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Source: Ardea, 97(1) : 43-50

Published By: Netherlands Ornithologists' Union

URL: https://doi.org/10.5253/078.097.0106

Migration and wintering of Baltic Dunlins *Calidris alpina schinzii* with known breeding origin

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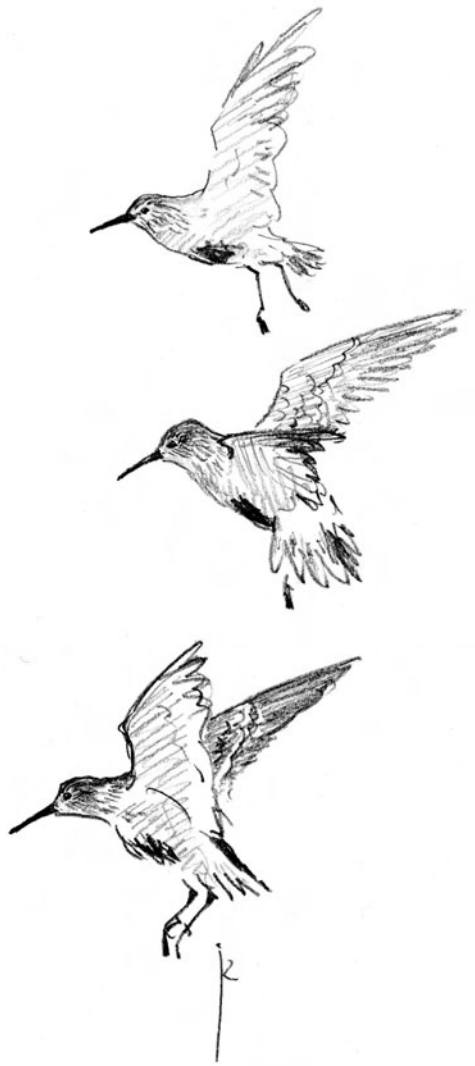

Thorup O., Timonen S., Blomqvist D., Flodin L-Å., Jönsson P.E., Larsson M., Pakanen V-M. & Soikkeli M. 2009. Migration and wintering of Baltic Dunlins *Calidris alpina schinzii* with known breeding origin. Ardea 97(1): 43–50.

The population of Baltic Dunlins *Calidris alpina schinzii* is very small and is declining rapidly. To optimize conservation efforts, knowledge about the location of staging and wintering sites is crucial. As part of intensive studies on Dunlins in Finland, Sweden, Denmark and Germany during the last 40 years, chicks and breeding adults have been marked, which has resulted in 110 recoveries during migration and winter. The majority of these recoveries are from western and northern Europe during the months immediately before and after the breeding season (21 February to 16 August), whereas there are only ten recoveries outside this period. Five of these ten recoveries, including four of six mid-winter recoveries, are from N and NW Africa (Mauritania, Tunisia and Morocco). Given the relatively small probability of obtaining recoveries from these areas, the data indicate that the main wintering areas of the Baltic Dunlin are the estuaries in northern Africa, which it shares with other European and Nearctic populations of small-sized Dunlins breeding in Greenland, Svalbard, Iceland, Faeroe Islands, Ireland and Great Britain. The autumn migration period of the Baltic Dunlin is so short that the post-breeding moult must take place primarily at the wintering grounds. During spring and autumn, the Baltic Dunlin migrates well before the larger and much more numerous *alpina* subspecies, which breeds in arctic Eurasia. The recovery data suggest that the estuaries in the Baltic, the Wadden Sea, SE and S England, the Atlantic seaboard in France, and the Iberian Peninsula are of similar importance for the Baltic Dunlin as they are for the *alpina* Dunlins.

Key words: Baltic Dunlin, *Calidris alpina schinzii*, winter quarter, migration, moult

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INTRODUCTION

The Baltic Dunlin is one of three biogeographically distinct populations of the southern Dunlin *Calidris alpina schinzii* and is one of the smallest and most vulnerable shorebird populations in Europe (Thorup 2006a). Its numbers have decreased rapidly in recent years with 6000–7000 individuals in the late 1980s, 3000–4000 in the late 1990s and perhaps only half that in 2008 (Thorup 2006a, and unpubl. data). The Baltic Dunlin breeds patchily in temperate coastal grasslands and lowland bogs around the Baltic Sea, in Denmark and at the Wadden Sea (Fig. 1), while other *schinzii* populations breed in the North Atlantic (in particular in

Figure 1. Breeding distribution of Baltic Dunlin, 1965–2004 (from Glutz von Blotzheim *et al.* 1975, Hagemeijer & Blair 1997, Svensson *et al*. 1999 and Thorup 2004) with a dashed line separating 'western' and 'eastern' breeders as used in the current analysis.

