

Knots in the Delta area, southwest Netherlands

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Information is summarized on the use of the Oosterschelde and Westerschelde, southwest Netherlands, by Knots. Numbers and seasonal patterns differ greatly between the two estuaries. The Oosterschelde is important as a wintering area with about 13,000 birds, with much lower numbers in autumn and spring. A shift in distribution within the estuary occurs during winter. Numbers wintering in the Westerschelde are much lower (3,000), but here relatively many Knot are found in early autumn (up to 4,000) and in May (up to 10,000). Data on ringing recoveries and biometrics of Knot using the Oosterschelde are presented. From these and from the seasonal pattern of occurrence, it is concluded that the Oosterschelde is mainly used by *Calidris canutus islandica*, while Afro-Siberian Knots *C. c. canutus* occur in small numbers during August and May. In contrast, the Westerschelde seems to be more important for Afro-Siberian birds during passage in July-August and May.

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INTRODUCTION

After the Wadden Sea in the north of the country, the Delta area in the southwest, formed by the rivers Rhine, Meuse and Scheldt, is the largest estuarine area in The Netherlands. This area is inhabited by large numbers of waterbirds, including about 180,000 wintering waders (Leewis *et al.* 1984; Schekkerman *et al.* in prep). Two of the four major estuarine basins, Haringvliet and Grevelingen, have been enclosed and are now stagnant lakes (Figure 1). The other two, Oosterschelde and Westerschelde, remain tidal although only the Westerschelde is still a true estuary. The completion in 1987 of a storm-surge barrier in the mouth of the Oosterschelde and of two secondary dams, which closed off the Krammer-Volkerak and the eastern-most part of the Oosterschelde, caused a considerable loss of intertidal area and virtually eliminated the input of fresh water.

These two remaining tidal basins were shown to be the most important areas in the Delta for migrant and wintering Knot *Calidris canutus* (Wolff 1967; Leewis *et al.* 1984). Before enclosure in 1971, the Grevelingen estuary also held considerable numbers: about 10 counts in 1966 - 1971 revealed peak

numbers of over 2,000 in this area (Wolff 1967; Lambeck *et al.* 1989; J. Beijersbergen unpubl.). The few data from the Haringvliet before its enclosure in 1970 estuary indicate that this estuary was unimportant for Knot. Conditions for prey species here were unfavourable because of a low and variable salinity and a high silt load (Wolff 1969).



Figure 1. Map of the Delta area showing topographic names and delineation of sectors in the Oosterschelde.

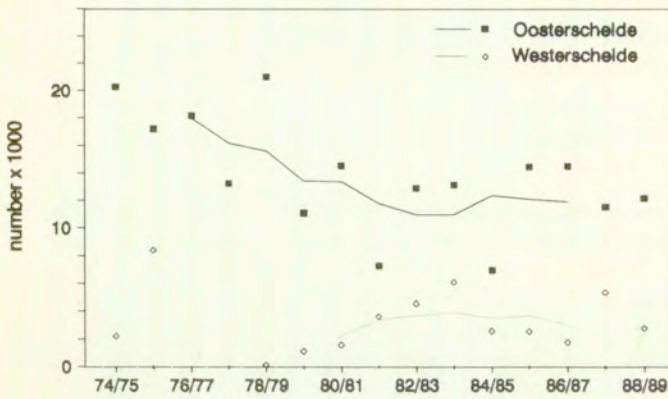
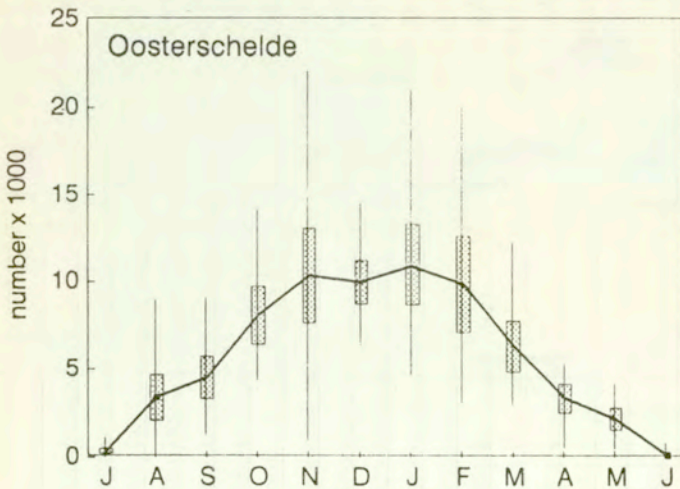


Figure 2. Wintering numbers (maximum December-February) of Knot in the Oosterschelde and Westerschelde, 1974/75 - 1988/89. Data points give actual numbers; the line gives the 5-year moving average.

