

THE SPRING MIGRATION SYSTEM OF NEARCTIC KNOTS *CALIDRIS CANUTUS ISLANDICA*: A RE APPRAISAL

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Most Knots breeding in Greenland and the eastern Canadian arctic and Greenland were believed to stage in May in western Iceland, and those staging in northern Norway to breed in Siberia. Studies in Balsfjord, north Norway in May 1985 and May 1986 have shown this population of 12 000-28 000 birds staging there to be Nearctic, probably breeding in both Greenland and Ellesmere Island. The approximately 30 000 Knots staging at the same time in Porsangerfjord may be also Nearctic breeders. Birds reach Balsfjord from wintering grounds around the southern North Sea, and early spring staging areas in Scotland, the Wash and the Wattenmeer. Both Balsfjord and Porsangerfjord are of major international importance to Nearctic Knots. Despite these discoveries, and the recent finding of another important May staging area in north-east Iceland, there remain many unanswered questions. These include the precise location of the breeding grounds of Knots using each staging area in May, the origins of Knots that stage briefly in north-east Iceland in late May, and the extent of a link between Norway and Iceland during May.

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INTRODUCTION

The migration of Knots between their west European and west African wintering quarters and their breeding grounds in arctic Canada, Greenland and the USSR has been extensively studied during the past 20 years (e.g. Prater and Wilson 1972, Morrison 1975, Andreasson and Rad 1977, Dick et al. 1976, Dick 1979, Roselaar 1983, Dick et al. 1987), so that Knots have seemed to have one of the best understood migration systems of any wader species. Furthermore Knots are known to make just a few long migratory flights and consequently use only a few staging sites, where they congregate in very large numbers (often 10 000 - 100 000 birds), and where they accumulate large stores of fat and muscle protein (Davidson and Evans 1986, in press). Knots breeding in mid-Siberia are known to overwinter chiefly in western and southern Africa, and during their northwards migration use spring staging areas in western France and the Waddensee (especially Schleswig-Holstein). Knots that breed in Greenland and the eastern Canadian arctic (especially Ellesmere Island) overwinter mostly around the coasts of the southern North Sea, south to western France. In early spring most congregate at a very few staging areas, notably in north-west England, the Wash and the Dutch and West German parts of the Waddensee. Many then pass through Iceland in May.

Despite this extensive work, and an apparently comparatively simple migration system, the presence of large numbers of Knots at spring staging posts in north Norway has become widely known only recently: previously only small flocks (up to 2500 birds) had been reported in spring (Andreasson and Rad 1977). Two major sites used in May have now been identified: Porsangerfjord (70° 20' N 25° 06' E) with at least 30 000 birds (Berg 1979, Haland and Kalas 1980), and Balsfjord (69° 21' N 19° 18' E) with up to 28 000 birds (Strann 1984, 1985, Davidson et

al. 1986). Both Haland and Kalas (1980) and Roselaar (1983) assumed that the Knots in Porsangerfjord belonged to the Siberian population *C. c. canutus*. However from studies in May 1985 we showed from their body size, ringing locations and timing of migrations that Knots staging in Balsfjord, and possibly also Porsangerfjord during May, belong to the Nearctic population *C. c. islandica* (Davidson et al. 1986). Previously, almost all of this population had been believed to stage in western Iceland during May (Cramp and Simmons 1983).

Further studies in Norway by Durham and Tromsø Universities, and elsewhere as part of the Wader Study Group project on the migration of waders along the East Atlantic Flyway have revealed more about the spring migrations of Nearctic Knots. In this paper we report the results of these further studies. We use them, and the findings of earlier studies, to make a re-assessment of the spring migration system of Nearctic Knots. Despite this new information, we have highlighted several substantial gaps in the knowledge of how Knots reach their Nearctic breeding grounds.

