

Species composition and population fluctuations of alpine bird communities during 38 years in the Scandinavian mountain range

Artsammansättning och antalsförändringar hos alpina fågelsamhällen under 38 år i de Skandinaviska fjällen

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Abstract

The breeding birds of four low alpine plots in Sweden were surveyed at Ammarnäs (65°50'N; two plots, each 100 ha, for 38 and 36 years), Abisko (68°18'; 130 ha, 12 years), and Anjan (63°45'; 150 ha, 11 years). Mean number of species of each plot was between 8 and 12 per year. Mean densities were between 37 and 89 pairs/km². *Anthus pratensis* was the most abundant species in all plots (33–52% of all pairs). *Pluvialis apricaria* had a mean density of between 3 and 4 pairs/km² in all plots, hence a density that may be typical for very large mountain areas. *Calcarius lapponicus*, endemic to low alpine habitats, varied much between the plots, from 24 pairs/

km² to none. Long-term trends at the Ammarnäs plots included increases of *Pluvialis apricaria*, *Lagopus lagopus* and *L. mutus*, and declines of *Anthus pratensis*, *Eremophila alpestris*, *Gallinago media* and *Tringa glareola*, but only that of *E. alpestris* being known to be more than local. The stable bird community accords well with the observed habitat stability.

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Received 19 May 2006, Accepted 4 November 2006, Editor: Å. Lindström

Introduction

Much of the terrestrial habitats of the world have been transformed by human influences. In Sweden, as elsewhere, farming and forestry have been the most important factors. Only a few percent of the productive land have been more or less unaffected in parts of northern and almost nothing in southern Sweden. No habitat has remained genuinely pristine since all of them have been affected to at least some extent, for example by long distance transport of nutrients and pollutants, possible anthropogenic climatic shifts, or indirectly by changes in adjacent, more heavily exploited habitats. Hence it is difficult to study properties of “natural” habitats, i.e. conditions under which species assemblages developed with only minimum human influence. Both for conservation and basic population research, pristine or near pristine habitats are important because many threatened species reside in them and population and selection processes may be different. This has been forcefully stressed several times, recently by Tomiałojć & Wesolowski (2004) and Wesolowski (2005) when reporting on studies conducted in the

Białowieża forest, the last remaining pristine temperate forest in Europe.

The alpine heaths and moors of the Scandinavian mountain range are among the least altered habitats in Europe, in spite of a long history of reindeer *Rangifer tarantus* farming. The only major part with a wild population of reindeer is Hardangervidda in Norway, where, however, the population size is regulated by hunting rather than by natural predators and winter conditions. The only other extensive habitats without heavy human influence are mire, particularly wet mires in northern and some raised bogs in southern Sweden, and subalpine forest, particularly the birch forest zone between the tree-less alpine zone and the coniferous zone below.

The present study was carried out in three alpine sites where human impact, with the exception of reindeer farming, has been low: (1) near Abisko in northern Lapland, (2) near Ammarnäs in southern Lapland, and (3) near Anjan in western Jämtland. At two of the sites, Abisko and Ammarnäs, permanent human settlements were not established until the 19th century. The Abisko area became easily accessible in 1902 when the railway between Luleå

and Narvik was completed and the Abisko tourist station was established, but by road not until the early 1980s. Ammarnäs got road access as late as in 1938. The Anjan area had settlements and was more easily accessible much earlier, located as it was between areas on both sides of the Norwegian–Swedish border that had been populated since very long. All three study areas are currently located within nature reserves: Abisko National Park, Vindelfjällen nature reserve, and Skäckerfjällen nature reserve, all three also being Natura 2000 Areas or Special Protection Areas (SPAs).

Reindeer farming, in one form or another, has been carried out from the 17th century, when hunting of wild reindeer gradually transformed into herding of domesticated reindeer. The study areas are currently mainly used by migrating herds in spring and autumn. During the 20th century, the total number of reindeer in Sweden has varied between 150,000 and 300,000 with about a 30 year cycle, but without any long-term trend. The numbers were low in 1965–1975 and high in 1985–1995. Then numbers declined to about 220,000 in 2000. For more information about reindeer husbandry, see SCB (1999) and Jordbruksverket (2003).

It has been argued that reindeer grazing, especially on lichens, has altered the vegetation structure fundamentally. This is true, but little is known about the possible effects on birds, and, in any case, it is difficult to judge what the situation would have been with a “natural” size of a wild reindeer population because such conditions have not prevailed for very long. The intensity of reindeer grazing has been argued to be beyond sustainability in Finmark (Tømmervik et al. 2004) with more or less complete depletion of the lichens and other vegetation degradation. Thick lichen mats are certainly absent also in the study areas, but can be seen on the top of large rocks and other sites where the reindeer cannot graze. However, my subjective impression of the alpine vegetation at the sites of the current study is more in line with the description given by Moen & Danell (2003), a generally moderate grazing intensity with degradation of the vegetation only locally. But as said above, the bird survey sites were not true summer grazing grounds with permanent presence of large herds.

Another human influence has been hunting, but this has not affected the habitats, although it has reduced the population size of a few species, particularly larger predators, both birds and mammals. More “natural”, i.e. larger populations of these predators may have resulted in other densities of their avian prey, at least temporarily.

During the 19th and first half of the 20th century (earlier in the Anjan region) some alpine meadows and mires were used for harvesting hay and grazing cattle, but this use ceased about 1950 or earlier, and the habitats have recovered slowly since then and few remaining effects can be seen to-day, or at least cannot easily be distinguished from the continuing effects of reindeer grazing. Therefore, this study has been carried out in areas that are as close to a pristine habitat as one can ever find in Sweden today.

In relation to the particular plots surveyed in this study a slight modification to the general statement needs to be mentioned. All were located near reindeer corrals or butcheries with guiding fences and enclosures where the reindeers were collected at certain times of the year. Within the enclosures, the vegetation was heavily trampled but the vegetation within the study plots was not observed to be different from that of the surrounding areas more distant from the corrals. Hence, the effect of reindeer grazing within the plots was, apparently at least, the same as in the three mountain areas in general.

For scientific names of birds, I refer to Table 1.

Study areas

The three study sites were located at different latitudes and elevations. However, because the vegetation zones shift elevation along the latitude gradient, they all lay in the same zone, namely in the low alpine zone not much above the tree line. The most important site was located at Ammarnäs in southern Lapland (65° 50' N), where two plots, each c. 100 ha, were surveyed for 38 and 36 consecutive years. The plots at the other two sites, Abisko in northern Lapland (68° 16', 130 ha) and Anjan in western Jämtland (63° 45' N, 150 ha), were surveyed during 12 years of a 15 year period and 11 years of a 14 years period, respectively. The time series from Ammarnäs was sufficiently long for population trend analysis whereas the other two series were too short for that purpose. They were, however, quite sufficient to show annual variation and to serve comparisons of species composition and densities between the sites. In the following, I use the term site for the three study areas in general, Abisko, Ammarnäs, and Anjan, and plot for the small areas where the birds were counted. The latter will be referred to as Pätjujaure (at Abisko), Kraipe K1 and K2 (at Ammarnäs), and Ottsjö (at Anjan). A site map is given in Figure 1.

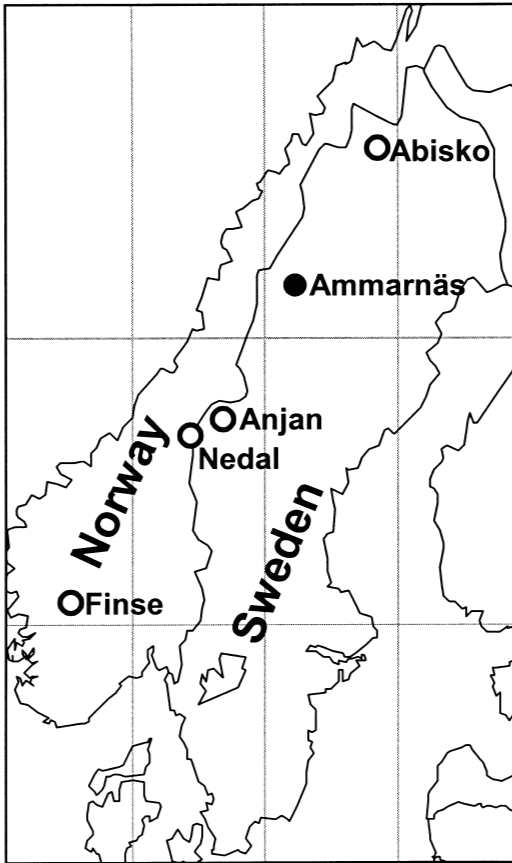


Figure 1. Map of Scandinavia with the study sites.
Karta över Skandinavien med undersökningsområdena.

Study plots K1 and K2 (Kraipe) near Ammarnäs, southern Lapland

Two plots, called K1 and K2, were surveyed in 1964–2001 and 1964–1999, respectively. The sizes were 1.00 km² and 1.14 km². In this paper they are treated as if they were exactly one square kilometre each. The plots were located about 16 km SSE of Ammarnäs and 6 to 9 km south of the village of Djupfors. The approximate coordinates were 65°50'N and 16°20'E. The exact kilometre coordinates of the corners of the plots were as follows (Swedish National Grid, RT 90 2.5 gon). K1: 1525.220/7302.570; 1524.830/7303.450; 1525.510/7304.070; 1526.120/7303.190. K2: 1523.800/7301.000; 1523.600/7301.500; 1523.460/7302.060 (the border was not straight between two of the corners); 1524.400/7302.400; 1524.790/7301.430.

The plots could easily be reached by road to a point only one km from the nearest plot and three km from the more distant plot. The distance between the plots was one km. The road went to a reindeer corral and butchery situated in the birch zone below the plots. The plots once got their names after K in Kuoltatjåikko, the name of the mountain on the map that we used at that time (Generalstaben's map, Sheet no. 33 Sorsele, issued 1896). In recent maps, this mountain was called Svare. We kept the original plot names, but today we refer to them as the Kraipe plots, Kraipe being the current map name of the reindeer butchery.

Plot K1 covered a gentle slope facing northeast with the lowest point at 790 and the highest point at 850 m a.s.l. K1 included a mixture of habitats, the most important ones being mire with a shallow peat layer with *Carex* species, low willows *Salix* spp. and dwarf birch *Betula nana*, and heath with low scrub vegetation such as dwarf birch, junipers *Juniperus communis*, crowberries *Empetrum nigrum*, and bilberries *Vaccinium myrtillus*. In small areas along two small streams there were taller willow fields. There were no trees within the plot apart from a few small and solitary birches *Betula pubescens czerepanovii*. The plot was, both to the human eye and according to general vegetation maps, representative for the slope on which it was situated, which stretched from Guonger in the northwest to Nase in the southeast and covered an area of 30–40 square kilometres, bordered by the birch forest zone at about 720–740 metres above sea level along the north-eastern fringe. The distance from the forest limit to K1 was about one km with scattered copses of birches becoming gradually sparser approaching K1. There was only one very small pond within and a few small ponds just northwest of the plot. The *Carex* mires were used for collection of winter fodder until the 1940s, and when we started the study in 1964, some poles from hay-fences could still be seen. A slow recovery of these formerly harvested areas was observed in the form of scattered low willows invading the wet *Carex* fields. According to the terminology of *Vegetationstyper i de svenska fjällen* (Vegetation types of the Swedish mountains), sheet no. 12, the two vegetation types of K1 were fresh heath (*frisk rished*), and dry fen (*torra kärr*).

Plot K2 was located on a ridge with two diagonally opposite corners (minimum elevation) at 880 m and the highest point at 940 m. The ridge was dry and well drained with little vegetation higher than bilberries, crowberries, flat junipers and scattered low willows. Lichens and mosses predomi-

nated and there were some block fields and small parts with snow fields that often did not melt until July. Only a few hectares at the lowest sections contained mire with a very shallow peat layer and small willow fields. There were no water bodies apart from a small pond, which, however, contained water only temporarily, during the snow-melting period and after heavy rains. This plot was typical for the mountains at this elevation in the whole area from Guonger to Nase and Valle, about 40 square kilometres. According to *Vegetationstyper i de svenska fjällen*, sheet no. 12, the vegetation types of K2 were dry heath (*torr rished*) with some fresh heath (*frisk rished*).

Study plot Pätjujaure, near Abisko, northern Lapland

This plot was surveyed in 1982–1990, 1992–1993, and 1996. The plot was located north and east of the lake Pätjujaure 14 km southwest of Abisko, mainly within the Abisko National Park. The approximate coordinates were 68°18' N; 18°31' E. The exact borders using the National Grid coordinates were as follows. In the west it was limited by a line from coordinate 1611.10/7579.90 to 1611.10/7580.75, in the north by a line from the latter point eastward to 1612.80/7680.75, in the east by a line from this point southward to 1612.80/7579.65, which was located at Pätjujokk 200 m from its outflow from the lake. Toward the south, the plot was limited by the lake. The total land area was 130 ha without any water bodies. The elevation was between 780 and 910 m. The forest line (birch) run at 640 m elevation. Although, the lake was not included in the survey area, the waterfowl on the lake were counted.