Information on the occurrence of Knot and other waders in the Delta has greatly improved since a census scheme was started in the 1970s. In 1984 - 1988, a wader ringing project was also carried out. This paper summarizes our knowledge of numbers, seasonal patterns, movements and biometrics of Knot in the Oosterschelde and Westerschelde.

METHODS

Numbers of Knots were assessed during high tide near mid-month. Few counts were made between 1972 and 1975. Since 1975 (1977 for the Westerschelde), birds were counted monthly between September and April, and since the season (running from July through June) 1978/79 in all months. In 1983/84 and 1984/85, only January counts were made. Data up to 1989 have been included in this analysis.



In order to describe changes in distribution within the Oosterschelde, four sectors have been defined: west, central, east, and north (Figure 1). Numbers of Knot occasionally present in the former Krammer-Volkerak prior to 1987 have been added to those in the northern sector of the Oosterschelde, as exchange of birds between these areas occurred frequently. Since Knot are virtually confined to the westernmost part of the Westerschelde in all seasons, no subdivision of this area was made.

Data on movements, biometrics and moult were obtained during ringing operations carried out in 1984 - 1988, using cannon-nets and mist-nets. In this period, 571 Knots were ringed, exclusively in the Oosterschelde. Most birds were caught in only a few large catches: 59 in February 1985, 205 in February 1986 and 254 in August 1987. Wing length (maximum chord) was measured to the nearest 1 mm using a stopped ruler, bill and tarsus length to the nearest 0.1 mm using calipers (see Marteijn & Meininger 1986). Body weights were measured on an electronic balance to the nearest 1 g, and corrected for weight loss after capture by adding 2.3 g/h to the measured weights during the first four h after capture, and 1.2 g/h afterwards (own data; Davidson 1983).

NUMBERS AND DISTRIBUTION

Numbers and seasonal patterns

In recent years about 16,000 Knot have wintered in the Delta area, about 13,000 of which stayed in the Oosterschelde. The Delta total constitutes about 5% of the total number of Knots wintering in western Europe (Smit & Piersma 1989). Numbers in the

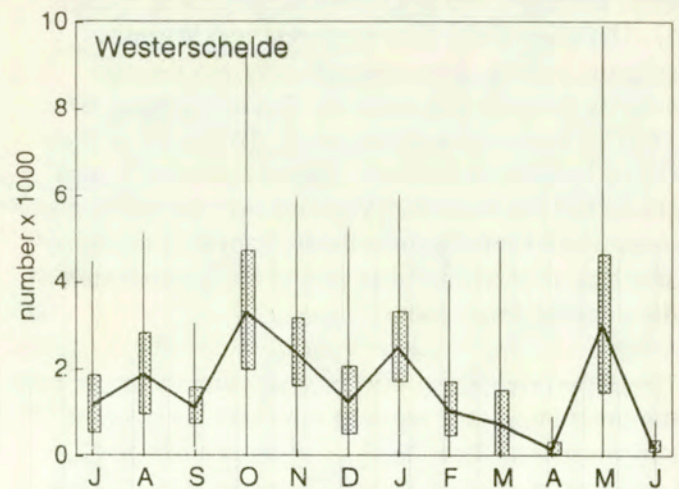


Figure 3. Seasonal pattern of Knot in Oosterschelde and Westerschelde, 1978/79 - 1988/89. Given are mean

(point), standard deviation (rectangle), and range (line).

Oosterschelde have declined considerably in the late 1970s (Figure 2). From about 1983 onwards this decline seems to have stopped and numbers remained more or less stable. The fewer counts from the Westerschelde show no clear long-term trend. The decline of Knot numbers in the 1970s has also been noted in other western European estuaries (Smit & Piersma 1989), as has the stabilization or slight recovery in numbers since the early 1980s (Kirby *et al.* 1990; Davidson & Wilson 1992).

