1, Fig. 1) was greatly diversified and included skerries, low, gravel beaches, flat moss and lichen tundra with periodic and permanent stream flows, ponds and rock hummocks. The second part of the area (plot T2, Fig. 1) is geologically and

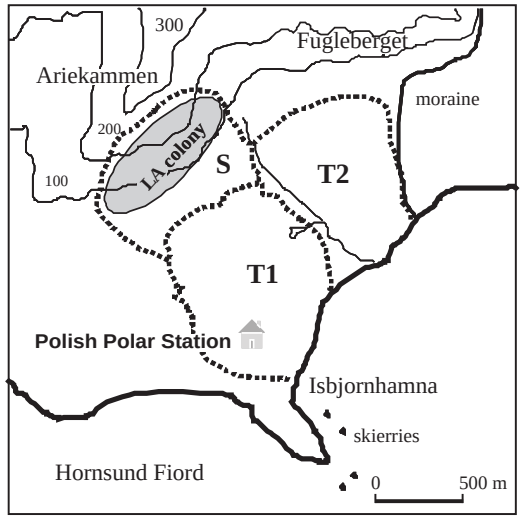

Fig. 1. Area of study. Borders of the particular studied plots (T1,T2, S) are marked with dotted line and little auks colony area with grey oval shape.

hydrologically far less heterogeneous, with sparse vegetation. The mountain slope (ca 0.5 km^2) is a mosaic of rock debris (average diameter of rock 0.5 m) and rich vegetation of vascular plants.

Nests of all bird species, and in case of *Passeriformes* – singing males, were recorded in four consecutive seasons within the whole study area. A singing male, which was observed at the same place at least 5 times during one season, was considered as breeding nearby. In order to estimate the nest density of little auks (*Alle alle*) colonially breeding in crevices within rock debris, fresh piles of chick faeces found in rock crevices were counted within the four 5 × 5 m plots in the centre of one of the colony patch in late chick rearing period in 2003. It is known that chicks defecate usually in the same place in the nest chamber, thus considerable amount of fresh faeces should indicate an active nest (Stempniewicz 1995).

Additionally, regular counts of geese (adults and gooslings separately), ducks, terns and gulls were performed in 2005 (24 May – 31 July) and 2006 (16 May – 7 August). All birds observed in the study area (Fig. 1) were counted 1–5 times a day (on average 1.4 times) during the prelaying, incubation and chick rearing period. Occasionally, inshore waters of the fjord (ca 1 km from the coast) were surveyed as well. Age and sex of birds were determined, whenever it was possible (using field guide by Mullarney *et al.* 1999). In total, 157 counts (81 in 2005 and 76 in 2006) were performed. Additionally, counts of glaucous gulls, *Larus hyperboreus*, were made during the period of little auk young departure from the colony (second week of August) in 2003 (N = 27 counts) and 2004 (N = 14 counts). Terms of phenological periods (prelaying, incubation and chick rearing) were determined according to species-specific breeding time.

Results

Of the 27 bird species observed during four seasons, ten species have been recognized as breeding within the study area (Table 1). The little auk was the most numerous colonially breeding species, followed by Arctic tern (*Sterna paradisea*). Virtually all breeding species were recorded on the slope and in plot T1, whereas in plot T2 only one nest of Arctic skua (*Stercorarius parasiticus*) and one nest of snow bunting (*Plectrophenax nivalis*) were noted.

Northern fulmars (*Fulmarus glacialis*), black-legged kittiwakes (*Rissa tridactyla*), Brünnich's guillemots (*Uria lomvia*), Atlantic puffins (*Fratercula arctica*) and black guillemots (*Cepphus grylle*) were regularly observed during the breeding season in the area and/or in the adjacent fjord waters, but did not nest there. One individual of ptarmigan (*Lagopus mutus*) was observed on the slope of Ariekammen in July 2005.

Eleven additional species were recorded on the beach or in the coastal tundra, but only during the period of spring and/or autumn migration. They were: brant goose (*Branta bernicla*) (12 individuals in autumn 2003 and 2 individuals in

Table 1

Number of breeding bird species in three studied plots (T1 – 0.75 km^2, T2 – 0.75 km^2, S – 0.5 km^2) in the vicinity of the Polish Polar Station in Hornsund, Spitsbergen, in 2003–2006 (ranges were given for the whole studied period, except for little auk – data from 2003)