RECENT RESULTS

1703 Knots were caught in cannon-nets in Balsfjord during May 1985 (Davidson et al. 1986); a further 564 Knots were caught there between 11 and 28 May 1986. The sizes and plumage characteristics of the birds caught in 1986 indicated a Nearctic breeding origin, as found in 1985. In May 1986 we caught 18 Knots that had been caught previously elsewhere, including one bird, originally ringed in Britain, that was caught in Balsfjord for the second consecutive year. We recaptured altogether 39 birds that had been caught in Balsfjord in May 1985. In May 1985 we caught

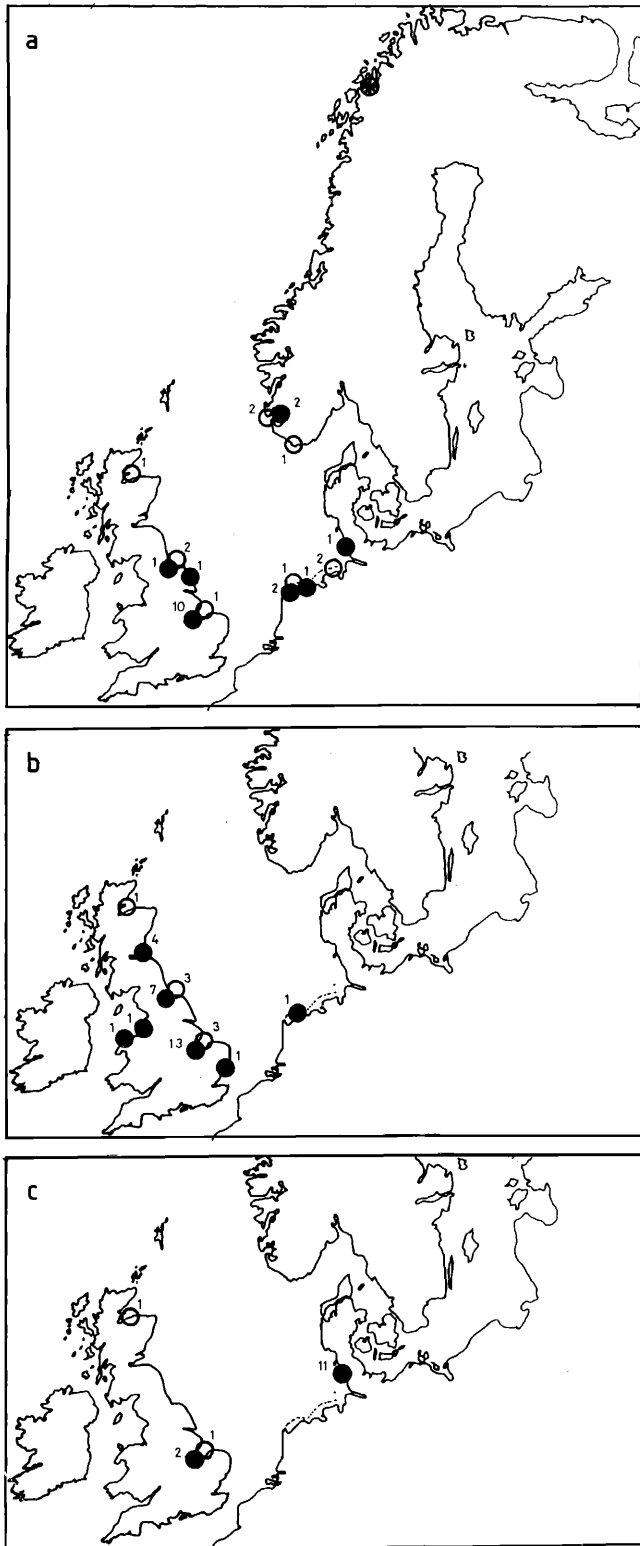


Figure 1. Ringing locations of Knots captured in Balsfjord in May 1985 and May 1986. Birds recaptured in Balsfjord, birds ringed in Balsfjord and recaptured elsewhere, and birds colour-marked in Balsfjord and seen elsewhere, are included. * marks the location of Balsfjord. a) autumn (August - October), b) winter (November - March), and c) spring (April - mid-May). ○ are birds ringed as immatures, ● are birds ringed as adults.

and ringed approximately 11% of the birds present in Balsfjord. 6.9% of the birds caught in 1986 had been captured in the previous year. Although the principles of mark-recapture analysis are not strictly applicable here, these figures do suggest that a large proportion of the birds in Balsfjord in May 1986 had been there also in May 1985. Hence many individuals regularly use Balsfjord as their late spring staging area.