The bedrock was partly calcareous with species-rich vegetation and with patches of *Dryas* heath within the predominant crowberry heaths. According to *Vegationskarta över de svenska fjällen*, sheet no. 2, the predominant vegetation type was grass heath (*gräshed*) with *Carex* and *Juncus*, meadow with low herbs (*lågörtäng*), and some fresh heath (*frisk rished*) with *Salix*, junipers and *Betula nana*. For a detailed vegetation description, I refer to Ek & Eknert (1983).

Study plot Ottsjö, near Anjan, western Jämtland

This plot was surveyed in 1983–1990, 1992–1993, and 1996. The plot was located on the western slope of Anjeskutan in the Skäckarfjällen range. The plot was rectangular (1×1.5 km, 150 ha). The approxi-

mate coordinates were 63°45' N; 12°35' E. Using the National Grid coordinates, the plot was bordered by straight lines between the following exact corner coordinates: 1340.0/7075.0; 1340.0/7076.0; 1341.5/7076.0; 1341.5/7075.0. The lowest and highest elevation was 600 and 640 m. The forest line was rather diffuse in the area, but there were forest areas (conifers and birch) up to about 600 m rather near the plot. There were about 40 water bodies within the plot, most of them small. Together they covered 15.6 ha (10.4% of the plot). All densities were calculated on the basis of the whole plot area, 150 ha, thus disregarding the areas of the small lakes. The largest ones were Hästskotjärnen (4.9 ha with two thirds within the plot) and a nameless lake (2.9 ha). The bedrock was amphibolite and sedimentary gneiss. The vegetation was a mosaic of dry heath with low scrub and areas with shallow peat with *Carex* and *Sphagnum* vegetation. According to *Vegationskarta över de svenska fjällen*, sheet no. 17, the predominant vegetation type was dry heath (*torr rished*) with narrow-leaf grasses, *Vaccinium*, *Empetrum* and *Betula nana*.

Methods

For most species, the territory mapping technique was used, as described by Svensson (1975) in the manual for the Swedish Breeding Bird Survey. That description is a slight modification of the version given by Svensson & Williamson (1970). Each plot was divided into two halves with one observer in each half. Details about the visiting schedules are given in Appendix 1. For the Kraipe plots, corresponding data for the period 1964–1983 were given in Svensson et al. (1984). The average survey effort in hours per square kilometre and year was 53 at K1, 27 at K2, 43 at Pätjujaure, and 35 at Ottsjö. The differences were mainly due to different number of visits but also to how easy it was to survey the plots. Especially K1 required more work because of its higher density of birds whereas K2 required less because large parts contained very few birds.

Most species were fairly easy to count with the territory mapping technique, especially the territorial passerines and plovers. It was also easy to count some of the rare birds, such as the Long-tailed Skua. However, there were also some difficult species. This will be discussed below for a selection of species separately. In spite of these difficulties, I am confident that our surveys correctly show both the composition of the community and the fluctuations of the species with a high degree of accuracy

for almost all species. Rather than the accuracy of the estimates, the main analytical problem was the small number of pairs of many species due to the relatively small plots.

The annual periods during which the surveys were distributed were sometimes rather brief. This, however, has little effect at these latitudes and elevations where the breeding synchrony between the species is high. The survey periods also varied somewhat between years, but also this affects population estimates only marginally. The same was found by Stenseth et al. (1979) when they compared population estimates from early versus late counts within the same season at Finse, Hardangervidda. At all three Swedish sites, the majority of the surveys were always carried out after almost complete snow melting, and all species were well established in the plots at the time of the counts. Kraipe K2 was affected by much snow late in the season in some years, but then the surveys were delayed accordingly.

When I dealt with the data from the whole 38 year period at Ammarnäs (for example in the diagrams of Figure 2), I inserted values for plot K2 (see Appendix 2) also for the years 2000 and 2001, when this plot was not surveyed. The K2 values for these two years were calculated assuming that they had the same relation to the average value of 1995–1999 as the K1 values had. This was done only for the purpose of obtaining values of better comparability for these two years in the pooled data set. These adjusted values were not used in other analyses.

Species turnover rate between two adjacent years was calculated in the following way: $(I+E)/S1+S2$, where I is the number of species present in the second but absent in the first year, E the number of species present in the first but absent in the second year, and S1 and S2 total number of species in each of the two years. Turnover rates between two non-adjacent years were calculated in the same way for individual pair of years different number of years apart. Then the average was calculated for each such distance between years, from maximum to one year apart, this latter value being equal to mean annual turnover rate.

For simple descriptive statistics I used Excel and for other calculations STATISTICA.

Results

The results are given in Appendix 2–4. In order to provide complete information in this paper I also include the data for the two Kraipe plots for 1964–

1983 although they have been published previously (Svensson et al. 1984). Table 1 gives a comparative summary of the number of species and densities. For the Påtjujaure plot, the waterfowl counted on the lake are included, but densities were calculated only for the species of the land area. In the same table, I have included data from Norwegian plots for comparison (Moksnes 1973, Østbye et al. 2002).

Number of species, total densities, and species turnover

Table 1 shows that the average annual number of species in the Swedish plots was roughly the same in all plots: about 9 per year at Påtjujaure, about 11 at Ottsjö, and about 12 and 8 in Kraipe K1 and K2, respectively. The densities differed somewhat more. The average density at Påtjujaure was 52, at Ottsjö 45, at K1 90, and at K2 37 pairs per sqkm. Among individual species, there were both considerable similarities and differences in densities. For example, the Golden Plover had about the same density in all plots whereas the density of the Lapland Bunting was very different between the plots.

The total number of species recorded in all years was rather similar in the different plots. In K1, 26 species were found during all 38 years (25 with waterfowl excluded). During the first 36 years when both plots were surveyed, 24 species were recorded in K1 and 19 species in K2. In both plots 30 species were recorded in the first 36 years and 32 species during all 38 years, with two new species added in 2000 (Common Gull and Whimbrel). The average number of species per year was 11.6 (11.5 during the first 36 years) in K1 and 8.2 species in K2. The average number in both plots during the first 36 years was 14 (s.d. = 0.3; range 11–17). This number varied about a stable level throughout the period (Figure 2).

The cumulative number of species in K1 and K2 together increased from 14 in 1964 to 32 in 2001 (Figure 3). The rate of increase followed a power function (linear relationship in a log-log diagram). At Påtjujaure, the total number of species was 24 (20 with waterfowl excluded) and at Ottsjö, it was 23 (22).

There was a continuous turnover of species between years at all three study sites. No site had two adjacent years with exactly the same species composition. The average turnover rate was 16% in the pooled Kraipe plots (35 comparisons), and there was no trend (Figure 4). It was higher at both Påtjujaure (21%, 9 comparisons) and Ottsjö (26%, 8 comparisons) than at Kraipe, but only the differ-

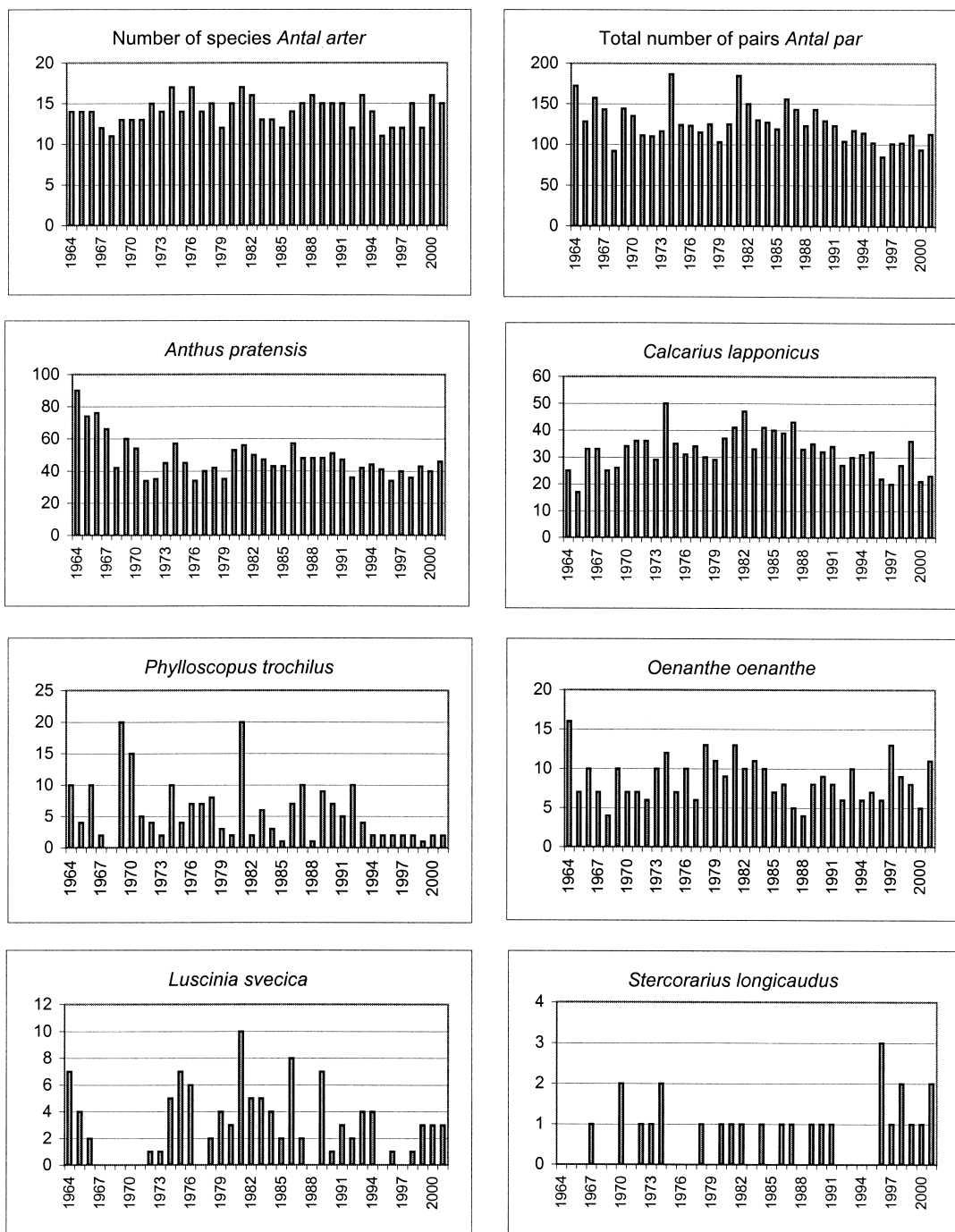


Figure 2. Number of species, total number of pairs, and number of pairs of selected species in the Kraipe plots K1+K2 at Ammarnäs (2 sqkm) in 1964–2001. Values for K2 in 2000 and 2001, when this plot was not surveyed, are “guestimates” for the purpose of these diagrams only (cf. Appendix 2).

Antal arter, totalt antal par samt antal par av valda arter inom provytorna K1 och K2 i Ammarnäs (2 kvkm) åren 1964–2001. Uppskattade värden har lagts till för K2 åren 2000 och 2001, då denna provyta inte inventerades (se Appendix 2).