Family	Species	Number of nests	Nesting habitat (studied plot)
Alcidae	Little auk* *Alle alle*	on average: 1.6 per 1 m^2	slope (S)
Anatidae	Pink-footed goose *Anser brachyrhynchus*	0–1	slope (S)
Anatidae	Barnacle goose *Branta leucopsis*	0–1	skierres (T1)
Anatidae	Eider *Somateria mollissima*	0–1	tundra (T1)
Scolopacidae	Purple sandpiper *Calidris maritima*	0–1	tundra (T1)
Sternidae	Arctic tern *Sterna paradisea*	10–12	near to shore tundra and beach (T1)
Stercoraridae	Arctic skua *Stercorarius parasiticus*	1–1 1–1	tundra (T1), tundra (T2)
Laridae	Glaucous gull *Larus hyperboreus*	1–2	skierres (T1)
Emberizidae	Snow bunting** *Plectrophenax nivalis*	3–4 2–3 0–1	slope and rocks (S) tundra (T1) tundra (T2)
Turdidae	Wheatear*** *Oenanthe oenanthe*	0–1	slope (S)

* nest density, ** nests or singing males, *** pair of adults; probably only breeding attempt

spring 2006), king eider (*Somateria spectabilis*) (1 male in spring 2005 and one pair in spring 2006), long-tailed duck (*Clangula hyemalis*) (2 males and 1 female in spring 2005), ringed plover (*Charadrius hiaticula*) (1 individual in autumn 2005 and 2 individuals in spring 2006), whimbrel (*Numenius phaeopus*) (1 adult in spring 2005), common redshank (*Tringa tetanus*) (2 observations of 1 adult in spring 2005 – 1 ind.), ruddy turnstone (*Arenaria interpres*) (1 adult in spring 2003), red phalarope (*Phalaropus fulicarius*) (one pair in spring 2005 and two males and one female in spring 2006), great skua (*Catharacta skua*) (few observations of one individual in spring 2005 and 2006), and black-backed gull (*Larus fuscus graelsi*) (1 individual in spring 2005 and 2006). One carcass of adult barn swallow (*Hirundo rustica*) was found in spring 2006 (probably died in autumn 2005).

Counts of birds:

Barnacle geese (adults) were recorded in considerable numbers throughout the whole breeding season; greatest numbers were noted during the chick rearing period (Kruskal-Wallis test, 2005–2006 combined, $H_2 = 10.01$, N = 157, P = 0.007, Dunn test, P <0.05; Fig. 2). Barnacle geese were observed more frequently on the slope (S in Fig. 1) than in the flat tundra (T1 and T2 on Fig. 1) during the prelaying (Mann-Whitney test, 2005–2006 combined, Z = 4.86, N = 60, P <0.001) and the incubation period (Mann-Whitney *U*-test, 2005–2006 combined, Z = 3.80, N = 122, P <0.001). The opposite pattern (more geese in the flat tundra comparing with the slope) occurred during the chick rearing period (Mann-Whitney *U*-test, 2005–2006 combined, Z = -2.47, N = 96, P = 0.01). Up to 8 families (adults and gooslings) in 2005 (on average 6.9 ± 2.8, N = 29 surveys) and 10 in 2006 (on average: 4.4. ± 1.3, N = 54 surveys) were observed foraging and resting in the studied area.

Pink-footed geese (adults) were observed in the course of the whole breeding season; however, they occured in highest numbers during the prelaying period (Kruskal-Wallis test, 2005–2006 combined, $H_{2,157} = 60.82$, P = 0.005, Dunn test, P <0.05; Fig. 2). Regardless of the period, pink-footed geese were recorded almost solely on the slope and hardly ever on the flat tundra (Mann-Whitney *U*-test, 2005–2006 combined: prelaying: Z = 4.48, N = 60, P <0.001; incubation: Z = 5.19, N = 122, P <0.001; chick rearing: Z = 2.03, N = 96, P = 0.04).

Eiders (adults) were recorded in small numbers, up to 12 males and 15 females [on average 0.4 ± 1.64 males and 0.4 ± 1.88 females (N = 157, 2005–2006 combined) were recorded per the survey]. All birds were observed during the incubation period at the banks of ponds in both flat plots (T1, T2 on Fig. 1).

Arctic terns were found with an average 14.3 ± 7.71 (N = 157) adult individuals per survey in the course of whole breeding season (2005–2006 combined) and solely within the coastal belt of tundra and beach.