Despite the proximity of the two estuaries the seasonal patterns of Knot numbers in Oosterschelde and Westerschelde are strikingly different (Figure 3). In the Oosterschelde the first birds arrive in July, but numbers do generally not exceed a few hundreds before August. Birds arrive in the area throughout the autumn until a maximum is reached between November and February. Numbers then decrease from March onwards and almost all birds have left by late May. In June, very few Knots remain in the Oosterschelde (maximum 200). A positive correlation (Spearman rank correlation $r_s = 0.86$, $n = 7$, $p < 0.05$) between June numbers in the Oosterschelde and percentages of juveniles in winter catches in Great Britain (the latter data taken from Underhill *et al.* 1990), may indicate that these are mainly first-year

islandica Knots which do not migrate to the breeding areas in Greenland and Canada.

In comparison with the Oosterschelde Knots tend to arrive earlier in the Westerschelde, where on average 1,100 are already present in July (Figure 3). Numbers do not increase much after August, but irregular influxes occur in autumn and winter, sometimes associated with cold weather. Wintering birds leave between February and April. Numbers in May have ranged between 0 and 10,000, reflecting a strong migratory influx of birds in some years. It seems likely that in such years Afro-Siberian Knots *C. c. canutus* on their way between the major spring staging areas in Mauritania and Schleswig-Holstein (Dick *et al.* 1987) interrupt their flight in the Westerschelde. In the Oosterschelde there is no such migratory peak in May.

A similar situation is found on the Westplaat, a small intertidal area at the northwestern edge of the Delta. Knots occur here only irregularly and in small numbers in winter (maximum 750), but in May passage is noted with numbers reaching 2,000 in some years (Eijkelenboom & Eijkelenboom 1990). Peak years in the Westerschelde and on the Westplaat often, but not always, coincide.

