



Population structure and origins of Purple Sandpipers *Calidris maritima* in north Norway during winter

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Wintering Purple Sandpipers *Calidris maritima* were captured at Varangerfjorden, Finnmark, in March 1992, and compared with samples from Troms county in November 1988 to describe the population structure in north Norway in terms of age and sex classes, and to determine the origins of these wintering birds. The overall percentage of first-year birds was 35% at Varangerfjorden, higher than that in Troms (21%). However, there may have been biases in the catches at Varangerfjorden, and the percentage in the largest catch was 23% first-year. In both regions, the percentage of first-year birds varied among sites, indicating age segregation. There was a higher percentage of males than females in the first-year population at Varangerfjorden and in both age classes at Troms. The wing and bill lengths of the different age/sex classes at Varangerfjorden and Troms were similar, indicating largely similar origins. Comparison of bill and wing lengths of wintering birds with samples from the breeding grounds supports results from ringing data that the wintering birds come predominantly from Russia, but with some also from Svalbard.

The Purple Sandpiper *Calidris maritima* breeds in Arctic, sub-Arctic and alpine regions from Canada in the west to northern Russia in the east, including Greenland, Iceland, Svalbard, Fennoscandia and Scotland (Cramp & Simmons 1983). These breeding populations spend the winter along different parts of the coasts of the North Atlantic. For some of these populations, the wintering areas have been described from ring recoveries and the matching of bill and wing lengths (Atkinson *et al* 1981, Boere *et al* 1984, Nicoll *et al* 1988, Hake *et al* 1997), but the wintering areas of some are still unclear.

The Purple Sandpiper is the most northerly wintering wader and even occurs in large numbers north of the Arctic Circle in Norway during winter. Troms county was estimated to have 18,000 in winter (Summers *et al* 1990) and it is likely that the other northern counties of Norway have similar numbers. The study in Troms in 1988 (Summers *et al* 1990) found that the population had a predominance of males (60% males) and contained 21% first-year birds. A comparison between the biometric data from the Troms birds and birds from likely breeding areas suggested that most of the wintering birds were derived from the Russian breeding population (Summers *et al* 1990).

In 1992, we extended this study to Finnmark (the most northerly county) to examine the structure of the Purple Sandpiper population occurring in the Varangerfjorden in late winter (March). We also reviewed the biometrics of birds from the wintering and breeding grounds, and the ring recoveries to elucidate the origins of Purple Sandpipers wintering in northern Norway.

METHODS

Study area and catching methods

Varangerfjorden was visited between 15 and 22 March 1992, and Purple Sandpipers were cannon-netted at high-tide roosts at eight localities (Figure 1, Table 1). The data from Troms county were obtained from catches at six sites (460 birds) between 5 and 11 November 1988 (Summers *et al* 1990). Captured birds were aged as first-year or adult from the colour of the inner median coverts (Prater *et al* 1977). They were ringed with a metal and two yellow colour rings, and measured. Maximum wing length was measured with a stopped ruler to 1 mm and bill length was measured with dial callipers to 0.1 mm. Measurements were taken by RWS and RR who cross-checked measurements for consistency. Both observers were also involved in the Troms study, thus minimising bias between the two studies.

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Table 1. Details of catches of Purple Sandpipers at different sites at Varangerfjorden during March 1992.

Date	Place	Number of first-years	Number of adults	Total	Percent first-year
15 March	Vadsö	2	4	6	33.3
16 March	Nesseby	15	14	29	51.7
17 March	Kiby	4	6	10	40.0
18 March	Nyhamn	6	1	7	85.7
19 March	Urdness	8	17	25	32.0
20 March	Ekkeröy	4	0	4	100.0
20 March	Nesseby	14	4	18	77.8
21 March	Skallelv	40	137	177	22.6
21 March	Ekkeröy	18	18	36	50.0
22 March	Vadsöya	1	7	8	12.5
Total		112	208	320	35.0