In May 1985 most Knots carrying rings from elsewhere had been caught on the east coast of Britain during autumn and winter. In 1986, most (11 birds) of the 18 that had been caught previously elsewhere had likewise been present in eastern Britain (from Suffolk north to the Moray Firth) during autumn and winter. The distribution of these ringed birds in 1985 and 1986 is shown in Figure 1a and 1b, which include several observations of birds fitted with colour-rings in Balsfjord in May 1986. Other Knots in the Balsfjord population in 1985 and 1986 had moulted on the Dutch and West German parts of the Waddensee in autumn, and some adults and immatures were present on the coasts of southern Norway at this time (Figure 1a).

877 Knots were caught and colour-marked on the Wattenmeer in Schleswig-Holstein (West Germany) on 22 April 1986. At this time of year only Nearctic-breeding birds are believed to be present (Dick *et al.* 1986). Five of these had been ringed in Balsfjord during May 1985. Another was recaptured in Balsfjord in late May 1986, one month after its capture on the Wattenmeer. Other Knots marked on the Wattenmeer at the same time were seen in mid-May 1986 in north-east Iceland and west Iceland (Whitfield and Magnusson 1987, G. Gudmundsson pers. comm.). Other early spring staging sites used by Knots reaching Balsfjord in May are the Wash, and Findhorn Bay in north-east Scotland (Figure 1c). Two Knots that subsequently reached Balsfjord in May had overwintered on the Wattenmeer when they were immature.

497 Knots caught in Balsfjord in May 1986 were marked with a permanent colour-ring as part of continuing studies to establish the extent to which birds are faithful to late spring staging areas between years. One of these birds, marked on 11 or 13 May, shortly after its arrival in Balsfjord, was seen in west Iceland (where it probably remained for at least 5 days) on 26 May, only 2 weeks later. This bird must have been amongst the earliest departures from Balsfjord (Table 1). However on the basis of this one observation we cannot yet be sure whether such a movement is a regular or abnormal occurrence.

Table 1. The migration timings of Knots in Balsfjord, north Norway.

	1984 ^a	1985	1986
first arrivals	4 May	8 May	6 May
>75% arrivals	12-16 May	12-15 May	15-18 May
max. populations	28 000	15 000	12 000
>75% departures	25-29 May	25-28 May	26-28 May

^a from Strann (1985).

Confirmation that some Knots that use Balsfjord in spring breed in the Nearctic comes from an adult ringed in mid-May 1985 in Balsfjord and shot on 6 June 1986 at Disco, in west Greenland. Disco is on the migration route between Iceland and the breeding grounds of north-west Greenland and Ellesmere Island, confirmed by Alerstam *et al.* (1986).

The timings of arrivals and departures of Knots in Balsfjord are very consistent between years (Table 1), and most Knots depart between 25 May and 1 June. This corresponds well with the arrival dates of Knots in north-east Greenland (26 May to early June) and Canada (a few days later) (Meltofte 1985). The flight from Norway to Ellesmere Island is likely to take about 3 days. Hence the departures from Balsfjord in 1986 accord well with the timing of arrivals on Ellesmere Island from 30 May onwards (R.I.G. Morrison *pers. comm.*). Departures from Balsfjord occur at a similar date to those of Nearctic Knots from Iceland (Alerstam *et al.* in press, Whitfield and Magnusson 1987). Siberian Knots staging in the West German Wattenmeer depart later (2-10 June) (Dick *et al.* 1987).

The arrival and departure dates of Knots in Porsangerfjord are less precisely known than for Balsfjord. However evidence reviewed by Davidson *et al.* (1986) suggested that the timings are similar to those in Balsfjord. This implies a Nearctic origin for these birds too. The presence of 25 000-30 000 Knots in Porsangerfjord on 20-22 May 1986 is also consistent with this, as are the observations of flocks of Knots leaving the mouth of Porsangerfjord during the last days of May in several recent years. These birds disappeared in a westerly direction, i.e. towards the Nearctic rather than Siberia (Rolf Lyder *pers. comm.*).