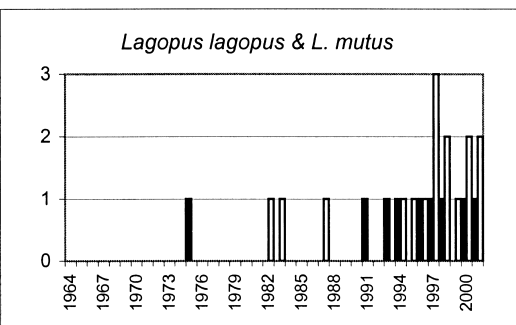
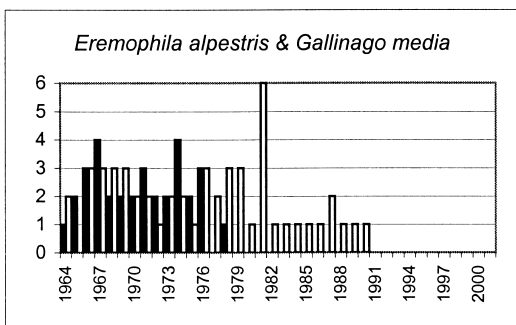
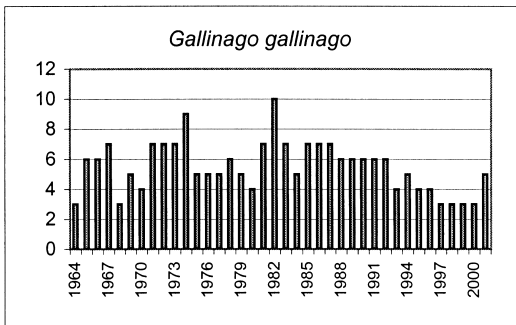
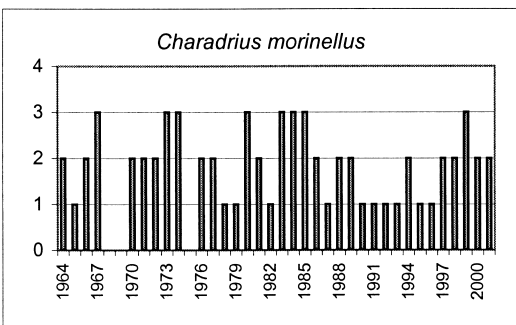
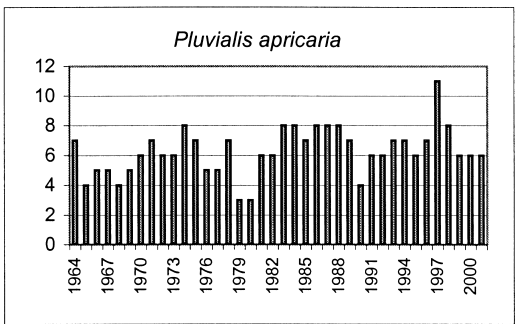
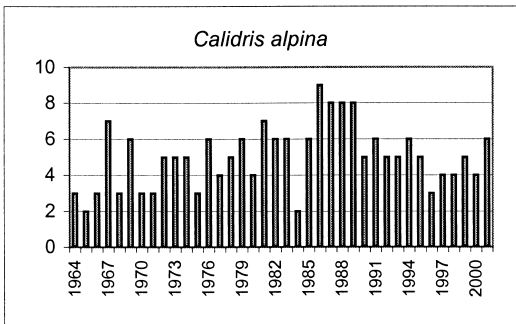
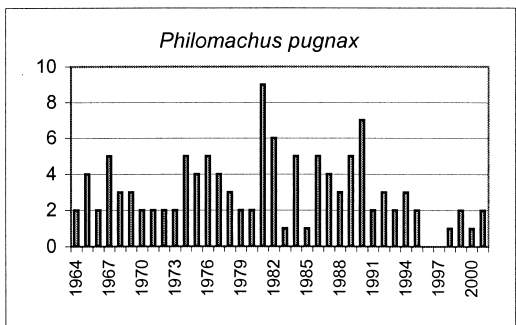
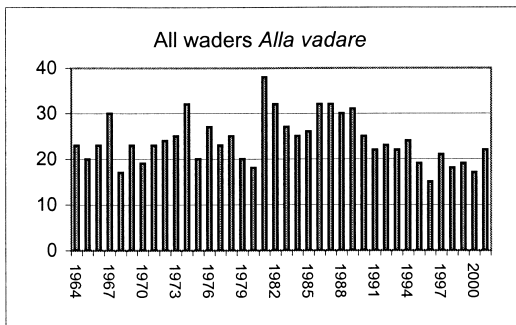


Table 1. Mean densities (pairs per square kilometre) for the four Swedish plots of this study and three Norwegian plots. K1 and K2 = Kraipe at Ammarnäs (1964–2001), P = Pätjujare at Abisko (1982–1996), O = Ottsjö at Anjan (1983–1996), F = Finse (1967–1985), Ns = Nedal, subalpine bog and heath (1967–1971), Na = Nedal, alpine plot (1969–1971). A plus sign denotes presence with a density less than 0.05. Norwegian data from Moksnes (1973) and Østbye et al. (2002).

Jämförelse mellan tätheterna (par per kvadratkilometer) i de fyra svenska provytorna i denna studie och tre norska provytor. K1 och K2 = Kraipe vid Ammarnäs, P = Pätjujare vid Abisko, O = Ottsjö vid Anjan, F = Finse, Ns = subalpin myr och hed vid Nedal, Na=alpin hed vid Nedal. Plustecken anger närvaro med en täthet under 0,05.

Plot Provyta Size Storlek (ha)	Sweden Sverige				Norway Norge		
	K1	K2	P	O	F	Ns	Na
	100	100	130	150	71	57	28
<i>Lagopus lagopus</i> Willow Grouse <i>Dalripa</i>	0.2	0	0	0.4	0.9	4.1	0
<i>Lagopus mutus</i> Ptarmigan <i>Fjällripa</i>	0.1	0.3	1.3	2.1	0	0	1.2
<i>Buteo lagopus</i> Rough-legged Buzzard <i>Fjällvråk</i>	0	0	0.1	0	0	0	0
<i>Charadrius hiaticula</i> Ringed Plover <i>Större strandpipare</i>	0	0.2	0.1	0	0.2	0	0
<i>Charadrius morinellus</i> Dotterel <i>Fjällpipare</i>	0.2	1.6	0.2	0.1	2.8	0	3.0
<i>Pluvialis apricaria</i> Golden Plover <i>Ljungpipare</i>	3.2	3.1	4.2	4.0	2.1	0	0
<i>Calidris temminckii</i> Temminck's Stint <i>Mosnäppa</i>	0.1	0.4	0.2	0	0.2	0	0
<i>Calidris maritima</i> Purple Sandpiper <i>Skärnsnäppa</i>	0	+	0	0.1	0.7	0	1.2
<i>Calidris alpina</i> Dunlin <i>Kärnsnäppa</i>	3.4	1.6	0	0	0.2	0	0
<i>Philomachus pugnax</i> Ruff <i>Brushane</i>	2.8	0.3	0	0	0	0	0
<i>Gallinago gallinago</i> Common Snipe <i>Enkelbeckasin</i>	5.0	0.5	0	0.7	0.2	2.6	0
<i>Gallinago media</i> Great Snipe <i>Dubbelbeckasin</i>	1.4	0	0	0	0	0	0
<i>Numenius phaeopus</i> Whimbrel <i>Småspov</i>	+	0	0	0.3	0	0	0
<i>Tringa totanus</i> Redshank <i>Rödbena</i>	0	0.1	1.2	1.7	0	0	0
<i>Tringa nebularia</i> Greenshank <i>Gluttsnäppa</i>	0	0	0	0.1	0	0	0
<i>Tringa glareola</i> Wood Sandpiper <i>Grönbena</i>	0.3	0	0	0.1	0	2.1	0
<i>Actitis hypoleucos</i> Common Sandpiper <i>Drillsnäppa</i>	0	0	0.1	0.1	0	0	0
<i>Phalaropus lobatus</i> Red-necked Phalarope <i>Simsnäppa</i>	0	0	0	0	0	0	0
<i>Stercorarius longicaudus</i> Long-tailed Skua <i>Fjällabb</i>	0.5	0.2	0.7	0	0	0	0
<i>Larus canus</i> Common Gull <i>Fiskmå</i>	+	0	0.4	0.3	0	0	0
<i>Sterna paradisaea</i> Arctic Tern <i>Silvertärna</i>	0	0	0	0.3	0	0	0
<i>Cuculus canorus</i> Cuckoo <i>Gök</i>	0	0.1	0	0.3	0	0.7	0
<i>Nyctea scandiaca</i> Snowy Owl <i>Fjälluggla</i>	0	0	0.1	0	0	0	0
<i>Asio flammeus</i> Short-eared Owl <i>Jorduggla</i>	0.1	0	0	0	0	0	0
<i>Alauda arvensis</i> Skylark <i>Sånglärka</i>	0	0	0	0	0.2	0.4	0
<i>Eremophila alpestris</i> Shorelark <i>Berglärka</i>	0	0.9	0	0	3.3	0	0
<i>Motacilla alba</i> Pied Wagtail <i>Sädesärta</i>	0	0	0	0	0.1	0	0
<i>Anthus pratensis</i> Meadow Pipit <i>Ångspiplärka</i>	35.8	12.2	27.4	18.6	27.6	55.4	22.6
<i>Antus cervinus</i> Red-throated Pipit <i>Rödstrupig piplärka</i>	0.1	0	0	0	0	0	0
<i>Cinclus cinclus</i> Dipper <i>Strömstare</i>	0	0	0.3	0	0	0	0
<i>Luscinia svecica</i> Bluethroat <i>Blåhake</i>	2.8	0.1	2.7	3.8	0	0	0
<i>Oenanthe oenanthe</i> Wheatear <i>Stenskvätta</i>	2.9	5.7	12.0	5.2	13.6	4.9	11.3
<i>Turdus torquatus</i> Ring Ouzel <i>Ringtrast</i>	0	0	0.3	0.3	0	0	0
<i>Turdus pilaris</i> Fieldfare <i>Björktrast</i>	0.1	0.1	0	0	1.4	0	1.2
<i>Turdus iliacus</i> Redwing <i>Rödvingetrast</i>	0.3	0	0.1	0	0	0	0
<i>Phylloscopus trochilus</i> Willow Warbler <i>Lövsångare</i>	5.6	0	0	5.4	0	0.6	0
<i>Carduelis flavirostris</i> Twite <i>Vinterhämpling</i>	0	0	0	0.1	0.2	0	0
<i>Carduelis flamma</i> Redpoll <i>Gräsiska</i>	0.5	0	0.4	0.4	0	0	0
<i>Carduelis hornemanni</i> Arctic Redpoll <i>Snösiska</i>	0.1	0	0.1	0	0	0	0
<i>Calcarius lapponicus</i> Lapland Bunting <i>Lappspärv</i>	23.8	8.7	0.7	0	5.2	3.9	0
<i>Plectrophenax nivalis</i> Snow Bunting <i>Snöspärv</i>	0	0.7	0	0	5.7	2.1	17.9
<i>Emberiza schoeniclus</i> Reed Bunting <i>Sävspärv</i>	0.4	0	0	0.3	+	0.6	0
Density all species <i>Täthet alla arter</i>	89.5	36.7	52.4	44.5	64.8	90.3	58.3
Species per year <i>Arter per år</i>	12	8	9	11	9	9	5
Species all years <i>Arter alla år</i>	25	19	20	22	18	12	7
Years of study <i>Antal inventeringsår</i>	38	36	12	11	19	5	3

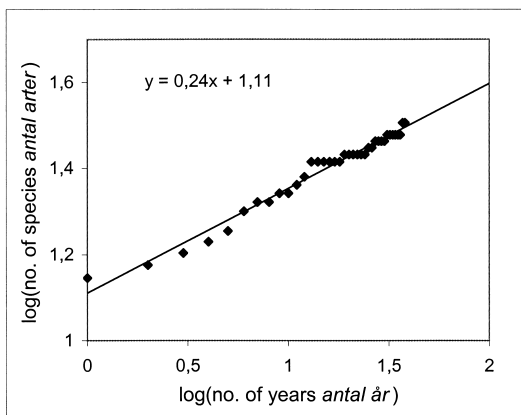


Figure 3. Cumulative number of species recorded versus number of years. Note that both axes are logarithmic.

Kumulativt antal registrerade arter mot antal år. Notera att båda axlarna är logaritmiska.

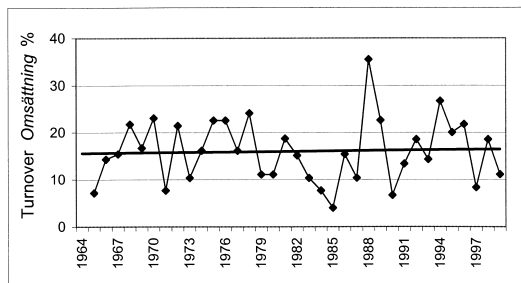


Figure 4. Species turnover rates between adjacent years at the Kraipe plots at Ammarnäs 1985–1999.

Artomsättningen mellan närliggande år för Kraipe-ytorna i Ammarnäs 1985–1999.

ence between Kraipe and Ottsjö was significant ($p < 0.01$; two-tailed t-test after arcsine transformation of the percentages).

Population trends and variation at Ammarnäs

The total number of pairs at the two Kraipe plots varied about a stable level until about 1990 and then there was some decline. The linear trend over all 36 years corresponded to an average decline of almost one pair per year (Figure 2; $b = -0.94$; $p < 0.05$). However, it was only the low numbers during the last decade that caused the trend to be significant. When the trend was calculated for successively longer periods from 1964 onwards, the decline became significant for the first time for the

period 1964–1997. The average number of pairs was 134 (s.e. = 4.3) in 1964–1991 and 105 (s.e. = 3.6) in 1992–1999, a difference that was significant ($p < 0.001$; one-tailed t-test). The reason for the decline was almost exclusively the decline of the second most common species, the Lapland Bunting. This species occurred in equally low numbers during the early phase of the study period, but at that time these low numbers were compensated by high numbers of the most common species, the Meadow Pipit, which was not the case in recent years. Apart from the high numbers in the very first study years, caused by the Meadow Pipit, two other years stand out as peak years, 1974 and 1981. The 1974 peak was mainly caused by unusually many Lapland Buntings in plot K2, and the 1981 peak by contemporary peak numbers in the two highly variable species, the Bluethroat and Willow Warbler.