Biometrics and analysis

Purple Sandpipers are sexually dimorphic with respect to bill size: males have shorter bills than females (Cramp & Simmons 1983). Therefore, frequency distributions of bill lengths are bimodal, but with some overlap. The percentage of males and mean bill lengths for the two modes were obtained graphically using Harding–Cassie plots (Harding 1949, Cassie 1954). The mid-point between the means of the two modes was used to separate the sample into males (shorter-billed birds) and females (longer-billed birds), accepting that a small percentage (3–4 %) of birds in the overlap zone would be misclassified (Summers *et al* 1990). Comparisons between bill and wing lengths of males and females from Varangerfjorden and Troms were made by examining the 95% confidence limits (CLs) of the differences between bill and wing lengths; those that included zero were regarded as not significantly different.

Bill length distributions were compared using chi-squared tests in which the number of birds within each 1 mm size class was compared. Some lumping of size classes was necessary where numbers were small.

Bill and wing lengths of the wintering birds were used to indicate possible breeding origins because the different breeding populations differ in biometrics (Nicoll *et al* 1991, Engelmoer & Roselaar 1998). The 95% ranges for bill and wing lengths were obtained from the means \pm 1.96 standard deviations from the means. These ranges were represented as ellipses by combining bill and wing lengths for males and females for the different breeding populations.

RESULTS

Population structure and biometrics

Three hundred and twenty birds were captured at Varangerfjorden, out of a population of several thousand

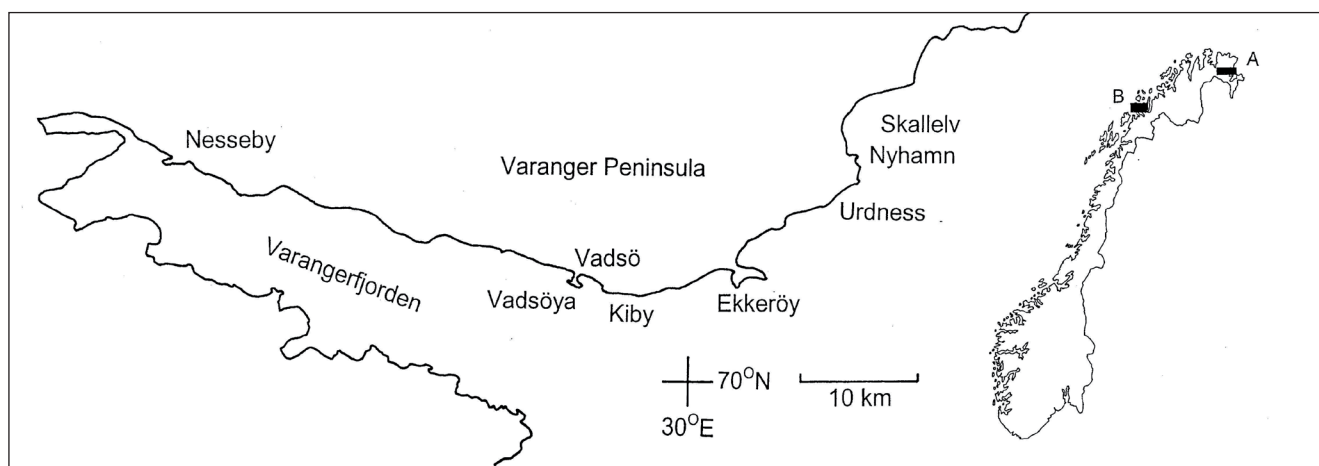


Figure 1. The study area at Varangerfjorden (A), north Norway, shown as a black rectangle on the inset map of Norway. The location of the Troms (B) study area (Summers *et al* 1990) is also shown.

Table 2. Mean bill and wing lengths (mm) of Purple Sandpipers wintering in north Norway. Standard deviations are in brackets. Bill lengths were derived from Harding–Cassie plots and sexing for wing lengths was on a bill separation point of 31.1 mm (Troms) and 31.4 mm (Varangerfjorden). The Troms data are from Summers *et al* (1990).