We observed closely over 6000 Knots in Porsangerfjord in May 1986. None carrying either rings or colour-marks were seen, in strong contrast to the population in Balsfjord at the same time. This implies Knots staging in Porsangerfjord may be from a different part of the wintering population to those staging in Balsfjord, where over 2% of Knots had been previously ringed elsewhere (Davidson *et al.* 1986). It also suggests that there is little or no interchange either within or between years of birds staging in Balsfjord and Porsangerfjord.

DISCUSSION

Why should some Nearctic Knots migrate in spring via Iceland and others via northern Norway? Knots flying from Iceland to the Canadian arctic do so by an indirect route westwards across the southern part of the Greenland ice-cap and then northwards along the west coast of Greenland. This avoids the unfavourable weather conditions across the more northerly parts of the ice-cap that would be met on a direct flight to Ellesmere Island (Alerstam *et al.* 1986). A direct flight from Balsfjord to the eastern Canadian arctic is shorter than the flight from Iceland. Furthermore, weather conditions at this time of year are favourable for a flight across northern Greenland (Alerstam *et al.* 1986).

We cannot yet identify precisely the breeding grounds of Knots staging in northern Norway. However, the presence of a bird in west Greenland in early June indicates that at least some must breed in north-west Greenland and/or Ellesmere Island. The fat loads of 30-35% of

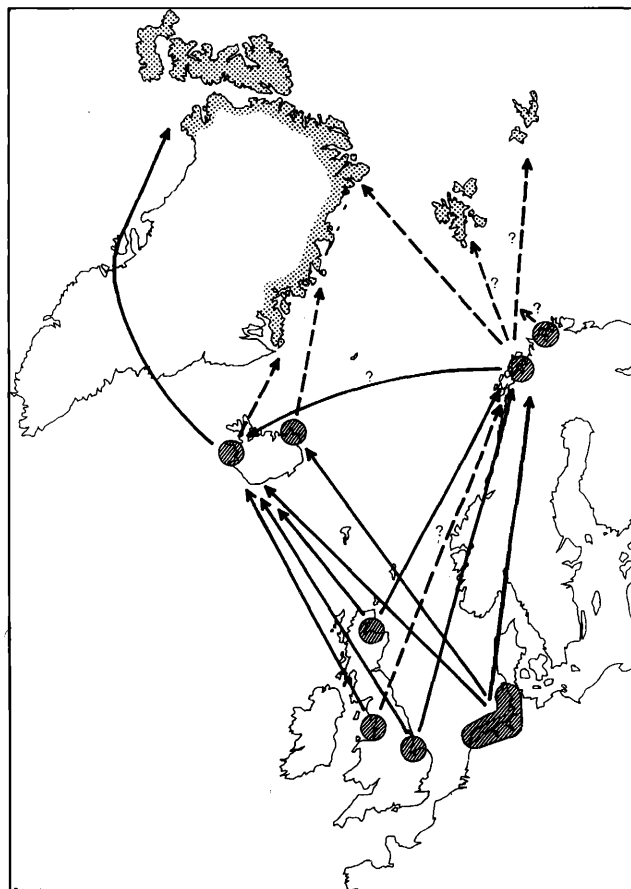


Figure 2. The spring migration system of Nearctic-breeding Knots *C. c. islandica* as now understood. Lines and arrows indicate links between early and late spring staging areas, and breeding grounds, but not necessarily the routes flown; solid lines where known, broken lines where presumed. Breeding areas are shown stippled and staging areas are shown hatched.

total body mass carried by many Knots when they leave Balsfjord in late May are substantially more than is needed for a direct flight of about 2800 km to Ellesmere Island (Davidson and Evans 1986, unpubl. data). Hence the birds can arrive on the breeding grounds with part of their fat reserve remaining. Not all Knots that breed on Ellesmere Island pass through northern Norway: some that breed in eastern Ellesmere Island are known to stage in west Iceland in May (Morrison 1975). Other Knots leave Balsfjord with smaller fat loads, and may fly only as far as breeding grounds in eastern and northern Greenland.

Figure 2 summarises the current state of knowledge of the spring migration system of *islandica* Knots.