Iceland and Scotland). Other subspecies have their breeding grounds in arctic Eurasia and North America (van Gils & Wiersma 1996, Thorup 2006a). Those occurring in Western Europe differ from *schinzii* Dunlins in plumage (Ferns & Green 1979) and measurements. The NE Greenland breeding birds *C. a. arctica* are slightly smaller, while *C. a. alpina* and *C. a. centralis* breeding in northern Eurasia are both larger than *schinzii* (Engelmoer & Roselaar 1998). The breeding distribution, population sizes and trends in the various breeding areas of the Baltic Dunlin are relatively well known (Thorup 2006a). Since the birds, however, spend approximately nine months away from the breeding sites (Soikkeli 1967, Jönsson 1988, Thorup 2006b), identification and protection of key staging and wintering sites is of major importance for the survival of the population.

To field observers, Baltic Dunlins outside their breeding grounds are impossible to distinguish from other small-sized Dunlins such as the Icelandic and Central North Atlantic breeders. Their morphology is similar to other *schinzii* Dunlins (Engelmoer & Roselaar 1998) and individuals cannot be identified to population level, even in the hand. Dunlin populations are known to segregate on migration and during winter (Lopes & Wennerberg 2006), and it is therefore risky to assume that Baltic Dunlins are found together with other small-sized and short-billed Dunlins at their staging sites. Ringing recoveries are currently the only available source of information to identify staging sites and winter quarters of Baltic Dunlins.

Jönsson (1986) analysed ringing recoveries of Baltic Dunlins with known breeding origin together with Dunlins ringed at Baltic ringing stations before 1 August and aged as juveniles. He found that the majority of recoveries from September to March were from France, while there were only a few recoveries from Spain and Morocco. Also most of the December to February recoveries were from France, and Jönsson concluded that France was an important wintering area. However, Jönsson also suggested the Iberian Peninsula and N Africa were probably more important wintering areas than indicated by the recoveries due to a much smaller recovery probability.

Since Jönsson's publication, Baltic Dunlins have been more intensively studied in Finland, W and SW Sweden and W Denmark. These studies included systematic trapping and marking with metal and colour

rings. Moreover, during the last 15 years, a number of bird expeditions have been conducted with the aim of trapping and identifying colour-ringed shorebirds in Tunisia, Guinea-Bissau and Mauritania (Zenatello *et al.* 1997, Wolf 1998, Zwarts *et al.* 1998a, 1998b, Spaans 2006). These activities have provided substantial new recovery data. This gave us the anticipation that a re-analysis of the available data could – for the first time – identify key staging and wintering sites of this vulnerable population, a significant conservation step forward.

METHODS

For 110 ringing recoveries of Dunlins, the breeding area was within the known breeding range of Baltic Dunlins in coastal Finland, Estonia, Poland, southern half of Sweden, Denmark and Germany (Fig. 1). Of these, 57 involved adult birds ringed when captured on the nest, 48 were ringed as pulli, 4 recaptured as adult breeders and 1 ringed as a very young juvenile at a breeding site. In total 106 birds were recovered outside the country in which they were ringed, while 4 recoveries were of birds sighted in their ringing countries but outside a breeding area. Approximately 90 of the recoveries had been ringed or recaptured as part of studies in Eiderstedt Peninsula, German Wadden Sea (1959–1965; Heldt 1966), Tipperne, W Denmark (1990–2007; Thorup 1999, 2006b), W Sweden (1985–2007; Blomqvist & Johansson 1991), SW Sweden (1981–1990 and 2006–2007: Jönsson 1988), Oie and Kirr, E Germany (1972–1987; Stiefel & Scheufler 1989), Reda Mouth, Poland (1979–1982; Król 1985), Pori, SW Finland (1962–1969; Soikkeli 1967) and Northern Ostrobothnia coastal area, NW Finland (2002–2007; K. Koivula, V.-M. Pakanen & A. Luukkonen, unpubl. data). The remaining data were obtained from the ringing centres in Wilhelmshaven, Copenhagen, Stockholm, Helsinki, Matsalu and Gdansk and from the literature (Glutz von Blotzheim *et al.* 1975). Recoveries included birds shot or found dead, recaptures of live birds and observations of metal and colour rings.