Place	Sample size	Bill length (mm)	Wing length (mm)
Varangerfjorden			
Adult male	105	29.3 (1.2)	131.9 (2.3)
First-year male	69	29.3 (1.1)	130.6 (2.3)
All males	174	29.3 (1.2)	131.4 (2.4)
Adult female	103	33.9 (1.3)	135.8 (2.8)
First-year female	43	33.4 (1.2)	135.4 (2.3)
All females	146	33.5 (1.3)	135.7 (2.7)
Troms			
Adult male	222	28.8 (1.2)	131.3 (2.3)
First-year male	58	29.2 (1.1)	131.6 (2.4)
All males	280	28.9 (1.2)	131.3 (2.3)
Adult female	142	33.2 (1.3)	135.6 (2.5)
First-year female	38	33.8 (1.1)	134.7 (2.4)
All females	180	33.3 (1.3)	135.4 (2.5)

birds (Table 1). Most of the catches were of fewer than 30 birds, and there was only one large catch, at Skallelv. In a comparison among those catches with more than 20 birds, there were significant differences among sites in the percentage of first-year birds, which ranged from 22.6% to 51.7% ($\chi^2 = 17.9$, $df = 3$, $P < 0.001$). The overall percentage of first-year birds was 35%.

There was no significant difference in the distribution of adult and first-year bill lengths of birds caught in either Varangerfjorden ($\chi^2 = 8.64$, $df = 9$, $P = 0.47$) or Troms ($\chi^2 = 6.55$, $df = 9$, $P = 0.68$, Fig 2). Furthermore, there was no difference between first-year Varangerfjorden and Troms birds ($\chi^2 = 4.34$, $df = 9$, $P = 0.88$), but there was a difference between Varangerfjorden and Troms adults ($\chi^2 = 16.9$, $df = 9$, $P = 0.05$). Longer bill lengths were slightly more common at Varangerfjorden than Troms. However, when both age classes were combined, there was no difference between bill lengths of Varangerfjorden and Troms birds ($\chi^2 = 12.7$, $df = 9$, $P = 0.18$).

Given the bimodal distributions of the bill lengths (Fig 2), estimates were made of the percentage of males (the lower mode) from Harding–Cassie plots. This approach indicated that there were 51% males amongst the adult birds and 62% for first-years at Varangerfjorden (54% combined). The sex ratio for the adult birds was not significantly different from unity, but that of the first-years was significantly different ($\chi^2 = 5.58$, $df = 1$, $P < 0.05$). These values were slightly different to the estimates for Troms county where the percentage of males was similar for the two age classes: 61% males in the first-year population and 60% in the adult population (Summers *et al* 1990).

At Varangerfjorden, the mean bill lengths and standard deviations of adults and first-years for the two modes in the distributions were derived from Harding–Cassie plots, and found to be close to the estimates for Troms (Table 2). The first-year males and females showed no significant differences between the two areas, but the adult male bills were on average 0.47 mm (95% CLs 0.19–0.75 mm) longer and the adult female bills were 0.71 mm (95% CLs

Table 3. Mean bill and wing lengths (standard deviation in brackets) of breeding Purple Sandpipers from Scandinavia, Svalbard and Russia.

Place	Sample size	Males	Females	Source
Bill lengths (mm)				
North Norway	9	25.8 (0.5)	29.4 (0.1)	Nicoll <i>et al</i> 1991
Svalbard	108	28.1 (1.0)	32.9 (1.0)	Nicoll <i>et al</i> 1991
Franz Josef Land	11	27.6 (1.0)	31.7 (0.7)	Tomkovich 1985
Franz Josef Land	8	28.7 (1.0)	32.9 (0.7)	Engelmoer & Roselaar 1998
Novaya Zemlya	20	29.5 (1.6)	33.4 (1.6)	Engelmoer & Roselaar 1998
Taimyr Peninsula	9	28.1 (1.1)	31.5 (1.5)	Engelmoer & Roselaar 1998
Wing lengths (mm)				
North Norway	9	126.1 (2.7)	128.5 (2.1)	Nicoll <i>et al</i> 1991
Svalbard	107	129.3 (2.3)	134.6 (2.6)	Nicoll <i>et al</i> 1991
Franz Josef Land	11	122.6 (1.7)	128.0 (1.7)	Tomkovich 1985
Franz Josef Land	8	128.4 (1.5)	131.3 (1.5)	Engelmoer & Roselaar 1998
Novaya Zemlya	21	130.0 (2.4)	136.0 (2.5)	Engelmoer & Roselaar 1998
Taimyr Peninsula	9	127.3 (2.9)	135.2 (3.7)	Engelmoer & Roselaar 1998