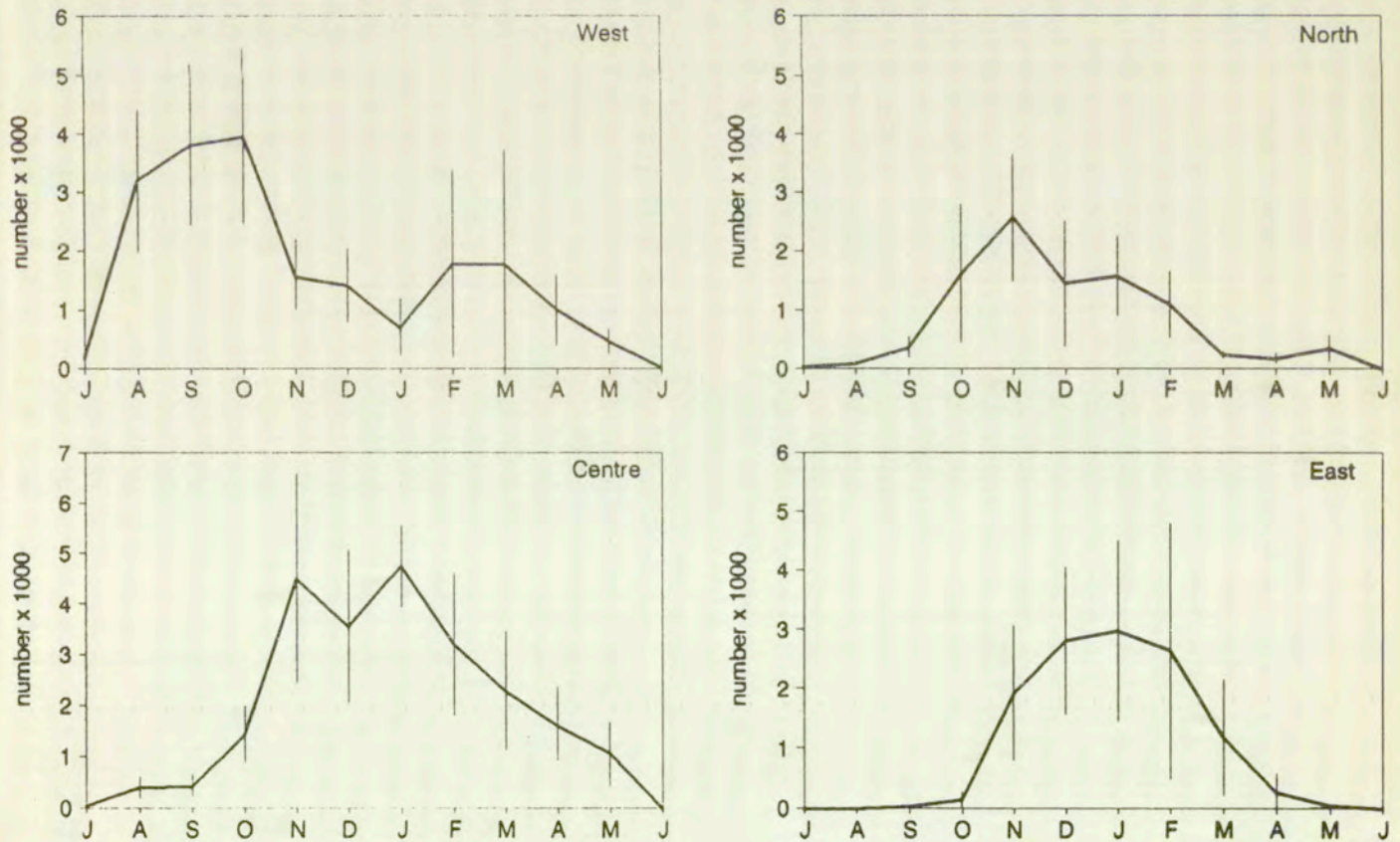


Figure 4. Seasonal patterns (monthly mean and standard deviation) of Knot in four sections of the Oosterschelde,

1978/79 - 1988/89 (see Figure 1 for delineation of sections).

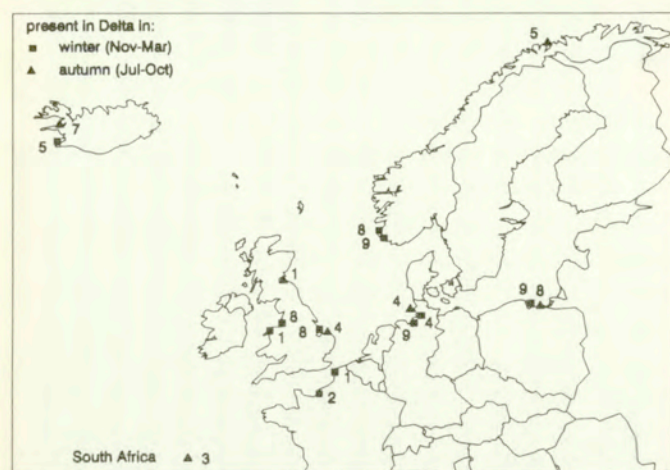


Figure 5. Foreign recoveries of Knots visiting the Delta. The season of presence in the Delta (symbols) and the month of presence abroad (digits) are shown.

Seasonal movements within the Oosterschelde

The distribution of Knots in the Oosterschelde shows consistent variations within the season (Figure 4). In late summer, 50-90% of the birds are present in the western sector of the estuary. Much smaller numbers occur at this time in the central and northern sectors, while Knots are almost absent from the eastern sector. The birds rapidly leave the western sector after October. In the same period, numbers in the central and northern sectors increase and the eastern sector is occupied, and these remain the most important areas throughout the winter. In early spring, numbers in the western sector tend to show a slight recovery. Recent years have seen a drastic decline of Knot numbers in the western sector in August and September, from c. 5,000 in 1979/80 - 1982/83 to c. 1,200 in 1985/86 - 1989/89.

RINGING RECOVERIES

So far, 17 foreign and 13 domestic recoveries of Knots are known from the Delta area. All domestic recoveries concern short-distance movements within the Oosterschelde, except for two birds ringed in the

Dutch Wadden Sea and found dead along the North Sea beach during a cold spell. It is possible that these birds never used the Delta estuaries but rather died on the open coast whilst making a cold-weather movement away from the Wadden Sea. Thus there is no firm evidence yet for movements of Knots between the Delta estuaries and the Dutch Wadden Sea.