Three recoveries were omitted from our dataset: in two cases, the date of death was very imprecise and the third was considered as most likely erroneous, since the bird was reported ringed as pullus in Denmark at a very late date (31 July), 1–2 weeks after the latest Danish juveniles usually fledge (Thorup 1998, and unpubl. data).

To detect differences in migration routes and wintering areas between birds from different parts of the breeding range, recoveries were divided into 'western' and 'eastern' (more continental) breeders (Fig. 1). We also divided the wintering areas into an 'eastern' wintering area in the Mediterranean and a 'western' along the Atlantic coasts of Africa and the Iberian Peninsula. We expect that all recoveries from Italy, Switzerland, Tunisia, and Mediterranean France and Spain represent birds using 'eastern wintering areas', whereas those from Atlantic Spain, Morocco and Mauritania reflect birds using 'western wintering areas'.

The recovery data were divided into four time periods. 1) Early autumn migration: June to August. This is when the first breeders start migration until approximately one month after the last Baltic Dunlins have left their breeding sites. 2) Late autumn migration and early winter: September to 15 November. Little is known about the arrival dates to the wintering area, but comparison with other Eurasian shorebirds suggests that Baltic Dunlins reach their wintering area during this period. 3) Winter: 16 November to 20 February. Spring migration of Baltic Dunlins is believed to start in late February. 4) Spring migration: 21 February to April.

RESULTS

The phenology of the 110 recoveries of Baltic Dunlins is shown in Fig. 2. The spring and early autumn migration periods were composed of similar proportions of western and eastern breeders ($\chi^2_1 = 0.81$; $P = 0.37$).

Early autumn migration

Two recoveries showed a quick departure of females from the breeding grounds. One female hatched a clutch at Lumijoki in Finland on 7 June 2005 and 11 days later she was seen at Tipperne, Denmark (1360 km SW). Another female hatched a clutch at Båtafjorden in Halland, Sweden on 20 May 1993 and 21 days later she was observed in the German Wadden Sea (400 km SSW).

More than half (54%) of all recoveries were within the early autumn migration period (Fig. 2, Fig. 3A). The very early 7 June recovery from Camargue, Mediterranean France, may have been a summering non-breeder, although it was an eight-year-old individual. The other 24 recoveries up to 14 July were from the Baltic, Denmark or the Wadden Sea.

The first breeders from the western part of the range recovered in France and SE England were observed on 14 July, while the first recovery in France originating from the eastern breeding range was from 28 July.

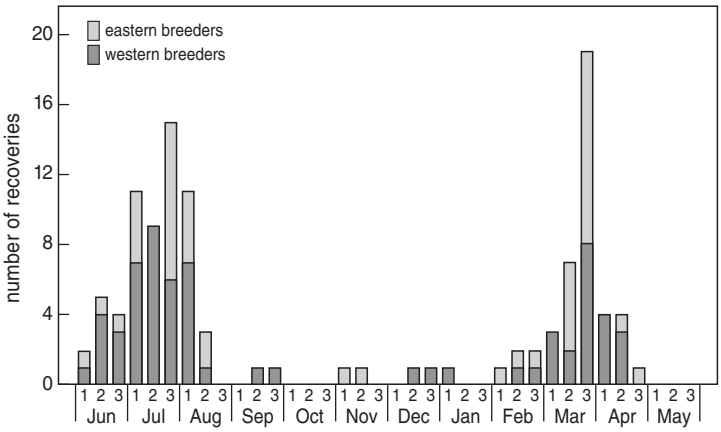

Figure 2. Phenology of all recoveries of Baltic Dunlins with known breeding origin (n = 110), shown in 10-day periods. The recoveries are divided into 'western' and 'eastern' breeders (see Fig. 1).

From the eastern part of the breeding range (E Baltic, E Sweden and Baltic Germany) there were in total 21 recoveries during the autumn migration, 17 within and four outside the Baltic Sea. Within the Baltic Sea, 15 recoveries were of first-year birds, which were observed between 6 July and 16 August, whereas two adults were recorded on 26 June and 3 August, respectively. The recoveries outside the Baltic were two adults (Tipperne, W Denmark (see above) and Malaga S Spain on 29 July) and two juveniles (NW France on 28 July and Norfolk, E England on 16 August).