The two most common species showed different long-term patterns. The Meadow Pipit declined from more than 70 pairs in 1964–1966 to an average level of c. 40 pairs for the rest of the period. The Lapland Bunting was less common at the start and end of the study period with minimum numbers around 20 pairs, and with a peak period in 1980–1987 with about 40 pairs. The waders as a group behaved in roughly the same way as the Lapland Bunting, a pattern that was mainly determined by three of the more common waders, Common Snipe, Dunlin, and Ruff, whereas the Golden Plover and the Dotterel differed from this pattern.

A simple linear regression analysis of each species on year, using the pooled data from K1 and K2 (1964–1999), revealed no significant trend in most species. Twenty-one non-significant slopes were about equally divided between positive (9) and negative (12) ones. Seven species showed significant trends, with three increasing species: Ptarmigan (slope coefficient = +0.02, $p < 0.001$), Willow Grouse (+0.50, $p < 0.001$), and Golden Plover (+0.07, $p < 0.05$), and four declining species: Great Snipe (−0.08, $p < 0.001$), Wood Sandpiper (−0.03, $p < 0.01$), Shore Lark (−0.09, $p < 0.001$), and Meadow Pipit (−0.65, $p < 0.001$).

Between-year variation is summarized in Figure 5. The observed variance of the 32 species in the Kraipe plots increases almost exactly as if variance equalled sample size (mean number of pairs of a species). This is a property of the Poisson distribution that is expected for small samples. However, individual species deviated from the regression line. If we consider the eleven species with an average of more than one territory in the plots, we find the following. Three species showed higher variance than

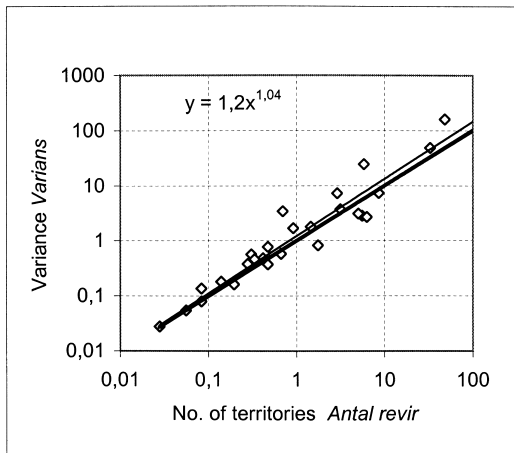


Figure 5. Population variance versus number of pairs in the alpine Kraipe plots of this study. Both scales are logarithmic. Thin regression line: observed data. Thick regression line: expected relation when variance equals sample size (approximating a Poisson distribution).

Populationsvariansen mot antal par för de alpina provtyrorna i Kraipe. Båda axlarna är logaritmiska. Tunn regressionslinje: observerade värden. Tjock regressionslinje: förväntad relation om variansen är lika med stickprovets storlek.

expected. Two of them, Willow Warbler and Bluethroat, are marginal to the habitat, being essentially woodland birds. The Meadow Pipit showed a variance higher than expected only because of the high counts in the first three years. Four species showed a variance close to the expected one, namely Ruff and Great Snipe, two lekking species, and Lapland Bunting and Wheatear, two territorial passerines. Four species showed lower variance than expected, Golden Plover, Common Snipe, Dunlin, and Dotterel. These species are territorial and a possible explanation to the low variance is territorial packing, i.e. that their densities are limited by competition close to the carrying capacity of the habitat, especially in combination with high territory fidelity and long lives. This explanation is of course only tentative and does not easily accord with the fact that the densities as such are low or very low compared with densities found in other habitats. On the other hand, the question has not been studied for the local situation.

Population trends at Anjan and Abisko

Although the survey periods were rather brief at the Ottsjö and Påtjujaure plots, I calculated the linear

population trends at each site for six species (Ptarmigan, Golden Plover, Bluethroat, Wheatear, Willow Warbler (only for Ottsjö), and Meadow Pipit). Significant trends were found for Golden Plover at Ottsjö ($b = +0.40$, $p < 0.01$), Wheatear at Påtjujaure ($b = -0.36$, $p < 0.05$), and Willow Warbler at Ottsjö ($b = -0.68$, $p < 0.05$). Hence, out of eleven trends, only three were significant, two of them only at the lowest significance level. Among all eleven trends, seven were positive and four negative.

Synchrony of population fluctuations

Five species seemed to be common enough to permit a comparison of the annual population fluctuations between the plots for the eleven years when all four plots were surveyed: Ptarmigan (only Ottsjö and Påtjujaure), Golden Plover, Meadow Pipit, Bluethroat (only K1, Ottsjö, and Påtjujaure), Wheatear, and Willow Warbler (only K1 and Ottsjö). In no case did I find a significant ($p < 0.05$) correlation (23 correlations in all). This means that not even for the two adjacent Kraipe plots were there any correlations during these particular years.

The Kraipe plots, however, permitted the same calculations for the longer 36 year period with contemporary surveys. Four species were common enough in both plots. No correlations were found for the Golden Plover, Wheatear, and Lapland Bunting. A strong positive correlation was found for the Meadow Pipit ($r=0.59$; $P<0.001$; $N=36$). However, when the first four years with unusually high numbers in both plots were excluded, there was no correlation ($r=0.14$; $P>0.10$; $N=32$). This means that the significance of the correlation for the whole period was caused by the initially contemporary decline and not by co-variation of the detrended numbers.

Species accounts

*Willow Grouse *Lagopus lagopus**

The Willow Grouse was absent or rare in all plots. At Kraipe, it was not until the early 1990s that it became regular. The reason for this unexpected absence in most of the previous years is unknown. The species is easy to count so it cannot have been missed. A similar pattern could not be found in a larger data set obtained by extensive line transects covering the whole Ammarnäs area, in both woodland and alpine habitats (Svensson 1996), which revealed only large variation between years but no long-term trend, and only weak evidence of a cyclic pattern.

Ptarmigan *Lagopus mutus*

Påtjujaure and Ottsjö differed from Kraipe in having a regular and denser Ptarmigan population. The fact that it was found in K2 only in 1994–1999 was surprising because the habitat was very similar to where it was regularly found in other parts of the Ammarnäs area throughout the study period. The general pattern (Svensson 1996) was peak numbers eleven years apart (1982 and 1993) and low numbers in between.

Dotterel *Charadrius morinellus*

The Dotterel was less regular at Påtjujaure and Ottsjö than at Kraipe, where the species was recorded in almost all years. The Dotterel is difficult to count. The nests are hard to find, and the females display over areas that are many times larger than the plots. At Kraipe it was in plot K2 that the species occurred almost annually, and the habitat of K2 is typical for areas where the Dotterel was frequently found at other locations surrounding Ammarnäs. Up to three “pairs” were estimated, but this is an uncertain figure. In terms of nests, the real density may have been lower or higher, but it is quite clear that the population has been stable, a subjective impression that I also have from numerous visits in other parts of the Ammarnäs area.

Golden Plover *Pluvialis apricaria*

The main feature of this species was similar densities in all plots (3–4 pairs per sqkm) and rather small annual variation. At Kraipe, there was a weakly significant positive long-term trend. At the other two sites no significant trends were found although some decline was recorded at Påtjujaure and some increase at Ottsjö. Since the density was so similar at sites so far apart, it is possible that a density of 3–4 pairs is typical for much of the low alpine zone.

Ruff *Philomachus pugnax*

Regularly present only in Kraipe K1, and absent in Påtjujaure and Ottsjö. Although the long-term trend was not significant, there was consistently low numbers in the most recent years, with only 0–2 assumed breedings in 1995–2001, clearly below the long-term average. The estimates are based on the number of females with breeding behaviour, but in recent years the number of displaying males has also been lower. Using females

as an indicator of numbers may cause underestimates of population size because females whose nests were depredated probably left the area. A better method would have been to count displaying males, but we started our counts too late in most years, when some males had already left their lek sites. A long-term decline is well documented for southern Sweden (Svensson et al. 1999), but for northern Sweden, particularly the alpine habitats, little or no information exists. However, a survey (one visit per year) of 16 sqkm of mire in the forest zone of western Jämtland in 1989–2003 (Holmberg 2004) also indicated a decline (from about 95 individuals per year in 1989–1996 to about 55 in 1997–2003; the linear trend, calculated by me, was significant with $b = -4.6$, $p < 0.001$). Another study in the Rautas area just east of Påtjujaure, covering alpine habitats, birch woodland, and mires, based on 643 km of single visit line transects within 268 sqkm (Berg et al. 2004), and surveyed in 1978 and 2001, found little change between the two years (116 versus 97 individuals). I have also access to yet unpublished data from three plots with counts of Ruffs from the Swedish Breeding Bird Survey. One plot is a 0.9 sqkm mire in the birch/pine zone at Abisko, surveyed in 1983–1995 and with an average population of 6 breedings: there was a weak, but non-significant increase. In the second plot, c. 13 sqkm alpine heath and mire, only about 25 km north-west of the Kraipe plots of this study, with an average of 10 breedings in 1984–1995, there was a weakly significant increase. In the third plot, a 1.1 sqkm mire in the coniferous zone in the Muddus National Park, surveyed in 1983–1984 and again in 1994–1995, there was a decline from 4 and 3 to 1 and 0 breedings, respectively. Thus, the total information is ambiguous. Although there is some information indicating decline in the most recent years, we cannot yet say with any confidence that the Ruff has started to decline generally also in northern Sweden.

Common Snipe *Gallinago gallinago*

Although this species is easy to observe during the display flights, it is difficult to estimate numbers correctly since the flights often cover areas far beyond the border of a plot. Records of a specific male tend to be more frequent within than outside the border since the observer spends most of the time within the plot border, so there is a risk of overestimating density. This has probably been done in K1, at least in some years.

The Snipe was absent at Påtjujaure, and not

found annually at Ottsjö and Kraipe K2. At K1, with an average of five pairs, there was a decline in the late 1990s but the number rose again in 2001, and the long-term trend was not significantly different from zero. The same was the case for a mire population in western Jämtland (1989–2003; Holmberg 2004). The stable population of this species in these two northern and close to pristine habitats contrasts with the situation in southern Sweden, where a more than fifty percent decline was observed by the Breeding Bird Survey in the period 1975–2003 (Lindström & Svensson 2006). This suggests that the total decline of the Swedish population is mainly driven by changes caused by forestry and farming practices.

Great Snipe *Gallinago media*

There was a display ground within K1 during the first half of the survey period. We did not determine the exact number of displaying males every year but a few night visits early in the season indicated that the number of males was up to about ten in the early years. Normally, we heard or flushed only a few of the males during our day-time visits, which were usually made after the most active display period. Hence I am certain that the number of males was underestimated in most years. On the other hand, females disperse rather widely around the display site so many nests may have been placed outside the plot border. Nests were found at only three occasions. The display site was deserted during the 1980s and in recent years we have no records at all within the plot. Single birds were flushed during our walks in the surroundings, indicating that the species still breeds in the area. Perhaps the display site has moved. One cannot take the disappearance of one single lek as an indication of a general population decline in the Ammarnäs area. I know of other leks in the area, but have no information of numerical changes at these leks for conclusions about large scale population change.

Shore Lark *Eremophila alpestris*

The occurrence of this species in Kraipe K2 during the early third of the study period, and its disappearance from the site follows the general development in the Ammarnäs area (Svensson 1990). It was estimated to breed with up to four pairs. This species has later been carefully studied (with colour ringed birds) in another part of the Ammarnäs mountains (Svensson et al. 1992, Svensson & Berglund 1994, Svensson 1997). The experiences

from these studies make me believe that we overestimated the number of pairs in K2 and that the maximum number of pairs could not have been more than two; the song display flights proved to be wider than we thought when we surveyed K2. However, this does not affect the main observation, the disappearance of the species.

Meadow Pipit *Anthus pratensis*

The Meadow Pipit was the most common species in all four plots, but the densities differed among plots. The highest densities were found at Kraipe K1 (36 pairs/sqkm) and Pätjujaure (27), and the lowest at Ottsjö (19) and K2 (12). Thus, the difference between the two Kraipe plots, situated only one km from each other and at only slightly different elevations, was larger than between the other sites, indicating that local conditions are more important than large latitudinal differences.

Lapland Bunting *Calcarius lapponicus*

The Lapland Bunting was not found at Ottsjö and it was rare and not annual at Pätjujaure. This contrasts starkly with the situation at Kraipe, where it was the second most common species in both K1 and K2. The Lapland Bunting and the Meadow Pipit together represented 67% and 57% of the whole bird community. In this respect, the alpine habitat was similar to the Ammarnäs birch zone where Enemar et al. (2004) also found two species, Willow Warbler and Brambling, taking the same dominant position in that community. The low numbers at Pätjujaure differ, however, from the observations by Berg et al. (2004) in the large Rautas area (480 sqkm) southeast of Pätjujaure. During their two years of line transects, they recorded 1168 Lapland Buntings and 2694 Meadow Pipits. This relation between the two species (1:2.3) is more similar to that found at Kraipe (1:1.5) than at Pätjujaure (1:39). Hence, considerable variation in local density occurred in the Lapland Bunting.