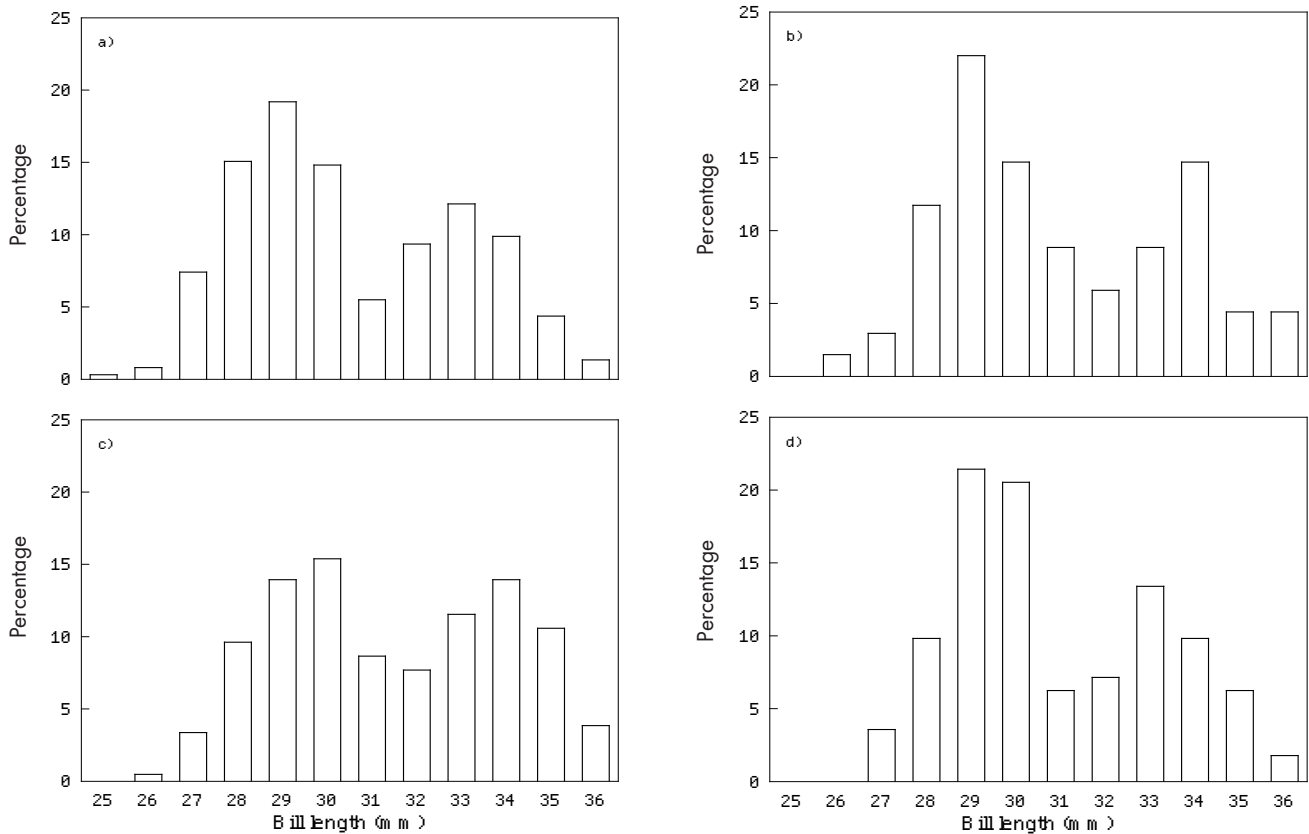


Figure 2. Bill lengths of Purple Sandpipers at Troms (a adults, b first-years) in November 1988 and Varangerfjorden (c adults, d first-years) in March 1992.