From the western part of the breeding range (German Wadden Sea, Denmark, W and SW Sweden) three records were short-distance recoveries, i.e. birds that had crossed the Öresund from Sweden to Denmark immediately after the breeding season (26 June to 16 July). In total, there were 28 recoveries of adult breeders from the estuaries SW of the breeding area: the German and Dutch Wadden Sea, the Dutch Delta area, and the Wash in E England. Most were found immediately after the breeding season; 18 (64%) were recorded between 10 June and 16 July, whereas 10 were noted between 17 July and 13 August.

During the early autumn migration period, seven birds from the western part of the breeding range were recovered from other sites than those mentioned above. Three adults were recorded from the Atlantic coast of France between 14 and 24 July and one from Cadiz at the Atlantic south coast of Spain on 29 July. There were two juveniles from the French Atlantic on 7 August and one juvenile from continental inland Europe in Switzerland on 10 August.

Late autumn migration-early winter

After 16 August, recoveries became scarce (Fig. 2, Fig. 3B), with only four records between 17 August and 15 November. One juvenile was shot near its place of birth in SW Sweden on 14 September, perhaps a weak bird that did not migrate. Another juvenile was recorded in NW Morocco on 21 September, while two birds of unknown age were found dead at the Atlantic coast of SW France on 1 and 15 November, respectively. Since Baltic Dunlins migrate quickly towards the south, we suspect that they do not complete their primary moult in NW Europe or France. A complete primary moult has an expected duration of approximately 70 days (Pienkowski & Dick 1975).

Winter

Winter recoveries were scarce with only six records between 16 November and 20 February (Fig. 3C). Four out of six winter recoveries were from Africa. On 22 December, a W Danish adult breeder was recaptured in Mauritania. A Finnish adult bird was found in Morocco on 3 February. Another Finnish bird was identified in Kneiss, Tunisia on 15 February, while a bird ringed at that site the day before was recaptured later the same year as a breeder in W Sweden. In addition, two adult breeders from the German Wadden Sea were found in France on 15 December and 4 January, respectively.

Spring migration

There were 39 recoveries between late February and mid April, comprising 35% of all recoveries (Fig. 2, Fig. 3D). The two February recoveries were both from northern Spain, as was a later recovery on 12 April. The majority of the spring migration recoveries (28) were from France (4 March to 30 April) of which 17 were from the Atlantic coast of southern France, five from the Mediterranean coast and six from the English Channel coast of northern France. There was one Moroccan recovery on 24 March, but this bird may have

