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Westhoek saltmarsh – important staging site for Curlew Sandpiper *Calidris ferruginea* in the Dutch Wadden Sea

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The Curlew Sandpiper *Calidris ferruginea* is a scarce species in the Dutch Wadden Sea, with short migration peaks during spring (May) and autumn (July–September). Due to these short peaks, the regular monthly counts of waders on high tide roosts may miss the peak numbers. To get a better estimate of the numbers of staging Curlew Sandpipers during autumn migration, we conducted weekly counts along an 11-km stretch of the Frisian Wadden coast, from Koehool to Zwarte Haan, during July 2001–September 2024. This stretch encompasses the two largest roosts of the species in the Dutch Wadden Sea, the salt marshes of Westhoek and Zwarte Haan. The annual maximum number during the first peak of autumn migration (from the end of July to early August) was 2,110–9,142 birds. Maximum numbers during the second peak (late August to mid-September) were usually lower than in the first peak (740–4,590). Many juveniles were recorded in some years, suggesting good breeding success. No juveniles were observed in July and early August, but they constituted 30–90% of birds mid-August to mid-September. Annual patterns in peaks from weekly counts differed from those in standard monthly counts, because the latter often missed the brief peak in migration. The high tide roost near Westhoek has become an important staging site for Curlew Sandpipers in both the Dutch Wadden Sea and the international Wadden Sea. High and increased densities of Mud Shrimps *Corophium volutator* could be a reason for its attractiveness.

Keywords

shorebird

high tide roost

autumn migration

Corophium volutator

silting mudflat

INTRODUCTION

The Curlew Sandpiper *Calidris ferruginea* is a scarce migrant in the Dutch Wadden Sea, visiting the area mainly during short periods in spring (May) and autumn (July–September; Roselaar 1979, Smit & Wolff 1980, van de Kam *et al*. 2004, Kleefstra & Schekkerman 2019). Numbers of migrants in spring are considerably smaller than in autumn (Kleefstra *et al*. 2022, Hornman *et al*. 2024). The population that migrates to western Africa via northwestern Europe breeds on the Arctic tundra of Central Siberia and was estimated at approximately one million individuals twenty years ago (Trolliet & Fouquet 2004, Wetlands International 2006, Delany *et al*. 2009). Numbers currently wintering in western Africa are estimated to be 300,000–400,000, which suggests a declining population (van Roomen *et al*. 2022). This may be caused by reduced breeding success, which is implied by an earlier pattern of autumn migration in recent decades (Barshep *et al*. 2011, Meltofte & Clausen 2016).

Only 1–2% of the international flyway population of Curlew Sandpipers visits the Wadden Sea; most birds are found on the mudflats of the German state of Schleswig-Holstein (Kleefstra *et al*. 2022). In the Dutch Wadden Sea, regular monthly counts at high-tide roosts within the framework of the Dutch waterbird monitoring scheme indicate a peak in August (382–6,448 birds in the period 2008–2017; Hornman *et al*. 2024). However, as these counts occur mid-month, they do not capture the short peaks in occurrence of Curlew Sandpipers, which occur around 1 August and 1 September. In addition, numbers of this scarce species can easily be underestimated among the tens of thousands of other sandpipers present (Jukema 1979, Roselaar 1979). We aimed to get a more detailed picture of numbers staging during autumn, by counting the largest high tide roosts of Curlew Sandpipers in the Dutch Wadden Sea on a regular basis from 2001 to 2024.

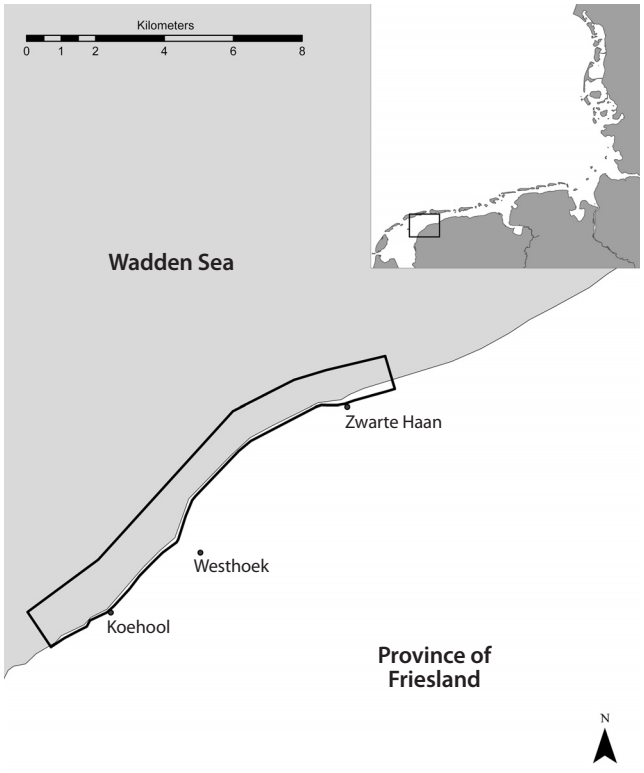

Fig. 1. Location of the research area (black outline) along the Frisian Wadden Sea coast in the Dutch Wadden Sea.