Glaucous gulls were recorded in small numbers (up to 8) but consistently flying over and/or sitting within the little auk colony during all stages of the breeding

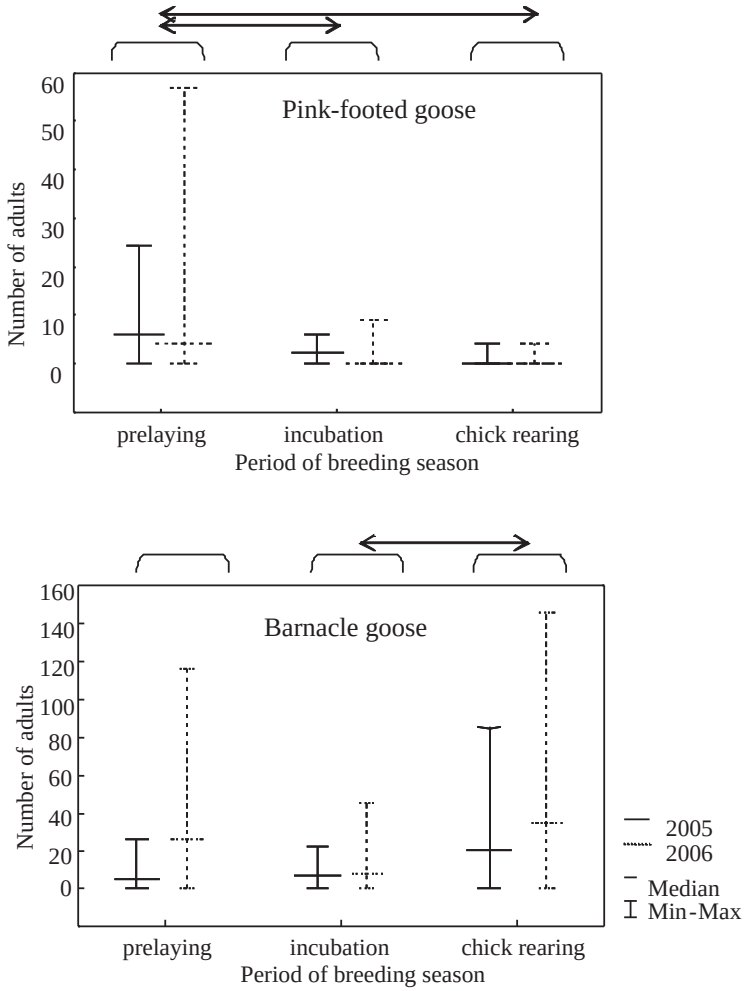

Fig. 2. Number of adult pink-footed goose and barnacle goose recorded in consecutive periods of the breeding season in the vicinity of the Polish Polar Station, in Hornsund in 2005 and 2006. Significant differences (Kruskal-Wallis test, $P < 0.05$) are marked with arrows.

season (2003–2006). Then, during the time of colony departure by young little auks, gulls were observed in higher numbers (on average 10.0 ± 7.19, $N = 27$; up to 23 in 2003 and 7.2 ± 2.40, $N = 17$; up to 14 individuals in 2004) in the flat tundra (T1 and T2 on Fig. 1).

Discussion

All breeding birds recorded, except of the wheatear *Oenanthe oenanthe* (which is an irregular breeder), are common or abundant in the study area, as well

as throughout Spitsbergen (Strøm 2005). Five species, which have been noted regularly but did not breed there, are also common in Spitsbergen. Their regular visits in the study plots were a consequence of their breeding in the proximity of the investigated region. There is a large seabird colony at Gnålberget (*ca* 10 km to the east), consisting mainly of black-legged kittiwakes and Brünnich's guillemots (several thousands pairs of each species, own estimation), but also of northern fulmars and Atlantic puffins breeding in smaller concentrations. Black guillemots are nesting in low numbers on Fugleberget mountain, adjacent to Ariekammen. A single record of ptarmigan was probably associated with its permanent presence (possibly breeding) on the near slope of Fugleberget, where the species was observed regularly in the earlier seasons (the staff of the Polish Polar station, personal communication).

All migratory species which visited the study area in spring and autumn (11 species) were observed in other sites of Spitsbergen and some of them are known to nest there (brant goose, king eider, long-tailed duck, ringed plover, ruddy turnstone, red phalarope, great skua). The rest are considered as frequent (whimbrel, common redshank, black-backed gull) and relatively frequent (barn swallow) visitors (Strøm 2005).

The estimated numbers of breeding pairs of particular species in the study area may be not precise due to the way of particular species nesting and to constraints of the applied methods. In case of the little auks, calculated nest density may be underestimated as some chick faeces depositions used for nest number estimation might have been unvisible. Nevertheless, the nest density presented in this study (1.6 nests per 1 m^2) seems to be one of the highest densities recorded for little auks (0.5–1.6 nests per 1 m^2, Isaksen 1995). This remains in agreement with other studies showing, that the Hornsund area is one of the most important breeding sites of little auk in Svalbard (Norsk Polarinsttitut thematic maps, http://miljo.npolar.no/temakart).