0.38–1.04 mm) longer at Varangerfjorden. The mid-point between the mean bill lengths (31.4 mm) was used to sex the sample, and thereby describe the wing lengths of the males and females. The mean wing lengths of the Troms and Varangerfjorden birds were similar for both males and females (the 95% CLs of the differences included zero).

Comparisons were made between the estimates for the bill and wing lengths from the wintering birds in north Norway and likely breeding areas, to obtain an indication of the origin of wintering birds. The possible origins of the wintering birds are Russia, Svalbard and northern Scandinavia (Table 3). The north Norway breeding birds were distinctly smaller than the wintering birds, so cannot comprise the bulk of the wintering birds. However, because they overlap with the wintering birds, they cannot be discounted entirely. The sizes of the Svalbard breeding birds are closer to the sizes of the wintering birds in Norway, while those from Russia (Novaya Zemlya) showed the closest similarity (Fig 3). The difference between the means for Svalbard and Russian birds is small, so it is difficult to draw firm conclusions about the origins of the north Norway birds from these data. The sample sizes from Russia are also small, so the means may not be accurate.

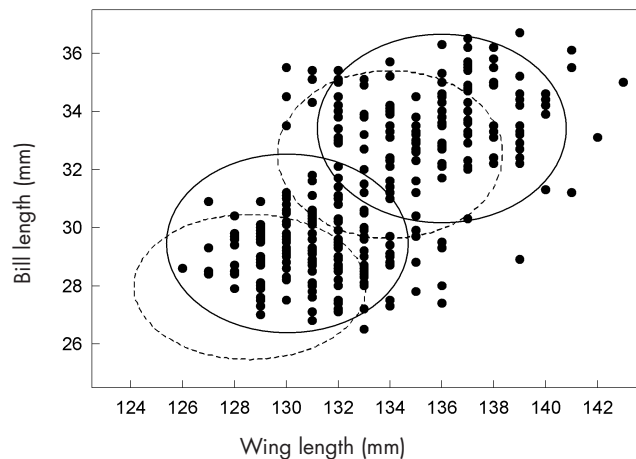


Figure 3. Bill against wing lengths of Purple Sandpipers caught at Varangerfjorden in March 1992. The superimposed ellipses represent the 95% ranges for breeding Purple Sandpipers from Novaya Zemlya (Russia) (solid lines) and Svalbard (dashed lines) (from Engelman & Roselaar 1998). The lower ellipses are for males and upper ones for females.

Table 4. Details of ring recoveries and a colour-ring sighting of Purple Sandpipers ringed in north Norway. From Hake *et al* (1997) and Tomkovich *et al* (2000).

Ring no.	Date	Age/sex	Place
8235204	21.3.92	Adult female	Skallelv, Varangerfjord, Norway (70°12'N 30°23'E)
	18.7.93	Trapped on nest	Ruski Island, Nordensheld Archipelago, Russia (77°08'N 96°30'E)
8235291	21.3.92	First-year female	Skallelv, Varangerfjord, Norway (70°12'N 30°23'E)
	9.6.96	Shot	Domashny Island, Russia (79°27'N 91°00'E)
EA16212	19.1.95	Adult male	Tromsdalen, Tromsø, Norway (69°41'N 19°00'E)
	14.6.96	Shot	Domashny Island, Russia (79°27'N 91°00'E)
8204312	11.11.88	Adult	Langnes, Tromsø, Norway (69°42'N 18°54'E)
	17.10.92	Colour-ringed	Langnes
	6–8.6.93	Colour-rings seen	Longyearbyen, Svalbard (78°13'N 15°38'E)
	6–15.6.94	Seen	Longyearbyen
	8.6.95	Seen	Longyearbyen

Ring recoveries

Recoveries of birds ringed at Skallelv (Varangerfjorden) and Tromsdalen (Troms) confirmed that Russian breeding birds were present in north Norway in winter (Table 4). There was also a colour-ring sighting of a bird ringed in November at Tromsø and later seen in Svalbard. It has been shown that many Svalbard breeding birds winter in southwest Sweden (Hake *et al* 1997), so these birds must pass through north Norway on migration.