METHODS

We counted roosting Curlew Sandpipers during high tide along an 11-km stretch of the Frisian Wadden Sea coast from the hamlets of Koehool (53.25°N, 5.50°E) to Zwarte Haan (53.31°N, 5.63°E) in the period July 2001–September 2024 (except 2011–2012). The largest high tide roosts were the narrow salt marshes of Westhoek and Zwarte Haan (Fig. 1). Counts were made by 1 or 2 observers using telescopes, from an elevated position (6–9 m asl) on the seawall situated about 200–500 m from the roosts. In the years 2001–2010, most counts were made from mid-July to mid-August; in 2013–2024 many were done from early July to early September. Overall, there were 7–10 counts per summer season; fewer counts were made in 2017 (4) and 2018 (3). In 2020 and 2022, we surveyed the area from early July to mid-October (see Kleefstra *et al*. 2023).

Our counts were supplemented with others, contributed by (volunteer) birdwatchers to the websites Waarneming.nl and Lauwersmeer.com. We compared these numbers with those of high-tide roost counts in the entire Dutch Wadden Sea and along the entire Frisian Wadden Sea coast in the months July through September. These counts are usually conducted around the middle of each month and are organised by Sovon as part of the Dutch waterbird monitoring program (Hornman *et al*. 2024). They have been carried out along the Frisian Wadden coast for many years by the 'Wadvogelwerkgroep' of the *Fryske Feriening foar Fjildbiology* (Engelmoer *et al*. 2024).

Adult and juvenile Curlew Sandpipers migrate through western Europe at different times in late summer (Roselaar 1979, Wilson *et al*. 1980, Mason 1984, van de Kam *et al*. 2004, Koopman 2001, Meissner 2006). The migration of adults peaks in late July to early August, while juvenile birds mainly move through the Wadden Sea during late August and early September. The number of staging juveniles can serve as a proxy for breeding success on the Arctic breeding grounds (Summers 1986, Meltofte 1993, Schekkerman *et al*. 1998). In 2001–2010, we conducted counts only during the adult migration period. In 2013–2024, we also made counts during the staging period of juveniles. We estimated the proportions of juveniles among staging birds six times in counts from mid-July to mid-August and 12 times in counts from mid-August to mid-September.

To investigate whether a systematic trend can be identified in the numbers of (adult) Curlew Sandpipers in the study area, a Generalised Linear Model (Poisson distribution, log link) was fitted to the observed annual maxima.

RESULTS

Generally, the highest numbers of roosting Curlew Sandpipers were found at the Westhoek salt marsh. At Zwarte Haan, higher numbers occurred particularly during high spring tides, when the Westhoek salt marsh was flooded completely.

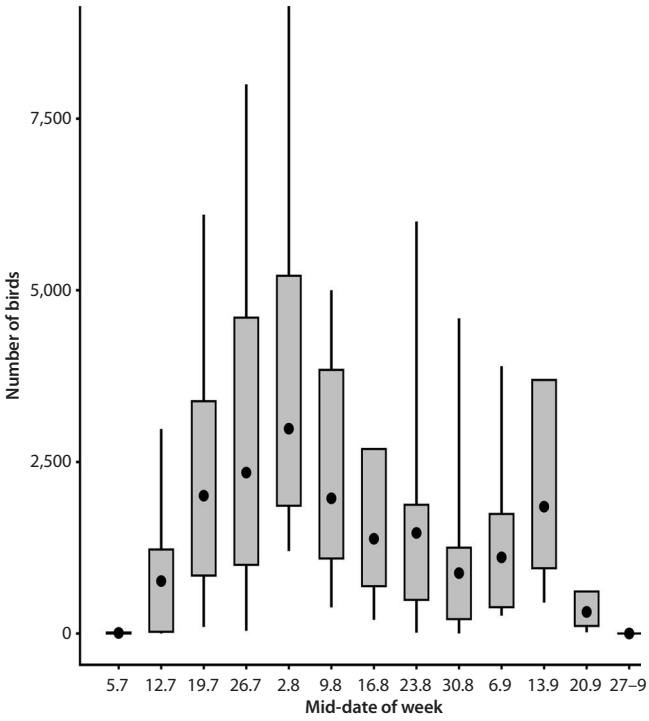

Fig. 2. Numbers of Curlew Sandpipers counted weekly July–September 2001–2010 and 2013–2024. Dots denote means, boxes encompass the 25% and 75% percentiles and whiskers the minimum and maximum counts.