Bluethroat *Luscinia svecica*

The Bluethroat was about equally abundant at Pätjujaure and Ottsjö as at Kraipe K1. The variations were large: 1–10 (Ottsjö), 0–7 (Pätjujaure), and 0–10 (K1+K2). The Bluethroat is mainly a birch zone species, and this probably explains the large variation in the alpine zone, with habitats likely to be suboptimal.

Willow Warbler *Phylloscopus trochilus*

In the Willow Warbler, the same density as in K1 was found at Ottsjö, but the species was absent at Påtjujaure, as it was in K2. As in the Bluethroat, the variations were large, 1–13 (Ottsjö) and 0–20 (K1), and the explanation may be the same, the Willow Warbler also being more of a woodland than a scrubland species.

Wheatear *Oenanthe oenanthe*

The Wheatear was regular in all plots with a particularly dense population at Påtjujaure. The absence of any long-term trend at Kraipe is very different from the situation in southern Sweden, where the population has declined with more than sixty percent since the 1970s (Lindström & Svensson 2006). Since there was also no trends in the Ottsjö and Påtjujaure plots, it seems that the mountain population has not been affected by the negative factors that are acting in southern Sweden. In this respect, the population development in the mountains is similar to what Sundström (1995) found at Holmöarna, two large islands east of Umeå (c. 64°N): 82 pairs in 1983 and 105 pairs in 1993. However, surprisingly, Berg et al. (2004) recorded a drastic difference in numbers counted along their 643 km of line transects in 1978 and 2001, a decline from 356 to 185 observed individuals in the Rautas area, adjacent to Påtjujaure. However, the data from the Kraipe plots shows that even the very precise counts with a territory mapping technique may vary equally much between some individual years without presence of any long term trend. Without any knowledge of densities during the intervening years it is impossible to judge whether or not the difference indicates a long-term negative trend at Rautas or a difference that was particular for the two survey years.

Discussion

Arctic bird communities are attracting increasing interest, partly because they are poorly known and understood, compared with temperate communities, partly because of increasing conservation concerns, and partly because Arctic areas are becoming easier to access. Waders are of particular interest in these respects because they have developed more species rich communities in the arctic region than elsewhere (Järvinen & Väisänen 1978), and several species are restricted to the arctic region as breeders. Among passerines, the pattern

is very different, and gradually fewer species are common as one moves north, and still fewer are restricted to the arctic biome. Henningsson & Alerstam (2005) suggested that the main reasons for variation of species diversity among waders is the flyway connectivity pattern between breeding and wintering grounds. The fact that the arctic region is a key region for so many wader species has caused a growing conservation concern coinciding with increasing exploitation and predicted human-induced climate change (Lindström & Agrell 1999).

Montane areas south of the Arctic often host bird communities that are similar to the arctic ones. The properties of a mountain elevation gradient often parallel those of an arctic latitudinal gradient. For example, moving northwards from the taiga border in the Arctic, the land bird fauna shifts from one dominated by passerines to one dominated by waders (Svensson 1995), and the several passerine species that occur at lower arctic latitudes are species that usually have large ranges south of the arctic region. This means that studies in the Scandinavian mountains, that are continuous with the Arctic zone, and by some workers treated as a part of that region, are particularly valuable in a pan-Arctic context.

Many arctic bird communities have been surveyed in North America (early reviews in Freedman & Svoboda 1982, Montgomerie et al. 1983). The results show that densities vary enormously, from close to zero at high arctic island sites with little vegetation to about 200 pairs per square kilometre at low arctic mainland sites. This means that in order to make meaningful comparisons between the Swedish sites and those in North American Arctic, it is necessary to select sites with similar conditions. For the purpose of this paper, it suffices to say that the densities found at the Scandinavian sites presented in this paper are well within the range of densities at the North American mainland tundra sites (i.e. if the high arctic sites with little vegetation are excluded). Had surveys been available from Scandinavian high alpine sites, bird densities would also have been close to zero.

Comparison with other alpine areas in Scandinavia

There is a paucity of detailed studies of alpine bird communities in the Scandinavian mountains, especially long-term ones. I know of only one major study, namely the one recently published by Østbye et al. (2002), covering a period of 19 years at Finse, Hardangervidda in Norway. Another study,

covering fewer years, comes from Nedal in central Norway (Moksnes 1973).

The Finse study was made in 1967–1985 and comprised three small plots, together, 0.71 sqkm, and one larger plot, one sqkm. The plots were located at 1200 and 1500 m a.s.l. which is higher than at Ammarnäs in relation to the tree line in spite of the fact that the Finse site is much more to the south. The large plot cannot be used for comparison because it contained much water and sedimentation flats without vegetation and birds, and it was not possible to identify how much of it that was suitable bird habitat.

The Nedal study was made in 1967–1971, and two of the plots can be compared with the plots of my study. One of the plots (0.57 sqkm, Mosknes' table VIII) was located in subalpine bog and heath habitats, but since these habitats were similar to corresponding low alpine habitats, I included it in the comparison. The other plot (surveyed only in 1969–1971) was located in the alpine zone with 0.1 sqkm in the low and 0.18 sqkm in the middle alpine zone (Mosknes' tables XI and XIII). The Nedal site was located only 90 km to the south of the Anjan site. The data from the Norwegian plots have been included in Table 1.

A third study (Berg et al. 2004), referred to earlier, was made in an area adjacent to Påtjujaure (only about 10–80 km to the south-east). This study covered a very large area (480 sqkm), but only two years (1978 and 2001), and both alpine habitats and subalpine forest. The survey method was different, namely single visit line transects, which precluded density estimates. Therefore, I have not used the results from this study for general comparisons.

The main observation in the Norwegian plots is that species richness and total densities were fairly similar to those of the Swedish plots. The average number of species per year was lower only in the Nedal alpine plot, which was much smaller and with only three survey years. The total densities were, on the other hand, quite similar to those of the other plots. The subalpine Nedal plot had a density very similar to that of K1 at Ammarnäs.

Community composition

Most temperate bird communities are characterized by a small number of abundant species (dominants) and a large number of less common and rare species. Many models have been proposed to describe different species-abundance relationships (May 1975). In spite of continued activity in the field, no general model based on fundamental spe-

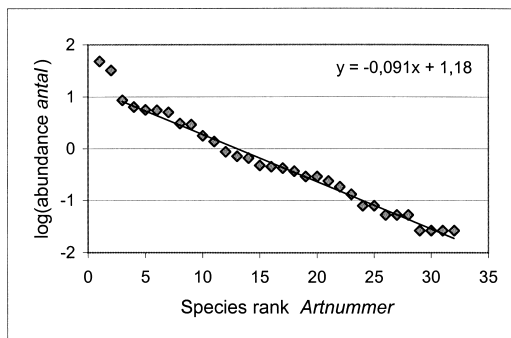


Figure 6. Community structure of the Kraipe plots at Ammarnäs. Species number is the sequence of species in abundance order.

Fågelsamhällets struktur i Kraipeytorna i Ammarnäs. Artnummer är artens ordningstal efter talrikhet.

cies ecologies and interaction mechanisms has yet been found (Ke-ming 2003). One problem is that we must always work with finite samples from a community, which means that the form of the relationship among the rarest species will be uncertain (Engen & Lande 1996), and often it is the form of the relationship in this region that determines which model fits best. However, different models can be compared, and introduction of covariates into the models may help to understand how specific factors contribute to the structure of communities (Etienne & Olff 2005).

With only small differences, bird community data sets usually take the form of an almost straight line for log(abundance) versus species sequence number (or abundance rank). This is also the case for the alpine community at Ammarnäs (Figure 6), with the exception of two “overabundant” species, Meadow Pipit and Lapland Bunting. The pattern is similar in the Ammarnäs birch zone (Enemar m.fl. 2004), but with two other species, Willow Warbler and Brambling, as “overabundant”. In fact, the Swedish bird fauna as a whole also shows the same pattern, with Willow Warbler and Chaffinch being the two “overabundant” species (Svensson 2000). The different species-abundance curves for the individual sites reflect the so-called alpha-diversity and that for all Sweden the gamma-diversity (Whittaker 1972), which both may be summarized by different indices (e.g. Shannon's or Simpson's).

The relation between abundance and species sequence number is of course mainly a descriptive property. It tells us little about why a particular relation prevails, and the relation is usually only cor-

relative (Wiens 1989). Much discussion has continued about the possible functional basis for different species abundance patterns within communities (Maurer 1999, Gaston & Blackburn 2000, Blackburn & Gaston 2001), and I refer to these works for more information. It is sufficient here to observe the fact that a simple relationship exists, meaning that predictions about community patterns can be drawn with much confidence even when rather meagre data are available. As soon as the slope of the regression line is known, inferences can be made about expected species diversity within large areas when results are available from small, representative sample plots.

Of special interest in this context is the suggestion by Tomiałojć & Wesolowski (2004) that “high species richness with low densities of individual species is probably a feature of all pristine forests, independent of climatic zone”. They draw this conclusion from a comparison between the Białowieża forest and tropical rain forests. In this respect, pristine forests should differ from habitats that have been affected by different human influences, these latter being characterized by higher densities divided among fewer species. However, the species abundance structure of pristine birch forest at Ammarnäs (Enemar et al. 2004) is rather similar to that of the alpine zone with two “overabundant” species. Thus both alpine heath and subalpine forest differ from the higher evenness of a temperate forest. Tomiałojć & Wesolowski (2004) suggest that the high species diversity and the evenness among species at Białowieża is a consequence of an unusually large species pool in that part of Europe. Another difference is that although the alpine heaths and subalpine birch woods of the Scandinavian mountains may be considered pristine, they may also be seen as habitats that are being kept in early successions by frequent disturbances, such as severe extremes of climatic events or large-scale forest regeneration after attacks of defoliating caterpillars (*Epirrita autumnata*, *Operophtera* sp.; Tenow 1972, Selås et al. 2001).

Cumulative increase of number of species

If the cumulative increase of the number of species follows a power function (Figure 3), the probability of adding a new species in the future will decline but never become zero. This is probably a likely model for a long period anywhere and for areas of any size. In the case of the two plots at Kraipe, if species will be added with the current rate in the future, another eight species will be re-

corded breeding within the next sixty years. This is a realistic value, since there are still quite a few potential breeders that have not yet been found breeding in the plots but are expected, for example Wigeon, Mallard, Hen Harrier, Rough-legged Buzzard, Bar-tailed Godwit, Greenshank, Snowy Owl, Skylark, Yellow Wagtail, Dunnock, and Whinchat (species that breed or has bred in the surrounding areas and would find suitable habitats within the plots; several of them have already been observed, occasionally or regularly). In 2005, a nest of another expected species, Red-necked Phalarope, was actually found in K1 (Thomas Andersson).

In order to see if the observed linear increase of the number of species in a log-log diagram could be found in another habitat in the same area, I used the data presented by Enemar et al. (2004; their appendix 2, only small passerines) for the Ammarnäs birch zone plots. The pattern was similar with only a marginally steeper slope of the regression line. During the next about sixty years another c. ten species would be expected to be recorded breeding in the forest plots. This is also a quite realistic value, considering the known species pool for the birch zone as listed in Enemar et al. (2004, their appendix 1).

Species turnover rates

Comparisons of species turnover rates are complicated since turnover rates depend on a number of factors, particularly the species-abundance relationship, trends in species number, and the occurrence of erratic species. In this study another difficulty is the small number of years available from two of the sites. When I compared the turnover rates for the brief periods of contemporary surveys, I found that the result was the same as with the full survey periods. Only Kraipes and Ottsjö differed at a low level of significance (26.0% and 14.5%, $p < 0.03$, $n = 8$). Another observation was that the correlation coefficients between the turnover rates were very different ($r = 0.48$ for Kraipe vs. Ottsjö, $r = -0.51$ for Kraipe vs. Pätjujaure, and $r = 0.05$ for Ottsjö vs. Pätjujaure; however, none of them was significant). Hence, turnover rates may be properties of local origin, and this would be consistent with the absence of similarity of several other properties of communities at the three sites.

Another aspect of species turnover is that it increases with increasing interval between the years (Figure 7). That increase was reported in the first analysis of the Kraipe plots (Svensson et al. 1984) and has since been observed in several communi-

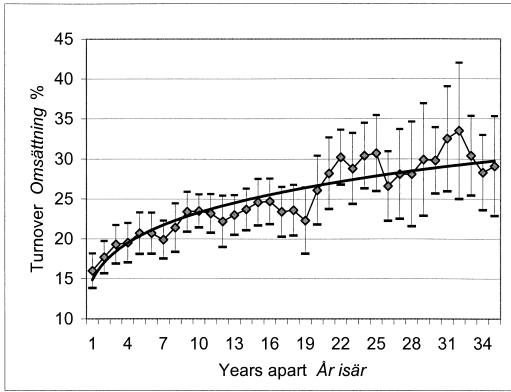


Figure 7. Species turnover in the Kraipe plots at Ammarnäs between years different number of years apart.