There have been only two ringing records of birds that probably refer to the north Norway breeding population. One was a juvenile ringed on 5 July 1948 on the coast towards the south of the region with which we are primarily concerned, but still north of the Arctic Circle (at Finneidfjord 67°N) and recovered on 15 February 1950 on the northeast coast of Scotland (Atkinson *et al* 1981). The other refers to a colour-ring sighting of a bird ringed on Helgoland (off the German coast) on 28 December 1990 and sighted on the breeding grounds of the Varanger Peninsula on 15 July 1991 (Dierschke 1995). This sighting took place at a time when other colour-ring schemes were concurrent, so further supporting evidence would be valuable. However, taking the two recoveries together, it does suggest that Purple Sandpipers that breed in north Norway winter on North Sea coasts rather than locally.

DISCUSSION

The overall percentage of first-year birds at Varangerfjorden was high (35%) in comparison to other studies. In Troms, it was 21% in winter 1988/89 (Summers *et al* 1990).

Other studies have recorded similar values: 18–20% in Orkney (Corse & Summers 1999) and 24% in eastern Scotland (Atkinson *et al* 1981). Perhaps there had been a very successful breeding season in 1991. An alternative possibility is that, because Purple Sandpiper flocks segregate partially according to age class (Summers *et al* 1990, Summers *et al* 2005, this study), samples caught at sites favoured by young birds will have influenced the overall figure at Varangerfjorden. Also, many of the catches at Varangerfjorden were small, and sampled only a small percentage of the flock. The large sample at Skallelv, where we caught most of the flock, had one of the smallest percentages (23% first-year birds), so this may have been more representative for Varangerfjorden.

The sex ratio at Varangerfjorden showed that there were more males than females among the first-year birds, similar to the situation at Troms (Summers *et al* 1990). A greater percentage of males has also been found in other studies of Purple Sandpipers: Iceland (Morrison 1976), eastern Scotland (Atkinson *et al* 1981) and The Netherlands (Boere *et al* 1984), indicating that this may be a general phenomenon, rather than segregation of the sexes on the wintering grounds, as found for other species of sandpiper (eg Western Sandpiper *Calidris mauri*, Page *et al* 1972).

The comparison of the bill length distributions of Purple Sandpipers at Varangerfjorden and Troms showed that there was little difference, with perhaps slightly more longer-billed birds (particularly adults) at Varangerfjorden (Fig 2). The wing lengths of the males and females were similar for the two regions. It would seem that the measurements of the Varangerfjorden and Troms birds were similar, indicating a common origin. However, ring

recoveries have shown that Purple Sandpipers that winter in north Norway are derived from the Russian breeding population and also from Svalbard. Because the biometrics of these two breeding populations broadly overlap, it is difficult to estimate the relative proportions of the two populations. The distribution of bill and wing lengths did, however, appear to be closer to those of the Russian breeding birds, suggesting that most come from here.

The timing of primary moult gives an additional clue to breeding origins: in Troms, Purple Sandpipers are late moulters (the average date for completion of primary moult is 2 November: Summers *et al* 2004). This late moult schedule fits with the late breeding of Russian birds, but not with Svalbard Purple Sandpipers, which start moult and apparently complete moult in September, prior to migrating from Svalbard (Bengtson 1975). Therefore, the available data support the idea that most of the north Norway wintering birds are from Russia rather than Svalbard. However, further work on the moult of Svalbard Purple Sandpipers is required to check whether primary moult is completed there, before departing from Svalbard.

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