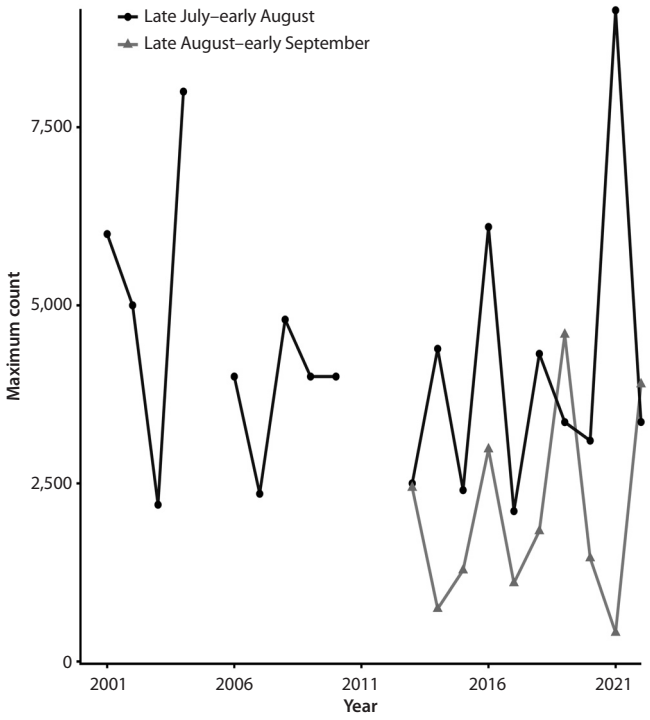

Fig. 3. Maximum numbers of Curlew Sandpipers counted in the study area during the first autumn migration peak in late July to early August and the second peak in September 2001–2004, 2006–2010 and 2013–2024.

Numbers of Curlew Sandpipers showed a bimodal pattern over the autumn, with a main peak in late July–early August and a second, generally lower, peak around mid-September (Fig. 2). We saw no juveniles in July and early August; from mid-August to mid-September the proportion of juveniles varied between 25–30% and 90%.

Maximum numbers during the first peak in late July and early August varied between 2,110 and 9,142 birds (Fig. 3). A slight apparent decrease (-1.1% per year, 2001–2024) in the yearly maxima was not significant ($F_{1,19}$=0.65, P=0.43). Maxima for the second peak in September were between 740 and 4,590 birds and were lower than in the first peak except in 2019 and 2022. Those two years exhibited the highest maxima for September; other high maxima occurred in 2013 and 2016. The log-linear trend over 2013–2024 was not significant ($F_{1,10}$=0.24, P=0.63).

Our counts and the standard Dutch waterbird monitoring program monthly counts (undertaken mid-month) did not show the same pattern (Fig. 4). Our peak counts were usually higher than those from the whole Frisian Wadden coast and even totals estimated for the entire Dutch Wadden Sea, often by a factor two or even up to ten. Moreover, there was only limited correspondence between years when comparing high and low numbers indicated by the standard monthly counts to those from our dedicated counts.