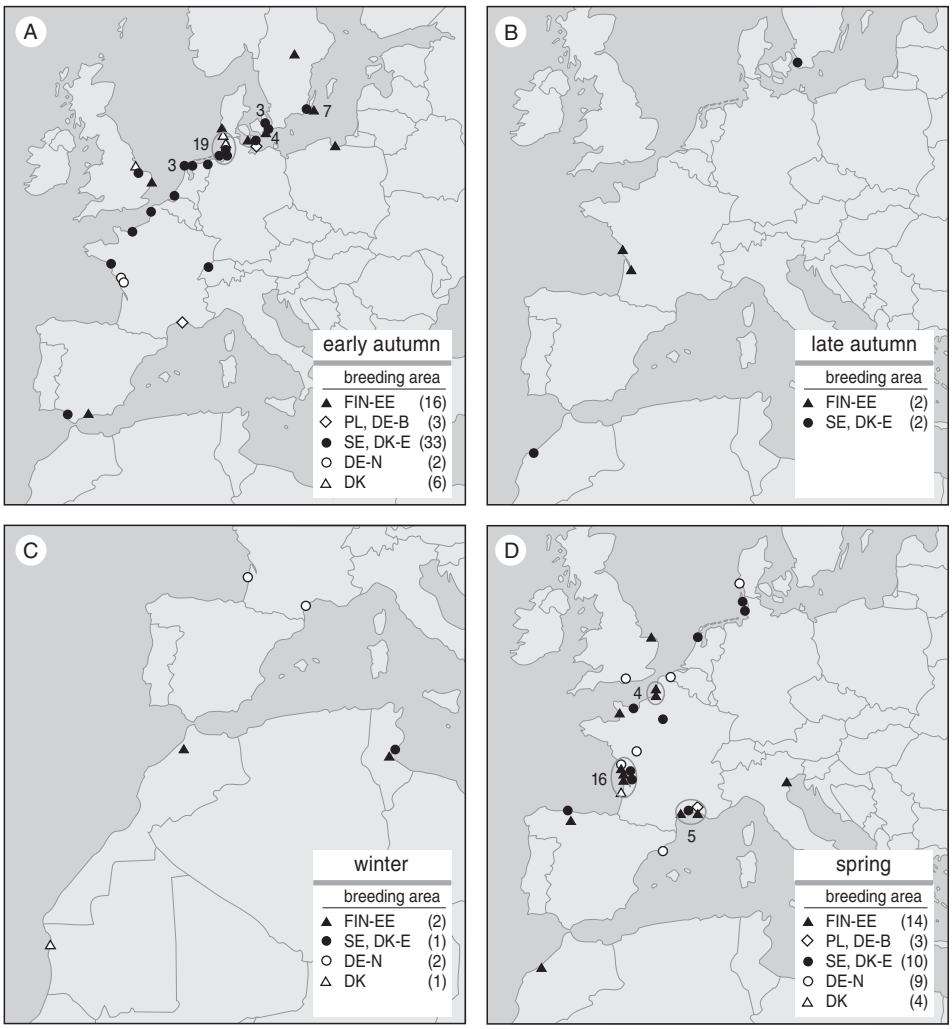

Figure 3. Recoveries of Baltic Dunlins from A) early autumn (June to August), supposedly the main autumn migration period; B) late autumn and early winter (September to 15 November); C) winter (16 November to 20 February) and D) spring (21 February to April). Numbers of recoveries indicate local concentrations (encircled) and sites with three or more recoveries. 'Eastern breeders' are from Finland (FIN), Estonia (EE), Poland (PL), and Baltic Germany (DE-B). 'Western breeders' are from Sweden (SE, including four records of 'eastern breeders' from E Sweden), eastern Denmark (DK-E), North Sea Germany (DE-N), and central and western Denmark (DK) (see Fig. 1).

died well before the recovery date. Of two English spring recoveries, one was from southern England on 8 March and one was from the east coast on 14 April. One individual was recaptured in Belgium on 14 March, while there were four recoveries from the Wadden Sea between 30 March and 13 April.

One adult Finnish breeder took a more easterly route and was recovered in NE Italy on 28 March, indicating that some eastern Baltic breeders might cross central Europe instead of using the western migration route along the Atlantic seaboard.

Segregation during winter and migration

Staging sites in the Baltic Sea were exclusively used by eastern breeders, and the only recovery suggesting a direct cross-continental European route to Tunisia (via NE Italy) was of an eastern breeder from Finland. However, there was no further evidence for segregation in the winter quarters between eastern and western breeding Baltic Dunlins. There were six recoveries of eastern and seven of western breeders in (or on the way to) Mediterranean wintering areas. Similarly, three eastern and four western breeders were recovered in (or on the way to) Atlantic wintering areas.

DISCUSSION

The wintering area of Baltic Dunlins

In contrast to earlier reports, our data suggest that most Baltic Dunlins winter along the Atlantic and Mediterranean coasts of Africa. Jönsson (1986) included birds recovered in the second half of February and early ringed juveniles at Baltic ringing stations among winter recoveries of Baltic Dunlins. He thereby obtained many more winter records from W Europe (11 from France and two from Spain) than the present study (only two recoveries). Jönsson (1986) reported only two winter recoveries from Africa – both from northern Morocco. Two Spanish recoveries were from the last week of February and may well have been of birds that had already started their spring migration. There was a higher proportion of French winter recoveries among the early ringed juveniles included in Jönsson's dataset than there is among Baltic Dunlins ringed at their breeding sites. This difference may be an effect of small sample sizes or misclassifications. A smaller proportion of French recoveries in our material compared to Jönsson (1986) may also be a result of the declining number of recoveries related to hunting since the 1980s. In the 1950s–1970s, for example, 65–80% of the Danish recoveries of dead shorebirds were reported as shot. This percentage was only around 40% during the last 20–25 years (Bønløkke *et al.* 2006).