Artomsättningen i Kraipeytorna i Ammarnäs mellan år som ligger olika antal år isär.

ties (Bengtsson et al. 1997, Enemar et al. 2004). In the current study, only the Kraipe plots cover a sufficient number of years. There was an initial increase from 16% for adjacent years to about 23% for intervals longer than eight years. Then, the turnover rate remained stable at that level up to intervals of 19 years. Then there was a new increase to a level of about 30%, where the turnover rate then remained fairly stable. The overall pattern seems to be modelled rather well by a power function.

Turnover rate as a community property is important not only for a theoretical understanding of community dynamics, but also – as stressed by Bengtsson et al. (1997) – when we apply ecological rules in conservation. There is to-day a growing interest in using sets of bird species as “quality of life” indicators (Gregory et al. 2005) or other indicators (von Euler & Svensson 2001) in monitoring the ecological health of different habitats and regions. The monitoring systems are based on sample site surveys. If the sampled communities are not stable in terms of species composition but rather tend to differ more and more as the time intervals increase, a selected set of indicator species will no longer be relevant when a sufficient number of years have passed. There is little problem with this if the habitat has changed; then the new species composition may be a simple reflection of this. But if increasing species turnover is an inherent property also of communities in stable habitats, we are in trouble. The only remedy to this problem is to perform more long-term surveys and to analyse

species composition changes in depth in order to distinguish between effects of habitat change and “stochastic” events.

Implications for conservation and red-listed species

The general conclusion from this study, including both the long-term study at Ammarnäs and the briefer ones at Anjan and Abisko, is that the alpine bird communities are stable with few changes that can be considered alarming from a conservation point of view. The same conclusion can be drawn from the study of the Ammarnäs subalpine birch zone by Enemar et al. (2004).

Some of the rare species demonstrated opposite patterns. The Shore Lark, and a Great Snipe lek disappeared, and the two grouse species became more regular as breeders. Apart from the Shore Lark, which is known to have declined drastically in the whole Ammarnäs area, there is no indication that the other changes reflect large-scale patterns. The more common species seem not to be generally affected by any detrimental factors. A possible exception is the Ruff, which has been recorded with low numbers in the most recent years. Since this species continues to decline without a known explanation in other parts of Sweden, and in spite of much habitat management, it deserves special attention. It is unlikely that any of the observed changes can be explained by habitat changes in the study areas.

Among the species listed in Table 1, and found in any of the Swedish plots, there are a few that are included in the most recent list of threatened species in Sweden (Gärdenfors 2005). Four species were classified as “near threatened” (NT): Temminck’s Stint, Great Snipe, Short-eared Owl, and Wheatear. Three species were classified as “vulnerable” (VU): Ruff, Shorelark, and Red-throated Pipit. Four of these species, Great Snipe, Wheatear, Ruff, and Shorelark, have been discussed above.

I am aware of the fact that counts in a small number of small plots is not the best way to monitor trends in red-listed species. These species tend, by definition, to be rare, and, as indicated earlier, it is difficult to generalize from the small samples. Nonetheless, the paucity of relevant data from the alpine habitats, motivates brief treatments.

The Temminck’s Stint was counted six times during the first and eleven times during the second half of the survey period at Ammarnäs. This result does not support the red-list classification. It is not known whether this species has declined in

the alpine habitats, and the classification is mainly based on the species' disappearance from low-land and coastal sites, where it formerly bred in man-made habitats (grazed shores along the Bothnian Bay and along rivers), which have recovered with taller vegetation as grazing and hay production has ceased. It is likely that the main part of the Swedish population belongs to the alpine habitats, so that the decline in relation to the total population may be only marginal. The number of trapped birds during autumn migration at Ottenby also suggests a long-term stable population (Hedenström 2004). No significant trend could be observed over the last fifty years, and the birds trapped at Ottenby ought to come from northern Scandinavia because the recovery map in the same paper indicates a migration direction straight to the south. As long as we do not know more about the long-term trend in the alpine habitats at large, the current red-list classification remains tentative and the conservation status of the species may be more satisfactory than assumed.

The Short-eared Owl only bred in two years (in K1). The red-list classification of this species was mainly based on the combination of the facts that low numbers had been breeding in many of the recent years and that the regular rodent peaks had deteriorated (Hörnfeldt 2004), suggesting that re-establishment of a large population was unlikely.

The Red-throated Pipit bred only twice during the first and once during the second half of the survey period. Hence, the Ammarnäs data are too scarce to confirm whether the drastic decline observed by Berg et al. (2004) is a widespread phenomenon. They recorded 23 individuals in 1978 but only one individual in 2001 during their 643 kilometres of line transects in northern Lapland. However, the count of visible migration at Falsterbo (Kjellén 2003) also indicates a recent decline in numbers.

In spite of the fact that so few long term surveys exist from alpine habitats in Sweden, there is comfort in the fact that the little information we have does not yet indicate any wide-spread serious declines among the species. But it is important to be able to detect declines and threats before they become critical. A partial remedy is the new surveys made by the Breeding Bird Survey (Lindström & Svensson 2006). Since 1996 this project is using permanent transect lines evenly distributed 25 km apart all over Sweden. Some of them will cover alpine habitats. In time, this project will provide geographically much wider information about population trends among alpine birds than a few small local plots. However, careful surveys of the kind presented in this paper are also needed in order to

determine absolute densities and true numerical relationships between species.

Acknowledgements

I thank the ornithologists listed in Appendix 1 for excellent field-work. This applies particularly for the Kraipe plots at Ammarnäs, where much of the work was voluntary. The surveys at Abisko and Anjan were parts of an environmental monitoring programme that was temporarily operated by the nature conservation agency, which also covered parts of the costs in some years at Ammarnäs. Other bodies that provided grants for the Ammarnäs work were the Natural Science Research Council, the Royal Academy of Sciences, the Royal Society of Arts and Sciences in Göteborg, the Carl Trygger Foundation, the Seth M. Kempe Memorial Foundation, and the Swedish Ornithological Society. I am very grateful for all the inspiration and support given by Anders Enemar throughout the many years. Finally, I am particularly grateful to Thomas Andersson, who took over the responsibility for the Kraipe plots in 2002 and completed the surveys in both plots through 2006, with the commendable intention to carry the project into a distant future.

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Sammanfattning

De flesta biotoper har på ett eller annat sätt omvandlats genom mänskliga aktiviteter, främst de areella näringarna. Ingen biotop i Sverige är helt ursprunglig eftersom den åtminstone påverkats av fjärrtransporterade föroreningar och näringsämnen eller påverkats indirekt av exploatering av kringliggande områden. De biotoper som är minst påverkade och som har vidsträckt utbredning är myrmarker, subalpina skogar (främst björkzonen) samt fjällhedar. I denna uppsats redovisas fågelinventeringar av tre fjällhedar i olika delar av fjällkedjan: (1) nära Abisko i norra Lappland, (2) nära Ammarnäs i södra Lappland och nära Anjan i västra Jämtland. De två förstnämnda platserna fick permanent bebyggelse först i sen tid och kalfjällen runt omkring har förutom av rennäringen exploaterats i mycket ringa utsträckning. Anjanområdet har en längre historia av permanent bebyggelse, men även här är det i stort sett bara rennäringen som påverkat kalfjällets biotoper. Rennäringen har dock ungefär samma omfattning under hela 1900-talet och kan därför knappast ha förändrat förhållandena under den tid som fågelinventeringarna omfattar. Alla tre undersökningsområdena är visserligen belägna i närheten av renslakteri eller rengården. Innanför stängslena är marken mycket hårt sliten, men de undersökta provytorna har inte påverkats så långt detta gått att bedöma visuellt. De kan därför betraktas som representativa för liknade biotoper inom stora områden runt dem.

K1 och K2 (Kraipe) nära Ammarnäs

De provytor som studerats längst tiden är de som kallas K1 och K2, vardera en kvadratkilometer stor. De fick en gång sina namn efter fjället Kuoltatjåkko på den gamla generalstabskartan. Detta fjäll heter Svaren på den nyare topografiska kartan. Numera

kallas de dock Kraipe-ytorna efter det närbelägna renslakteriet med detta kartnamn. Ytorna ligger söder om Djupfors ungefär 16 km sydsydost om Ammarnäs. Provytan K1 ligger på nivån 790–850 m.ö.h., vilket är rätt nära trädgränsen på 720–740 m, och sluttar svagt mot nordost. Den består av en mosaik av torrare områden, smärre kullar och ganska stora myrmarker. Det finns ett par bäckar med högre viden, men i övrigt är risvegetationen relativt låg och domineras av blåbär, kråkbär, viden, enbuskar och dvärgbjörk. K2 ligger något högre (880–940 m) på en rygg och är torrare med få myrstråk. Risvegetation som är högre än låga blåbär saknas över större delen av provytan. Där ris finns består det av relativt låga viden och krypande enbuskar. De två provytorna inventerades 1964–2001 resp. 1964–1999 (Appendix 1). Resultaten från dessa två ytor har redovisats tidigare för de första tjugo år (Svensson m.fl. 1984). De två Kraipe-ytorna inventeras även fortsättningsvis (Thomas Andersson).

Påtjujaure nära Abisko

Provytan var belägen norr och öster om sjön Påtjujaure ca 14 km sydväst om Abisko och på en höjd av 780–910 m, drygt 100 m ovan trädgränsen. Större delen låg inom Abisko nationalpark. Den totala landarealen var 130 ha och saknade helt sjöar och småvatten. Under inventeringsarbetet bevakades också själva sjön med avseende på lommar och änder som låg i sjön. Berggrunden var bitvis kalkrik varav följde en artrik vegetation med inslag av fjällsippehedar i de dominerande gräs- och kråkrisshedarna. Delar av provytan omfattade partier med högre risvegetation. Arealen myr var liten. Provytan inventerades tolv år under perioden 1982–1996 (Appendix 1).

Ottsjö nära Anjan

Provytan var 150 hektar och låg på Anjeskutans västra sluttning ner mot Ottsjön. I öster nådde den till Hästskotjärnen, som finns namngiven på topografiska kartan, och sträckte sig sedan 1,5 km västerut. Lägsta och högsta höjd över havet var 600 respektive 640 meter. Trädgränsen var diffus men låg nära provytans lägsta del. Inom ytan fanns drygt 40 sjöar och småvatten, vilka tillsammans täckte 15,6 ha (10,4% av provytan). Störst var Hästskotjärnen (totalt 4,9 ha med två tredjedelar inom provytan) och en namnlös sjö (2,9 ha). Vegetationen var torr rished med obetydligt inslag av frisk rished och enstaka vindblottor. Områden med lättframkomlig myrmark med grunt torvlager fanns i relativt be-

gränsade omfattning. Provytan inventerades elva år under perioden 1983–1996 (Appendix 1).

Inventeringsmetod

I samtliga provytor användes revirkartering och för enstaka arter boletning (t.ex. fjälllab). Både antalet besök och antalet inventeringstimmar varierade eftersom det var anpassat till provytans svårighetsgrad (Appendix 1). Vissa år var besöken koncentrerade till en mycket kort tidsperiod. Detta spelar dock ringa roll eftersom fåglarna har en mycket stark synkroniserad häckningstid på fjällheden. Trots att mycket tid lades ner på inventeringarna var det svårt att säkert bestämma det exakta antalet par eller revir för en del arter. Ett exempel är fjällpiparen eftersom hanarna och deras bon är ytterst svåra att finna och honorna spelar över områden som är många gånger större än provytorna. De flesta arter var dock relativt lätta att inventera och jag anser att täthetsvärdena i stort är goda och korrekta uppskattningar. Under alla omständigheter är tidsserierna och jämförelserna mellan provytorna rättvisande eftersom samma metod använts i alla ytor alla år.

Resultat

Inventeringsresultaten presenteras i detalj i Appendix 2–4. Vidare illustreras beståndsutvecklingen för ett urval av arter med diagram i Figur 2. I Appendix 2 anges värden för provytan K2 åren 2000–2001 trots att denna provyta inte inventerades dessa år. Dessa värden är gissningar grundade på antagandet att värdena i K2 förändrades på samma sätt som i K1 i förhållande till de föregående fem åren. Dessa fiktiva värden används bara i diagrammen i Figur 2. I övriga analyser har dessa två år i K2 uteslutits.