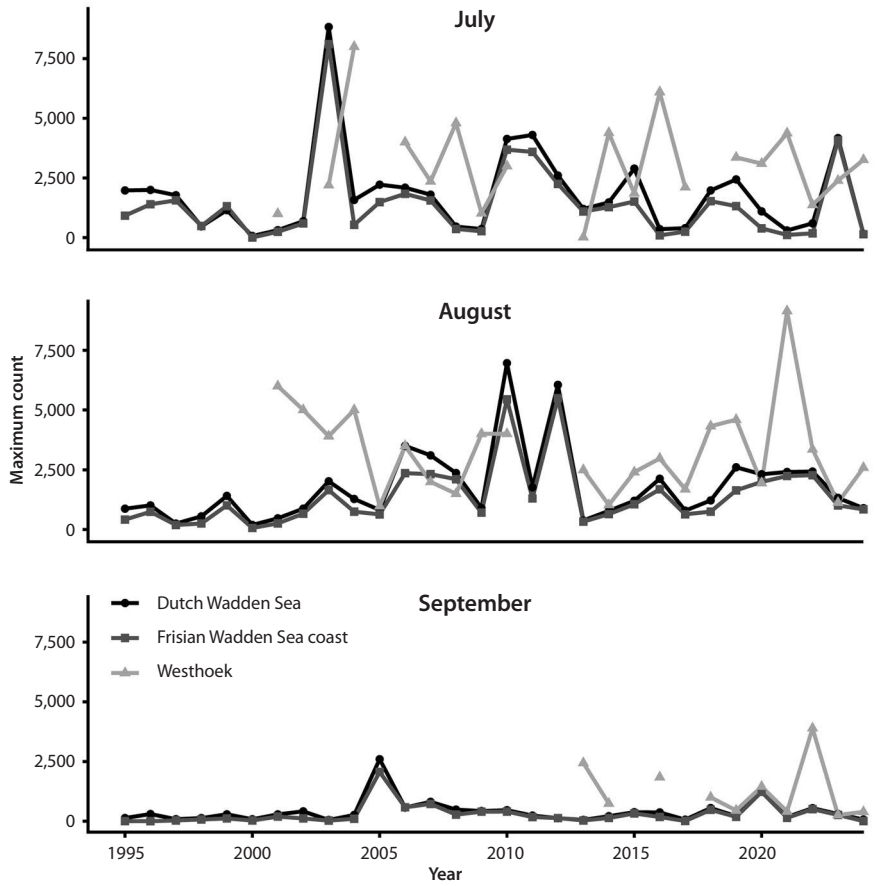

Fig. 4. Counts of Curlew Sandpiper in **(a)** July, **(b)** August and **(c)** September, based on our counts in 2001–2024 and on monthly counts in the Dutch Wadden Sea and along the Frisian coast, 1995–2024 (see Methods for sources of data).

DISCUSSION

Numbers and timing of autumn migration

The timing of the staging periods of Curlew Sandpipers around Westhoek (Fig. 4) – with peaks in late July to early August and late August to early September – is consistent with findings of Roselaar (1979) and Zeiske (1992) in the Dutch and German Wadden Sea respectively. It also aligns with the migration patterns in Belarus (Mongin *et al.* 2006), Poland (Meissner 2006), Denmark (Thorup 2006, Meltofte & Clausen 2016) and France (Sueur & Triplet 2006). In all those reports, the second peak in early September (generally consisting mainly of juveniles) is usually higher than the first (mainly adult) peak in early August (see also Koopman 2001). However, our second peak was usually lower than the first. This may reflect low breeding success (Barshep *et al.* 2011; see next paragraph). In Denmark, the second peak is now lower than it was in 1980–2001 (Laursen & Frikke 2013). However, in the Elbe estuary, the juvenile peak was never higher than the adult peak in the late 1980s and early 1990s (Zeiske 1992). It is possible that these differences reflect geographic variation in age composition of staging birds. We lack counts from the 1970s, 1980s or 1990s for the Westhoek area that could shed light on whether adults have always predominated there.

We noted strong interannual fluctuations, based on both our counts and the standard monthly counts. Roselaar (1979) linked such strong fluctuations in this species to a three-year population cycle of the Siberian Brown Lemming *Lemmus sibiricus*. The peaks he observed coincided with peak lemming years in the Siberian breeding range, when sandpipers were hypothesised to experience lower predation of nests and chicks. Other workers have since suggested that numbers of juvenile birds at migratory staging sites can be an index of reproduction in Arctic breeding areas (Summers 1986, Meltofte 1993, Schekkerman *et al.* 1998). Our maximum counts during the second (juvenile) migration peak were highest in 2013, 2016, 2019 and 2023. Breeding success of waders and lemming abundance in northern Siberia were average or high in 2010, 2013, 2016, 2019 and 2022 (P.S. Tomkovich, www.arcticbirds.net). Therefore, our observations may be explained in part by interannual variation in breeding success. Another effect of years with high predation and low reproductive success is on the timing of adult migration. Adult males do not participate in incubation or brood care, so usually migrate earlier than females. In years with low reproductive success, migration of the sexes is more synchronized as females also depart earlier (Mlodinow & Medrano 2023). Fig. 3 suggests that this may have happened in some years (e.g. 2014, 2018, 2021), but data for 2016, 2017 and 2023 (or of Zeiske (1992) for Germany) do not follow that pattern.

Our peak counts along part of the Frisian coast were often considerably higher than monthly high-tide roost counts for the entire Wadden Sea. We interpret this discrepancy as a result of the different frequency and timing of those counts. Brief peaks in numbers will be detected more accurately in weekly than in monthly counts. Furthermore, peaks in numbers that we observed occurred around the transitions between months (July–August and August–September), whereas the standard monthly counts took place around the middle of the month. An additional factor contributing to variability of the standard monthly counts is that their timing varies across years by up to about 10 days because they are scheduled for a weekend close to the date of the highest spring tides in that month.