Our analysis suggests that between mid August and the end of February, few Baltic Dunlins are present in France. In this period, there were only four French recoveries compared to 35 between 1 March and 15 August. The small number of recoveries was not due to a generally lower recovery probability from France in winter. In the small-sized NE Greenland *arctica* Dunlin, wintering primarily in Africa, 10 out of 11 French recoveries were from 16 August – 29 February (Lyngs 2003). The difference between the occurrence of Baltic and *arctica* Dunlins in France was statistically significant ($\chi^2_1 = 23.6$, $P < 0.0001$). Similarly, more non-Baltic Danish Dunlins were recovered in France in winter (133 out of 199 were from 16 August – 29 February) than Baltic Dunlin ($\chi^2_1 = 40.2$, $P < 0.0001$). Thus, it is very unlikely that the low frequency of Baltic Dunlin recoveries in France during late autumn and winter is due to a sampling artefact.

Jönsson (1986) suggested that the W Iberian Peninsula could host hitherto unknown important wintering sites for Baltic Dunlins. However, among the Danish ringing recoveries alone, there were 15 non-Baltic Dunlin recoveries from W Iberia between November and February. If W Iberia would be a major wintering site for Baltic Dunlins, it seems unlikely that there was not a single recovery between August and mid February, given that there were two recoveries in July, and three between mid February and mid April.

Pienkowski & Dick (1975), Jönsson (1986) and Wymenga *et al.* (1990) considered it unlikely that Baltic Dunlins would winter in W Africa south of Morocco, because there were no indications for a link between W Africa and the Baltic at that time. Although winter recoveries of Baltic Dunlins are still sparse, the new recovery data, including one record from Mauritania and two from Tunisia, indicate that coastal wetlands in N, NW and W Africa are wintering areas of Baltic Dunlins. It is worth noting that a single shorebird ringing expedition to the Kneiss mudflats in Tunisia provided two Baltic Dunlin winter recoveries (Zenatello *et al.* 1997).

Recovery data vs. morphometric data

Based on morphometric data collected by ringers in the Dutch Wadden Sea, Engelmoer (2008) estimated that in the 1970s up to 14% of the Dunlins (in the period 15–21 August) were males of the *schinzii* subspecies. Approximately 150 000–160 000 Dunlins are present in the Dutch Wadden Sea in August (Meltofte *et al.* 1994, Engelmoer 2008), and 25% of these are found at Vlieland and Schiermonnikoog from where the estimates were derived (Engelmoer 2008). Since the total population of Baltic Dunlins at that time was estimated to consist of only 7500 individuals, corresponding to less than 4000 males (Jönsson 1986, Thorup 2004), the Baltic Dunlins can at most comprise a small fraction of these *schinzii* Dunlins. Furthermore the recoveries in our dataset show that many Baltic Dunlins already reached France and Spain before mid August.

In our Baltic Dunlin dataset, five of six Dutch recoveries from the autumn migration are from the Wadden Sea, with five records from July and the last observation from 13 August. The *schinzii* Dunlins in the Dutch Wadden Sea in August must therefore primarily be of British-Irish or Icelandic origin with populations totalling approximately 70 000 and 800 000 individuals, respectively (Thorup 2006a). There are no recoveries of British or Irish breeders from The Netherlands (Clark 2002). On the other hand, there are only 24 recoveries of breeders from the British Isles in total, of which less than ten were recorded outside the British Isles (Clark 2002). The general migration pattern of British and Irish breeders is similar to what we found in the Baltic Dunlins: a departure of adults before early August, and winter recoveries in West Africa (Clark 2002). However, there are recoveries of juveniles in Britain

until early September, and *schinzii* Dunlins found in the Dutch Wadden Sea in the second half of August may therefore contain juveniles from Britain and Ireland.

In contrast, Icelandic breeders have been recovered in The Netherlands (Speek & Speek 1984), and due to their large numbers probably comprise the main part of the late *schinzii* Dunlins in the Dutch Wadden Sea. However, there is a tendency for a decline in the proportion of *schinzii* Dunlins in the Dutch Wadden Sea from the 1970s to the 1990s (Engelmoer 2008). This coincides with a period of a marked decline of British-Irish Dunlins, but not of Icelandic Dunlins (Thorup 2006a). So, most likely British-Irish Dunlins do visit the Wadden Sea, as the change in proportion of *schinzii* cannot be caused by an increase in population size of other subspecies. The population size of *alpina* Dunlins of the East Atlantic flyway was similar in the 1970s and the 1990s (Rösner 1997).