Foreign recoveries are shown in Figure 5. Fifteen birds recovered in the Delta during autumn and winter had been ringed in Iceland, Norway, Poland, Germany, England and South Africa. Two additional birds ringed in the Delta have been found in France in winter, and one of these also in the German Wadden Sea in April. There are three recoveries indicating possible changes of wintering area: a bird ringed in western Britain was recovered in the Oosterschelde in November, and two ringed in the Delta in February were found in northern France one and two years later. The latter two may relate, however, to severe winter weather movements, as both birds were recovered during cold spells.

Most recoveries fit well into the established pattern of movements of *C. c. islandica*: autumn arrival in western Europe of adults via Iceland and Norway, and spring departure via staging areas in Britain, the German Wadden Sea, Iceland and northern Norway (Uttley *et al.* 1987). The two birds ringed in Poland were probably of Siberian breeding origin but it cannot be excluded that (juvenile) *islandica* Knots wander into the Baltic in autumn. The only definite recovery of an Afro-Siberian Knot concerned an adult ringed in South Africa and found dead in the Oosterschelde in August.

BIOMETRICS

Measurements

Data on bill, total head and wing length of birds from the Oosterschelde are given in Table 1, while

Table 1. Bill, total head and wing lengths (in mm; mean, SD and sample size) of Knots from the Oosterschelde.

Period	Bill length			Total head			Wing length		
	mean	SD	n	mean	SD	n	mean	SD	n
August	33.9	1.83	137	63.3	1.93	135	174	4.6	134
Dec-Feb	32.1	1.86	99	62.6	2.13	74	173	4.1	99
May	34.6	2.01	10	64.3	1.84	8	172	4.5	10

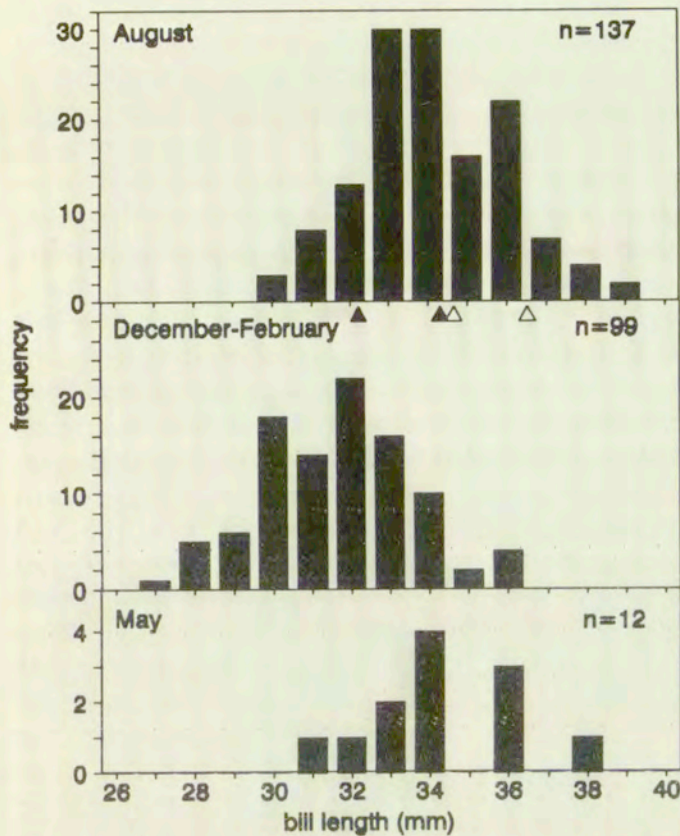


Figure 6. Frequency distributions of bill length of adult Knots captured in the Oosterschelde in mid-August, December-February and mid-May. Triangles indicate mean bill lengths of male *islandica* (filled) and *canutus* (open) Knots, given by Roselaar (1983).

Figure 6 shows bill length distributions of adults at different times of the year. The two subspecies of Knot occurring in western Europe are best separated on bill length (Roselaar 1983). The wintering birds in the Delta have bills consistent with those of *C. c. islandica*, while the few birds captured in May more closely match *C. c. canutus* in dimensions. Plumage characteristics of these birds also resemble *canutus* Knots (Meininger & van Swelm 1989). The mean bill length of birds captured in August is intermediate between *islandica* and *canutus*, and the frequency distribution suggests that at least some *canutus* are present at this time. This assumption is based on a bimodality in bill length found among non-moulting adults, which indicates that about 50% of these belong to *C. c. canutus* (Figure 7). Since 18% of the August sample consisted of birds without active primary moult, the proportion of *canutus* in the total population at that time may be estimated at about 9%.