Tabell 1 ger en sammanfattning av inventeringsresultaten för alla provytor och år. Ammarnäs K2 var den fattigaste provytan både i artantal och fågeltäthet medan Ammarnäs K1 var den klart rikaste. Dessa skillnader stämmer i stort sett med arealen och höjden av risvegetationen i provytorna. I tabellen har jag också fogat in tre provytor från Norge, som inventerats med samma metod. De ger en likartad bild av både artantal och täthet. En slutsats är att det troligen sällan kan finnas mer än ett hundra fågelpar på en kvadratkilometer fjällhed i Skandinavien. Allteftersom vegetationen sedan blir fattigare med ökande höjd i förhållande till trädgränsen sjunker fågelrikedomen för att gå ner till noll när man nått det riktiga hög fjället och grän-

sen för glaciärerna. Provytan K2 i Ammarnäs visar dock att fågelrikedomen sjunker ganska tydligt med obetydligt ökande höjd. Redan inom den lågalpina regionen blir fågelfaunan tidigt utarmad.

Ju fler år man inventerar, desto fler arter tillkommer. Figur 3 visar hur artlistan ökat i de två provytorna sammanslagna i Ammarnäs. Det kumulativa antalet arter följer i ett logaritmiskt diagram en rät linje som inte visar några tecken på att vika neråt. Prognosen blir att ytterligare åtta arter kommer att tillföras provytorna under de kommande sextio åren. Och detta är en helt realistisk prognos; flera arter som regelbundet setts i provytorna och som häckat i samma biotop i trakten har ännu inte häckat inom ytorna, t.ex. bläsand, blå kärnhök, fjällvråk, myrspov, gulärta, järnsparv och buskskvätta. Och 2005 tillkom som häckfågel en av de förväntade arterna, nämligen simsnäppan, som hela inventeringsperioden häckat vid smågölar alldeles utanför provytan.

Som framgår av Appendixen är det en ständig omsättning bland arterna. Det är bara i medeltal 24% av arterna som registrerats samtliga år i en provyta. För provytorna K1 och K2 sammanslagna har jag beräknat den årliga artomsättningen (Figur 4). Den beräknas för varje år som antalet nya arter plus antalet förlorade arter i procent av antalet arter året i fråga plus antalet arter året före. Den genomsnittliga artomsättningen var 16% i Ammarnäsytorna, men kunde enstaka år vara betydligt lägre (1985) eller betydligt högre (1988). Som framgår av regressionslinjen i Figur 4, finns ingen trend i artomsättningen mellan närliggande år. Om man i stället beräknar artomsättningen för år som ligger allt längre ifrån varandra får vi en annan bild (Figur 7). Omsättningen blir allt högre, d.v.s. artsammansättningen alltmer olika, ju fler år som ligger emellan. Den varken stabiliserar sig eller återvänder till att bli mera lik.

Ångspiplärkan var den vanligaste arten i alla provytorna. Den näst vanligaste arten var däremot olika. I Ammarnäs var det lappspårven i båda ytorna medan stenskvättan låg nära efter i K2. I Pätjujaure var det stenskvättan som var den klart vanligaste arten efter ångspiplärkan, medan lappspårven inte ens var årlig. I Ottsjöytan var lövsångaren den näst vanligaste arten, troligen för att ytan låg så nära trädgränsen, dock tätt följd av stenskvättan. Och lappspårven saknades helt i denna yta! En art med mycket likartad täthet i alla provytorna var ljunpiparen med sina 3–4 par per kvadratkilometer.

Endast serierna från Ammarnäs är tillräckligt långa för pålitliga trendanalyser. Dessa provytor visade att de flesta arter saknade signifikanta trender.

Det fanns 21 arter utan signifikanta förändringar, och bland dessa var nio positiva och tolv negativa. Sju arter visade signifikanta förändringar. Tre arter ökade, nämligen fjällripa, dalripa och ljungpipare, och fyra arter minskade i antal, nämligen dubbelbeckasin, grönbena, berglärka och ängspioplärka. Riporna saknades i provytorna de tidiga åren men blev årliga under det sista decenniet. Dubbelbeckasinens minskning bestod i att ett spel försvann. Det kan möjligen ha flyttats till utanför provytan men har inte eftersökts. Grönbena fanns med enstaka par hälften av åren det första decenniet men har sedan dess uppträtt bara enstaka år med långa mellanrum. Ängspioplärkans nedgång hänför sig utslutande till de tre första årens höga tal; görs en beräkning på resterande år finns ingen signifikant nedgång. För de nu nämnda arterna kan det röra sig om tillfälligheter. Däremot tror jag att ljungpiparens svaga ökning speglar en realitet i trakten, och berglärkans nedgång är en effekt av en känd generell populationsnedgång i hela Ammarnäsområdet. Det finns några trender även i Påtjujare och Ottsjö som är signifikanta, men jag är tveksam att dra några slutsatser av förändringar under så kort tid.

De årliga variationerna är inte synkrona mellan de fyra provytorna. Inte ens för de 36 år under vilka K1 och K2 inventerats fanns mer än en korrelation som var signifikant, och det var för ängspioplärkan. En närmare analys visade dock att denna signifikans utslutande berodde på att det fanns mycket ängspioplärkor i båda provytorna de allra första åren. Under resten av inventeringsperioden varierade antalen oberoende av varandra trots att provytorna bara låg en kilometer från varandra.

Diskussion

Först kommenteras några av arterna och därefter några mera allmänna frågeställningar. Artkommentarerna gäller de långa tidsserierna från Ammarnäs om inget annat sägs.

Riporna. Jag tror att ripornas uppträdande i provytorna under inventeringsperiodens senare del är en tillfällighet och inte ett tecken på en allmän beståndsökning. En tidigare analys (Svensson 1996) baserad på ett större linjetaxeringsmaterial från både björkskog och fjällhed visade inte på några långsiktiga trender, bara variationer mellan åren.

Fjällpipare. Arten har ibland påståtts minska i fjällen. Serien från Ammarnäs tyder dock inte på någon nedgång utan på ett långsiktigt stabilt bestånd.

Brushane. Arten förekommer regelbundet bara i Ammarnäs K1. Efter 1995 har värdena varit påtag-

ligt låga. Detta är intressant eftersom arten minskat i södra Sverige, på många håll utan att man kan förklara det med biotopförsämringar. Och i K1 har det inte skett några biotopförändringar. Man måste därför fråga sig om brushanen är utsatt för allvarlig biotopförstöring utanför häckningsområdena.

Lappspurv. Det intressantaste med denna art är de oväntade skillnaderna i täthet mellan undersökningslokalerna. Till en del kan de förklaras med artens biotoppreferenser, myrmarker med relativt hög risvegetation. Särskilt svårförklarlig är den totala frånvaron från Ottsjöytan, där det fanns lämplig terräng, vilket framgår av förekomsten av både lövsångare och blåhake. Den låga tätheten i Påtjujare (1 lappspurv per 39 ängspioplärkor) berodde antagligen på provytans höjdläge, eftersom Berg m.fl. (2004) på lägre nivåer i det närliggande Rautasområdet registrerade 1 lappspurv på drygt 2 ängspioplärkor. Lappsparven verkar således både med avseende på biotop och höjdzon vara mer selektiv än arter som ängspioplärka och stenskvätta.

Blåhake och lövsångare. Båda arterna är egentligen skogsfåglar, blåhaken nästan helt koncentrerad till fjällbjörkskog. Fjällheden är säkerligen en suboptimal biotop, vilket sannolikt är förklaringen till de stora variationerna i antal.

Stenskvätta. Det är betryggande att kunna konstatera att arten har goda bestånd i fjällen och att det inte finns någon tendens till långsiktig nedgång. Fjällpopulationerna skiljer sig således mycket från vad som registrerats för södra Sverige inom Häckfågeltaxeringen (Lindström & Svensson 2006), där det skett en mycket kraftig nedgång. Detta bör rimligtvis innebära att beståndsnedgången huvudsakligen drivs av lokala förändringar i jordbrukslandskapet, eftersom de flesta av Häckfågeltaxeringens punktrutter berör sådana biotoper, och troligen inte av försämrade övervintringsbetingelser i Afrika.

Arktiska fågelfaunor blir mer och mer intressanta både för att de är dåligt studerade i jämförelse med tempererade fågelfaunor, men också för att det finns ökande oro för deras bevarande i takt med att exploateringen ökar och möjliga klimatförändringar inträder. Vadarna är speciellt intressanta eftersom denna grupp är artrikare i arktiska områden än annorstädes. Bland tättingarna är det tvärtom eftersom allt färre arter förekommer ju nordligare man kommer och ytterst få är begränsade till det arktiska biomet.

I princip är fjällområdena söder om egentliga Arktis faunistiskt att betrakta som utlöpare av den arktiska regionen. De förändringar som sker när man förflyttar sig från söder mot norr på samma höjdnivå speglas mycket likartad när man rör sig

från låg till hög nivå på samma plats. Studier i de svenska fjällerna är således mycket värdefulla i ett all-arktiskt perspektiv.

Tyvänn finns det väldigt få inventeringar från de skandinaviska fjällerna att jämföra med. De jag funnit har jag tagit med i Tabell 1. De är från Norge och ligger på ungefär samma nivå i relation till trädgränsen, i något fall litet högre. Provytan Nedal alpin visar litet av det som präglar fågelfaunan när man kommer till litet högre nivå. Artantalet är klart lägre och förutom ängsbiplärka och stenskvätta blir nu också snösparven en dominerande art.

Konsekvenser för fågelskyddet

Eftersom denna uppsats redovisar de enda långtidsstudier som finns från svensk fjällhed har de naturligtvis konsekvenser för bedömningar om vissa arters hotstatus. Den generella slutsatsen är att arternas bestånd är stabila och inte tyder på att fjällfåglarna är utsatta för någon omfattande negativ påverkan, i varje fall inte under häckningstid. Samma slutsats kan man dra för fåglarna i björkzonen utifrån studien av Enemar m.fl. (2004). Det största problemet vid tolkningen av resultaten från fjällhedarna är de små stickproven (tre områden, fyra små provytor, få par av de flesta arter). Man kan därför naturligtvis ifrågasätta resultatens allmängiltighet, särskilt som långtidsbedömningarna dessutom kommer från en enda plats, Ammarnäs. Det som talar för att fjälltrakternas fågelfaunor inte är utsatta för några mera omfattande negativa faktorer under häckningstiden är givetvis det faktum att biotoperna inte heller är det. Det perspektivet gör att jag tror att den betryggande bilden är korrekt trots det blygsamma inventeringsunderlaget.

Den enda svenska studie som täcker en tidsrymd jämförbar med den i Ammarnäs är den undersökning som nyligen redovisats av Berg m.fl. (2004) från Rautasområdet sydost om Abisko. Denna studie baserade sig dock på bara två år, 1978 och 2001 och en annan metod, nämligen linjetaxering av

643 km vid ett tillfälle vardera året. Resultaten är mindre lätta att tolka eftersom för litet är känt om mellanårsvariationen. Om de två åren råkade vara speciella i något avseende, behöver de observerade förändringarna inte vara resultat av långtidstrender. Med denna reservation verkar dock resultaten stödja uppfattningen att fjällens fågelvärld inte är utsatt för någon generell negativ påverkan. Bland de arter som registrerats båda åren var det 26 som hade ökat, 32 som hade minskat och 2 som inte hade förändrades i antal. Fyra arter som registrerades 1971, kunde inte återfinnas 2001, medan hela 34 arter, som inte registrerades 1971, påträffades 2001. Totalt sett var det således stor dominans för ökande arter.

Bland de arter som i den svenska rödlistan (Gärdenfors 2005) förts till någon hotkategori, förekommer några i långtidsserierna från Ammarnäs. Fyra arter är klassade som "missgynnade" (mosnäppa, dubbelbeckasin, jorduggla och stenskvätta). Tre arter är klassade som "sårbara" (brushane, berglärka och rödstrupig piplärka). Tyvärr tillför inventeringarna inte mycket nytt eftersom bestånden är för små utom för brushane och stenskvätta, vilka diskuteras ovan. Särskilt beklagligt är detta för mosnäppan, vars placering i hotkategori möjligen kan vara felaktig eftersom grunden för placeringen var den kraftiga nedgång som drabbat det bestånd som förr häckade nära kusten och i älvdalar. På dessa platser fanns mosnäppan i människoskapade miljöer. Men när jordbrukets exploatering av dessa lättade eller upphörde, har det skett en naturlig restaurering, och biotopen med sin uppväxande vegetation passar de inte längre mosnäppan. Antalet mosnäppor i sådana miljöer kan dock ha varit litet i förhållande till fjällbeståndet. I Ammarnäs noterades häckning 6 resp. 10 år under första resp. andra 18-årsperioden, vilket i varje fall inte tyder på någon drastisk beståndsnedgång. Fångstsiffrorna vid Ottenby, som med tanke på artens sträckriktning bör spegla fjällbeståndet, tyder också på långsiktigt stabilt bestånd (Hedenström 2004).

Appendix 1. Survey data for the four Swedish plots: number of visits, June date of first visit, survey period in days, total survey hours, and observers. For the two Ammarnäs plots, corresponding data for 1964–1983 is found in Svensson et al. (1984). When half a day is given for the number of visits, one half of the plot was surveyed one day less than the other half.