Baltic and other European Dunlins compared

A large portion of the spring and early autumn recoveries of Baltic Dunlins were from estuaries in the Baltic, the North Sea and along the Atlantic seaboard of southern England, France and the Iberian Peninsula. These areas are also key sites for the much larger populations of *alpina* Dunlins breeding in arctic northern Europe and central Siberia (Rösner 1997). In the autumn, however, most Baltic Dunlins seem to have left NW and W Europe before large numbers of *alpina* Dunlins build up during end of July and August (Rösner 1997). In spring, the migration of Baltic Dunlins takes place from mid February to mid April, and during this time the Baltic Dunlins share staging sites with large numbers of *alpina* Dunlins in the W European estuaries which stay there until late April or May (Rösner 1997).

Baltic Dunlins apparently share their main wintering areas in N and NW Africa with *arctica* Dunlins from NE Greenland and Svalbard, and *schinzii* Dunlins from Iceland, Faeroe Islands, Great Britain and Ireland (Lyngs 2003, Stroud *et al.* 2004). A small number of individuals may winter as far north as southern France. In Tunisia, northern Morocco, the Iberian Peninsula and southern France, Baltic Dunlins also share their winter quarters with the southernmost wintering *alpina* Dunlins. Based on morphometrics, it is estimated that 58% of the birds wintering in Tunisia and 50% of those wintering in north Morocco are *alpina* Dunlins (Stroud *et al.* 2004).

ACKNOWLEDGEMENTS

We are most grateful to Jari Valkama at the Finnish ringing centre in Helsinki for compiling the recovery maps, and to Angela Pauliny for improving the language. Ringing data were kindly received from the ringing centres in Institut für Vogelforschung, Wilhelmshaven, Germany; Zoologisk Museum, Copenhagen, Denmark; Naturhistoriska Riksmuseet, Stockholm, Sweden; Luonnontieteellinen Keskusmuseo, Helsinki, Finland and Ornithological Station, Gdansk, Poland. We thank Ken Kraaijeveld, Danny Rogers and two anonymous referees for comments that improved the manuscript.

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SAMENVATTING

Bonte Strandlopers *Calidris alpina* van de ondersoort *C. a. schinzii* zijn te verdelen in drie geografisch gescheiden broedpopulaties. De groep die broedt rond de Oostzee (de 'Baltische Bonte Strandloper') is een van de kleinste en meest bedreigde steltloperpopulaties in Europa. De laatste vijftig jaar zijn er in meerdere landen intensieve veldstudies aan Baltische Bonte Strandlopers uitgevoerd, waarbij er veel werden geringd. Daarnaast hebben steltloperexpedities naar Noord- en West-Afrika de nodige terugmeldingen opgeleverd. In dit artikel worden deze gegevens geanalyseerd om meer duidelijkheid te krijgen over de trekroutes en overwinteringgebieden van Baltische Bonte Strandlopers. In tegenstelling tot eerdere berichten blijken Baltische Bonte Strandlopers voornamelijk te overwinteren in Afrika (Marokko, Mauritanië en Tunesië). Deze gebieden delen ze met Bonte Strandlopers uit IJsland, de Britse Eilanden, Groenland, Spitsbergen en gedeeltelijk ook met Scandinavische en Siberische broedvogels. Na het broedseizoen trekken de vogels in hoog tempo naar Afrika, voornamelijk via de Atlantische kust van Frankrijk en het Iberisch schiereiland. Na 16 Augustus zijn er nauwelijks nog terugmeldingen langs de trekroute. De voorjaarstrek begint eind Februari en loopt eveneens voornamelijk langs de Atlantische kust. De Nederlandse Waddenzee wordt zowel in het voorjaar als in het najaar aangedaan. Er waren geen aanwijzingen dat de Bonte Strandlopers uit het westelijke deel van het broedgebied (Denemarken, westkust Zweden en de Waddenzee) een andere trekroute volgden dan de broedvogels van de Oostzeekust. (KK)

Corresponding editor: Ken Kraaijeveld
Received 12 May 2008; accepted 1 January 2009

ARDEA

TIJDSCHRIFT DER NEDERLANDSE ORNITHOLOGISCHE UNIE (NOU)

ARDEA is the scientific journal of the Netherlands Ornithologists' Union (NOU), published bi-annually in spring and autumn. Next to the regular issues, special issues are produced frequently. The NOU was founded in 1901 as a non-profit ornithological society, composed of persons interested in field ornithology, ecology and biology of birds. All members of the NOU receive *ARDEA* and *LIMOSA* and are invited to attend scientific meetings held two or three times per year.

Layout by Dick Visser, Haren, The Netherlands
Printed by Van Denderen, Groningen, The Netherlands, April 2009