Weights

Mean weight of wintering Knots during January-February was 152 g (SD = 11.7, $n = 75$) for adults

and 149 g (SD = 10.7, $n = 149$) for first-year birds. These weights are similar to those found in Knots wintering on the Wash, England (150 g and 152 g respectively, Johnson 1985).

The few birds captured in mid May had low weights (124 g, SD = 14.5, $n = 10$) close to the mean winter (lean) weight of *C. c. canutus* (119 g, Zwarts *et al.* 1990), and to weights of birds interrupting spring migration on the Atlantic coast of France (Dick *et al.* 1987). This is in accordance with their presumed recent arrival from the African wintering grounds.

The mean weight of Knots in the August sample was 141 g (SD = 12.9, $n = 251$). As Figure 8 shows, birds in active primary moult showed a normal weight distribution, while among non-moulting birds relatively more light and heavy birds were present. Somewhat speculatively, these extremes may be illustrative for the condition of birds which have just arrived in the area, and birds preparing for a further flight, respectively. The heaviest weights are sufficient for a flight of several thousand kilometers (cf. Davidson 1984).

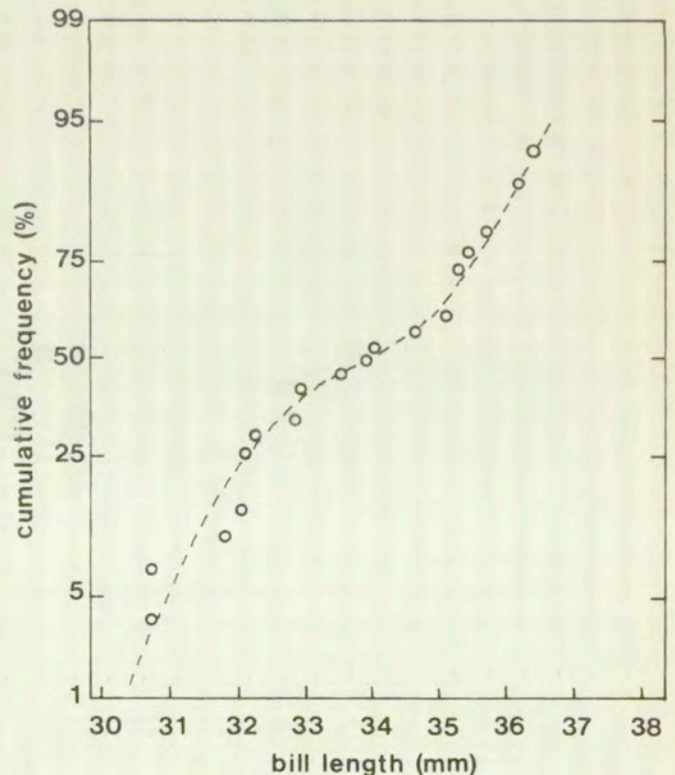


Figure 7. Percentage cumulative frequency distribution of bill lengths of adult Knots without active primary moult, Oosterschelde, 12 August 1987 ($n = 26$).

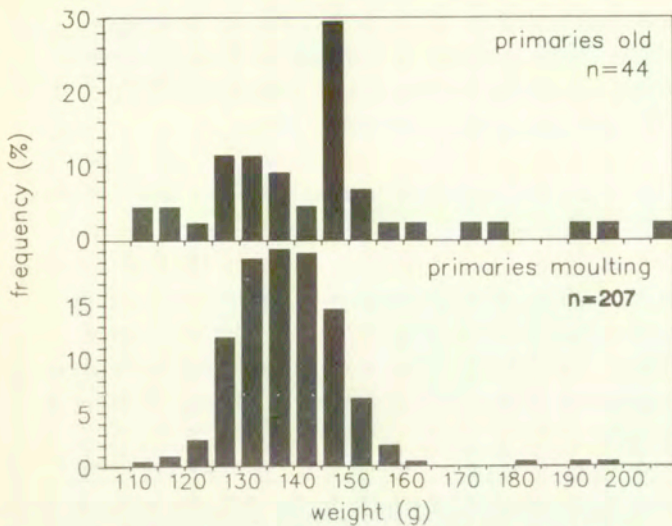


Figure 8. Frequency distributions of weights of adult moulting (primaries) and non-moulting Knots, Oosterschelde, 12 August 1987.