The number of breeding pairs of barnacle geese may be underestimated considering relatively high number of families recorded in the study area during the chick rearing period. On the other hand, families noted could have nested somewhere outside the studied area and then migrate towards the vicinity of the Polish Polar Station after hatching, attracted by the richness of plant life within the study plots. Nevertheless, high number of adults of barnacle geese recorded during the whole breeding season (counting results) indicates that the study area is an important foraging and resting place for this species. It is worth noting that they were rarely observed in 1970s–80s (few individuals by Jakubiec 1982; Stempniewicz 1990, 1992 and own, unpublished data). Increase in the barnacle goose population in this area is probably related to the general increase in the Svalbard population of this species. Since the banning of hunting many new areas have been colonized (*e.g.* Kongsfjorden in the 1980s), and the populations that survived the earlier hunting pressure at both ends of their migration route have all increased in number dramatically (Mehlum and Pokrovskaya 2000; Strøm 2005).

The number of breeding pink-footed geese, based on nests recorded, seems quite reliable or at most a little underestimated. The number of both breeding and staying geese within the study area during the breeding season, was relatively small and is similar to the results presented by Jakubiec (1982). However, according to Stempniewicz (1992) and own, unpublished data, the geese were observed twenty years ago much more frequently (5–10 nests) than in the present study. It is possible that the decline in the pink-footed goose local population is in part due to the increasing numbers of barnacle geese in the area. There is some evidence of food competition between these two species (Fox *et al.* 2006). Results of this study seem to confirm also the existence of competition between the two goose species, showing distinct spatial and temporal separation between them. In general, pink-footed geese use mountain slopes, and barnacle geese flat tundra habitats. It is also important to stress here that brant goose (*Branta bernicla*), which in this study was recorded only during migration, used to breed in this area regularly in the 1950s (Ferens 1958). In the 1970s, however, this species was already not recorded (Jakubiec 1982; Stempniewicz, unpublished data).

The number of breeding Arctic terns, although based on the nests recorded, may be overestimated. It is possible that a few pairs were counted more than one time because of replacement clutches. High predation pressure (mainly by Arctic fox, *Alopex lagopus*) resulted in very low breeding success throughout the four studied seasons (own unpublished data). Nevertheless, number of breeding pairs seems to be stable at least since the study by Jakubiec (1982).

Nests of glaucous gulls were relatively easy to find, thus estimations of numbers of breeding pairs are likely to be accurate. The study area seems not to be very important for the gulls as a breeding place. Greater numbers are breeding in the close vicinity of the study plots (Fugleberget and Revdalen; Stempniewicz 1995; Malinga 1999, own unpublished data from 2005 and 2006). Nevertheless, glaucous gulls are permanent "users" of the area because of the large numbers of little auks constituting their important prey (Stempniewicz 1995; Malinga 1999; Wojczulanis *et al.* 2005). Increasing gull numbers observed in the second part of August, when massive colony departure of little auk fledglings took place, were result of arrivals from neighbouring areas. There is some indirect evidence that the local population of glaucous gull and consequently its predatory pressure on little auk have increased over the last twenty years (Wojczulanis *et al.* 2005).

The estimates of number of eider, Arctic skua, purple sandpiper and snow bunting were based on recording of nest number and are quite reliable or at most somewhat underestimated. Numbers of these species recorded in this study seem to be similar to those presented by Jakubiec (1982), except for snow bunting, which was far less numerous in the present study. For this species the differences may be partly due to the criteria applied in the present study (at least five records of singing male at one place versus one record of a singing male in the earlier study).

Among bird species which used to breed in the vicinity of the Polish Polar Station in the past but not currently, are red-throated diver (*Gavia stellata*), ruddy turnstone and red phalarope (Jakubiec 1982). Nevertheless, because only single pairs of these birds were observed nesting in the past, their current absence brings no information about any changes in the studied area.

The majority of breeding birds were recorded within T1 plot, whereas in the plot T2 only few birds were nesting (Fig. 1). Also birds visiting the area to feed and rest were observed mainly in T1 plot. The reason of such plot diversification is a little auk colony situated in the neighborhood of T1 plot. Large amounts of excrements delivered by these planktivorous birds (~60 t dry mass/km^{-2} for the colony area, ~25 t km^{-2} in the circular flight zone around the colony and ~0.6 t km^{-2} for the tundra between the colony and sea) are considered a significant factor stimulating primary and secondary production near the colony area (Stempniewicz 1990, 1992; Stempniewicz *et al.* 2006). Thus, the areas adjacent to the little auk colony, like T1 plot, form rich pastures for herbivorous and insectivorous birds (Stempniewicz *et al.* 2007; Jakubas *et al.* 2008). Also the gathering of glaucous gulls in the immediate vicinity of little auk colony is not surprising as they are an important predator on the little auks (Stempniewicz 1995; Wojczulanis *et. al*. 2005). These findings emphasize the existence of mutual relationships between Arctic organisms. Any disturbance in such precisely functioning system may cause serious consequences for all of its components.

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