Estimating the present size of the Nearctic Knot population as about 250 000 (see Pienkowski and Evans 1985), the 12 000-28 000 Knots in Balsfjord represent 5-11% of this population. If the 30 000 Knots in Porsangerfjord also breed in the Nearctic, then northern Norway will hold 17-23% of the *islandica* population in late May. Hence both Balsfjord and Porsangerfjord are wetlands of major international importance for Knots. The only other areas known to be used by this

population as final spring staging sites are in Iceland. In west Iceland 200 000 Knots were estimated to be present in May during the early 1970's. This was about 57% of the *islandica* population at that time. In north-east Iceland Whitfield and Magnusson (1987) have estimated recently that at least 8 000 Knots (3% of the present *islandica* population) occur in May.

Our recent discovery that Knots staging in northern Norway belong to the Nearctic population has required a major re-assessment of what was previously supposed to be a well-understood migration system. There has been no recent census of the number of Knots present in west Iceland in spring. Hence we cannot be certain that all the spring staging sites of the Nearctic Knots that overwinter in western Europe have been located. However, unless the numbers using west Iceland have decreased substantially since the early 1970's, and unless Knots in Porsangerfjord are of Siberian origin, the total numbers using known staging sites in May are close to the estimated size of the wintering population. There are unlikely to be many more major undiscovered May staging areas for Knots. Nevertheless, some sites may still remain, in view of the recent discoveries of about 3% of this population using north-east Iceland (Whitfield and Magnusson 1987).

There are other identifiable gaps in knowledge. Many of the links between early and late spring staging areas have been identified from recaptures of ringed birds. However so few Knots have been ringed recently in western Britain in spring that any links between this important early spring staging area and Norway remain speculative. Figure 2 shows that Knots reach each of their late spring staging areas from most or all of the major early spring staging sites. Furthermore, different individual Knots from the same group marked on the Wattenmeer in early spring flew to each of the different late spring sites. Knots also disperse from a single wintering site to many early spring staging sites (Davidson *et al.* 1986). Hence choice of late spring staging site seems not to be determined by use of wintering site or early spring staging area. We can speculate, as have Alerstam *et al.* (1986), that this choice is determined by the location of breeding grounds. However little is known of which breeding grounds are used by Knots from each of the late spring staging areas. Some Knots passing through western Iceland are known to breed in Ellesmere Island, and those staging in north-east Iceland depart towards east and north-east Greenland. However the precise breeding ranges of these and the Norwegian birds are unknown.

There are other gaps. Most Knots in north-east Iceland in 1986 arrived in mid-May and departed in late May, on similar dates to those using western Iceland (Wilson 1981) and Norway (Table 1). Some others appeared not to arrive until late May, and then stayed only a few days before flying towards Greenland (Whitfield and Magnusson 1987). These birds arriving in late May may come from more southerly staging sites. However some may be coming from Norway, in view of the arrival in western Iceland in late May of the Knot marked two weeks earlier in Balsfjord. The presence of this Norwegian Knot in west Iceland may indicate a similar late May passage to that of north-east Iceland. The extent of this, and the extent of a late spring link between Norway and Iceland, remains conjectural.

The presence in early June in west Greenland of a Knot marked in Balsfjord the previous year raises the possibility of two previously unidentified migration strategies. One is that this bird changed its late spring staging area from Norway to Iceland in successive years. The other is that the bird flew from Norway to Iceland in late May 1986, as did the colour-marked individual described above, and then followed the migration route across southern Greenland towards breeding grounds in north-west Greenland and Ellesmere Island. If so, this route would add about 1850 km to the flight to the breeding grounds when compared to a direct flight from Norway to Ellesmere Island.

Despite the extensive past work, and these recent discoveries, Figure 2 illustrates the substantial gaps remaining in understanding the spring migration system of *islandica* Knots. There are known to be similarly large gaps in knowledge of the spring migration of the other population of Knots that passes through western Europe, the Siberian *canutus* population (Dick *et al.* 1986). The problem is at least as great for many other waders, and for other parts of their annual cycle (see *e.g.* Piersma *et al.* 1987). Co-ordinated studies aimed at filling some of these gaps for Knots and other waders are continuing (Davidson, Piersma and Thomas 1986), and are vital to build the understanding of the annual cycle of these waders. This knowledge is essential for ensuring the effective conservation of the birds and their habitats.

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