DISCUSSION

Occurrence of subspecies

The present evidence suggests that the Oosterschelde is predominantly visited by *islandica* Knots. Compared with the c. 13,000 wintering *islandica* birds, only small numbers of *canutus* Knots occur in the area: no more than a few thousands during spring passage in mid May, and probably only several hundreds during August.

Although not yet substantiated by morphometrics of captured birds, the occurrence of up to a few thousand Knots in the Westerschelde in July, often followed by a decrease in later months, suggests that *canutus* birds are involved. *Islandica* Knots do not generally arrive in numbers in the North Sea basin before August (Prater 1974; Davidson & Wilson 1992), while Afro-Siberian birds stage in the Dutch Wadden Sea between mid July and late August (Piersma *et al.* 1992). For years with data available, a positive correlation ($r_s = 0.90$, $n = 7$, $p < 0.05$) was found between August-numbers in the Westerschelde and breeding success of Afro-Siberian Knots as measured in southern Africa (Underhill *et al.* 1989). This relationship was not significant for the Oosterschelde ($r_s = 0.50$, $n = 9$, N.S.). Furthermore, there was a tendency for a negative correlation between July numbers in the Westerschelde and breeding success of *canutus* ($r_s = -0.64$, $n = 6$, N.S.). This tendency might be caused by adult birds passing early (July) in years with a breeding failure, and later (August) in successful years, as was shown for Curlew Sandpipers *Calidris ferruginea* by Roselaar (1979).

Assuming that the majority of Knot occurring in the Westerschelde in July and August belong to the Afro-Siberian (*canutus*) population, up to 4,000 of these birds use the Westerschelde during late summer in some years. In spring, the number of Afro-Siberian Knots in the Westerschelde also tends to be higher than that in the Oosterschelde. The general pattern is therefore that Afro-Siberian Knots migrating through the Delta mainly make use of the Westerschelde, while *islandica* birds occur mainly in the Oosterschelde. The reasons for this phenomenon are not clear. Birds interrupting their spring migration from Mauritania before they have reached the Wadden Sea presumably are forced to do so because of depleted energy reserves (Dick *et al.* 1987; Piersma *et al.* 1992). In that case, the larger numbers in the Westerschelde may be explained simply by the fact that it is the first large intertidal area encountered by birds arriving over the Delta area from the south. This argument does not apply, however, to the late summer situation. One other possibility is that some aspect of competition is involved. Although *canutus* birds tend to pass through the area before the majority of *islandica* Knots arrive, the temporal segregation is not complete, as indicated by the presence of both subspecies in the catch of 12 August. Geographical, in addition to temporal, segregation between the subspecies has also been observed during spring migration in the Wadden Sea of Schleswig-Holstein (Prokosch 1988).

Distribution and movements within the Oosterschelde

It is not really clear whether the majority of Knots moulting in the western sector of the Oosterschelde move further into the estuary later in autumn. Two adults in primary moult, caught in the western sector in August, had been ringed in the central sector in an earlier February. However, it cannot be excluded that some of the moulting birds move further west later in autumn to winter in the British Isles, as is suggested by the controls in August of birds ringed in eastern Scotland in January, and in northwest England in April. A return movement of these birds might then cause the slight upsurge of numbers in the western sector during February-April.

If the moulting and wintering flocks consist of the same birds, then why do they move further into the estuary in winter? One possibility is that food availability decreases during autumn in the western sector. On the Roggenplaat, small (0-year) Edible Cockles *Cerastoderma edule* are likely to be the main

food taken. As a result of growth, some of these small cockles may become too large during autumn to be readily taken by Knot. Other potential prey (Baltic Tellin *Macoma balthica*, Mudsail *Hydrobia ulvae*) are relatively scarce in this area. In the central and especially eastern sectors the winter diet probably consists mainly of Mudsails, which occur here in large numbers (5-15 g AFDM/m²). No field data on diet and feeding ecology has yet been collected from the Oosterschelde that would test this hypothesis.

ACKNOWLEDGEMENTS

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