Inventeringsdata för de fyra provytorna: antal besök, datum i juni för första besöket, inventeringsperiod i dagar, totala antalet inventeringstimmar och inventerare. För de två provytorna i Ammarnäs finns motsvarande uppgifter för 1964–1983 i Svensson m.fl. (1984). När en halv dag anges för antal besök inventerades ytans ena halva en dag mindre än den andra.

Plot Ammarnäs K1 *Provyta Ammarnäs K1*

Year <i>År</i>	Visits <i>Besök</i>	First <i>Första</i>	Period <i>Days dagar</i>	Total hours <i>S:a timmar</i>	Observers <i>Inventerare</i>
1984	8	7	18	50	GL, UC
1985	7.5	11	15	53	GL, SS
1986	7	7	18	47	GL, SS
1987	7	11	17	50	GL, SS
1988	8	10	23	50	GL, SS
1989	7.5	11	18	57	GL, ML
1990	8	9	20	62	GL, SE
1991	7	10	18	50	GL, SE
1992	7	6	26	46	GL, SE
1993	8	9	18	56	GL, SE
1994	7	11	16	42	GL, SE
1995	6	13	11	44	SE, AL
1996	8	17	12	54	AG, LL
1997	8	13	18	66	SS, LL
1998	8	15	15	74	MJ, LL, SS
1999	6	14	12	55	LL, SS
2000	7	12	14	47	CJ, JO, SS
2001	6	16	11	49	SS, TA

Plot Ammarnäs K2 *Provyta Ammarnäs K2*

Year <i>År</i>	Visits <i>Besök</i>	First <i>Första</i>	Period <i>Days dagar</i>	Total hours <i>S:a timmar</i>	Observers <i>Inventerare</i>
1984	5	16	9	29	GL, UC
1985	5	18	13	33	GL, SS
1986	4.5	12	18	29	GL, SS
1987	3.5	21	13	20	GL, SS
1988	4	16	6	24	GL, SS
1989	6	14	20	36	GL, ML
1990	5	21	14	28	GL, SE
1991	4	21	8	20	GL, SE
1992	4	10	16	24	GL, SE
1993	5	16	12	25	GL, SE, ML
1994	2.5	21	9	13	GL, SE
1995	5	14	18	25	SE, SS
1996	6	15	14	33	AG, LL
1997	5	17	8	36	SS, LL
1998	5	15	15	33	MJ, LL, SS
1999	4	15	15	24	SS, LL, SE

Observers Inventerare: AG = Anna Gårdmark, AL = A. Lindström, CJ = Christer Johansson, GL = Göran Liljedahl, JO = Jan Ohlsson, LL = Leif Lithander, MJ = Mikael Jönsson, ML = Mikael Larsson, SE = Sophie Ehnbohm, SS = Sören Svensson, TA = Thomas Andersson, UC = Ulf T Carlsson

Appendix 1 continued

Plot Pätjujaure at Abisko *Provyta Pätjujaure vid Abisko*

Year <i>År</i>	Visits <i>Besök</i>	First <i>Första</i>	Period <i>Days dagar</i>	Total hours <i>S:a timmar</i>	Observers <i>Inventerare</i>
1982	5	4	8	32	Nils Kjellén, Magnus Svensson
1983	6	22	15	52	Lars-Anders Hansson
1984	6	20	15	72	Mikael Wigforss, Robert Emilsson
1985	6	13	14	76	Mikael Wigforss, Olof Johansson, Sören Svensson
1986	6	11	20	68	Ronny Fransson, Folke Gabriëlsson
1987	6	21	14	62	Ronny Fransson, Mikael Wigforss
1988	6	20	12	56	Ronny Fransson, Mikael Wigforss
1989	6	21	9	50	Ronny Fransson, Mikael Wigforss
1990	5	25	5	37	Torkel Lundberg, Mikael Wigforss
1992	6	21	7	54	Torkel Lundberg, Daniel Palmgren
1993	6	24	6	64	Torkel Lundberg, Daniel Palmgren
1996	5	25	7	47	Lars Råberg, Niklas Holmqvist

Plot Ottsjö at Anjan *Provyta Ottsjö vid Anjan*

Year <i>År</i>	Visits <i>Besök</i>	First <i>Första</i>	Period <i>Days dagar</i>	Total hours <i>S:a timmar</i>	Observers <i>Inventerare</i>
1983	6	6	13	62	Pelle Adenäs, Anders Haglund
1984	6	5	14	32	Pelle Adenäs, Peter Sieurin
1985	6	1	16	55	Pelle Adenäs, Peter Sieurin
1986	6	3	14	48	Peter Sieurin, Mats Williamsson
1987	6	5	10	60	Ulf Lovén, Jan-Olov Svedberg, Mats Williamsson
1988	6	6	13	45	Pelle Adenäs, Mats Falkdalen
1989	6	11	12	64	Tomas Carlberg, Per Johansson
1990	6	9	13	52	Erik Ahlgren, Tomas Carlberg
1992	5	1	17	70	L.-E. Starkman, Sören Svensson
1993	5	15	10	52	L.-E. Starkman
1996	5	16	6	39	Lars Råberg, Niklas Holmqvist

Appendix 3.

Survey results for the plot at Påtjujaure, Abisko, northern Lapland: number of pairs each year, mean number of pairs per year (M), standard deviation (SD), density in no. of pairs per square kilometre (D) and number of years with species (Y). Waterfowl were excluded from the totals. Size of plot: 130 ha.

Inventeringsresultat för provytorna vid Påtjujaure, Abisko, norra Lappland: antal par varje år, medeltal par per år (M), standardavvikelse (SD), täthet i par per kvadratkilometer (D) och antal år med arten (Y). Sjöfåglar uteslutna från summorna. Provytans storlek: 130 ha.

Year År	82	83	84	85	86	87	88	89	90	92	93	96	M	SD	D	Y
<i>Gavia arctica</i>	–	–	–	–	–	1	1	1	1	1	–	1	0.50			6
<i>Aythya marila</i>	–	–	–	–	1	–	–	–	–	–	–	–	0.08			1
<i>Clangula hyemalis</i>	3	4	3	2	3	2	1	1	1	2	2	1	2.08			12
<i>Melanitta fusca</i>	3	5	3	4	4	5	2	1	–	–	–	2	2.42			9
<i>Buteo lagopus</i>	–	1	–	–	–	–	–	–	–	1	–	–	0.17	0.39	0.13	2
<i>Lagopus mutus</i>	4	–	1	2	2	3	1	2	1	–	3	1	1.67	1.23	1.28	10
<i>Charadrius hiaticula</i>	–	–	–	–	–	–	–	–	1	1	–	–	0.17	0.39	0.13	2
<i>Charadrius morinellus</i>	–	–	–	–	–	–	1	1	–	1	–	–	0.25	0.45	0.19	3
<i>Pluvialis apricarius</i>	8	6	8	7	5	6	3	4	5	4	4	5	5.42	1.62	4.17	12
<i>Calidris temminckii</i>	1	–	–	–	–	–	–	–	–	1	1	–	0.25	0.45	0.19	3
<i>Tringa totanus</i>	1	2	1	1	2	1	1	2	2	2	2	1	1.50	0.52	1.15	12
<i>Actitis hypoleucos</i>	–	–	–	–	–	–	–	–	1	–	–	–	0.08	0.29	0.06	1
<i>Stercorarius longicaudus</i>	2	–	–	–	1	3	–	–	–	5	–	–	0.92	1.62	0.71	4
<i>Larus canus</i>	1	1	–	1	1	1	1	–	–	–	–	–	0.50	0.52	0.38	6
<i>Nyctea scandiaca</i>	1	–	–	–	–	–	–	–	–	–	–	–	0.08	0.29	0.06	1
<i>Anthus pratensis</i>	37	34	34	37	40	31	39	38	28	35	40	34	35.58	3.65	27.37	12
<i>Cinclus cinclus</i>	–	–	–	1	1	–	–	–	1	1	–	–	0.33	0.49	0.26	4
<i>Luscinia svecica</i>	3	6	1	7	5	4	4	3	–	4	5	–	3.50	2.24	2.69	10
<i>Oenanthe oenanthe</i>	16	18	15	16	15	18	16	17	16	16	16	9	15.67	2.31	12.05	12
<i>Turdus torquatus</i>	–	–	–	–	–	–	–	–	1	1	1	1	0.33	0.49	0.26	4
<i>Turdus iliacus</i>	1	–	–	–	–	–	–	–	–	–	–	–	0.08	0.29	0.06	1
<i>Carduelis flammea</i>	–	–	–	1	–	1	1	–	–	–	2	2	0.58	0.79	0.45	5
<i>Carduelis hornemanni</i>	–	–	–	–	–	–	–	1	–	–	–	–	0.08	0.29	0.06	1
<i>Calcarius lapponicus</i>	1	2	–	–	–	1	–	4	1	1	1	–	0.92	1.16	0.71	7
No. of pairs <i>Antal par</i>	76	70	60	73	72	69	67	72	57	73	75	53	68.08			52.37
No. of species <i>Antal arter</i>	12	8	6	9	9	10	9	9	10	13	10	7	9.33			

Appendix 4.

Survey results for the plot Ottsjö, near Anjan, western Jämtland: number of pairs each year, mean number of pairs per year (M), standard deviation (SD), density in pairs per square kilometre (D) and number of years with species (Y). Size of plot: 150 ha.

Inventeringsresultat för provytan Ottsjö nära Anjan, västra Jämtland: antal par varje år, medeltal par per år (M), standardavvikelsen (SD), täthet i par per kvadratkilometer (D) och antal år med arten (Y). Provytans storlek: 130 ha.

Year År	83	84	85	86	87	88	89	90	92	93	96	M	SD	D	Y
<i>Anas penelope</i>	–	–	–	–	1	–	–	–	–	–	–	0.09	0.30	0.07	1
<i>Lagopus lagopus</i>	–	–	1	1	1	–	2	1	–	–	–	0.55	0.69	0.40	5
<i>Lagopus mutus</i>	4	3	4	2	2	2	3	1	4	3	3	2.82	0.98	2.09	11
<i>Charadrius morinellus</i>	–	–	1	–	–	–	–	–	–	–	1	0.18	0.40	0.13	2
<i>Phuvisialis apricarius</i>	4	4	4	6	3	3	7	4	7	8	9	5.36	2.11	3.97	11
<i>Calidris maritima</i>	–	–	1	–	–	–	–	–	–	–	–	0.09	0.30	0.07	1
<i>Gallinago gallinago</i>	2	–	1	2	–	1	–	3	1	1	–	1.00	1.00	0.74	7
<i>Numenius phaeopus</i>	–	–	–	1	1	–	1	–	2	–	–	0.45	0.69	0.34	4
<i>Tringa totanus</i>	2	2	2	2	2	2	3	2	2	2	4	2.27	0.65	1.68	11
<i>Tringa nebularia</i>	–	–	–	–	–	–	–	–	1	–	1	0.18	0.40	0.13	2
<i>Tringa glareola</i>	–	–	–	–	–	–	–	–	–	–	1	0.09	0.30	0.07	1
<i>Actitis hypoleucos</i>	–	–	–	–	–	–	–	–	1	–	–	0.09	0.30	0.07	1
<i>Larus canus</i>	–	–	1	–	1	–	–	–	2	–	–	0.36	0.67	0.27	3
<i>Sterna paradisaea</i>	–	1	1	–	–	–	1	–	–	–	1	0.36	0.50	0.27	4
<i>Cuculus canorus</i>	1	–	–	–	–	–	1	–	1	–	1	0.36	0.50	0.27	4
<i>Anthus pratensis</i>	28	20	24	23	29	30	34	22	17	25	24	25.09	4.85	18.59	11
<i>Luscinia svecica</i>	6	1	10	3	5	6	8	4	6	3	4	5.09	2.51	3.77	11
<i>Oenanthe oenanthe</i>	4	4	6	7	11	6	9	12	6	5	7	7.00	2.65	5.19	11
<i>Turdus torquatus</i>	–	–	–	–	–	–	2	–	–	2	–	0.36	0.81	0.27	2
<i>Phylloscopus trochilus</i>	13	9	7	9	4	10	13	7	5	3	1	7.36	3.91	5.45	11
<i>Carduelis flavirostris</i>	–	–	–	–	–	–	–	–	–	–	1	0.09	0.30	0.07	1
<i>Carduelis flammea</i>	–	–	–	–	–	1	–	–	–	5	–	0.55	1.51	0.40	2
<i>Emberiza schoeniclus</i>	–	–	2	–	–	–	1	–	–	–	1	0.36	0.67	0.27	4
No. of pairs <i>Antal par</i>	64	44	65	56	60	61	85	56	55	57	59	60.18		44.58	
No. of species <i>Antal arter</i>	9	8	14	10	11	9	13	9	13	10	14	10.91			