The importance of Westhoek and surroundings for the Curlew Sandpiper

Our observations reveal that the Frisian mudflats are an important autumn staging site for Curlew Sandpipers. Assuming a flyway population of 300,000–400,000 (2016–2020; van Roomen *et al.* 2022) and an average seasonal maximum of 3,800 over the same period, approximately 1% of the flyway population uses the Westhoek saltmarsh. This represents the largest recorded concentration of the species in the Dutch Wadden Sea (Fig. 5). This has not always been the case. The salt marsh near Holwerd (27 km east of Westhoek) used to be important but, beginning around 2000, higher numbers have staged at Westhoek. The salt marsh there is relatively young, formed by silting of the mudflats, and is still accreting. Current numbers of Curlew Sandpipers there agree with a modest increase in the Dutch Wadden Sea, whereas they have declined strongly in Germany (Kleefstra *et al.* 2022). Until the early 1990s, numbers of staging Curlew Sandpipers between the mouths of the Elbe and Eider rivers sometimes reached >25,000 (e.g. Zeiske 1992); today there are a few thousand at most (K. Günther pers. comm.).

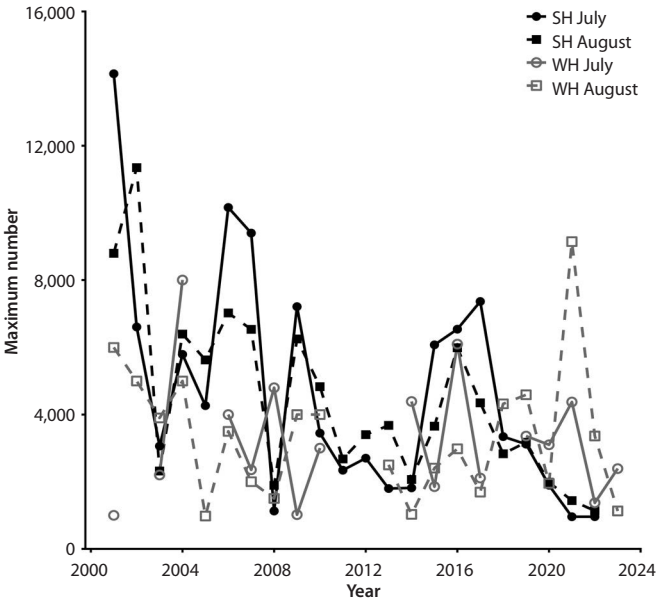

Fig. 5. Numbers of Curlew Sandpipers in the Schleswig-Holstein Wadden Sea (SH; data National Park Schleswig-Holsteinisches Wattenmeer) and at the Westhoek saltmarsh (WH) in July and August 2001–2022 (SH data for 2023 and 2024 were not available as this paper was being written; see Methods for sources of data).

Zeiske (1992) describes how adult Curlew Sandpipers on the German mudflats near the mouth of the river Elbe go through a (large) part of their moult of body feathers from summer to winter plumage, and some even renew a few flight feathers. Given the very similar seasonal pattern in numbers, this is also plausible for Westhoek. We also observed a general 'bleaching' of plumages during the counting period, but moult stages were not systematically examined.

The question is why Curlew Sandpipers prefer the area around Westhoek. Food can play an important role. Curlew Sandpipers take a wide range of animal prey, including insects, worms, molluscs, shrimps and even small fish (Cramp & Simmons 1983, Engelmoer *et al*. 1984, Khomenko 2003, Lifjeld 1984, Puttick 1979, Verkuil *et al*. 2003, Zeiske 1992). Benthos sampling, within the framework of the Synoptic Intertidal Benthic Survey programme of the Netherlands Institute for Sea Research (NIOZ), shows that high densities of potential prey species of Curlew Sandpipers occur on the mudflats north of our study area along the Frisian coast, such as Mudsnails *Peringia ulvae*, Ragworms, worms *Oligochaeta* sp. and in particular Mud Shrimps *Corophium volutator* (Compton *et al*. 2012, Duijns *et al*. 2013, Folmer *et al*. 2017). It could well be that the increase of Mud Shrimps in the silting mudflats along the Frisian Wadden Sea coast is attracting Curlew Sandpipers in greater numbers to Westhoek, although the food choice of the species has not been investigated in this area so far. In 2024 and 2025, respectively 14 and 6 Curlew Sandpipers were tagged with GPS-VHF loggers (R. Bom, NIOZ; R. Kleefstra, Sovon) and in both years 11 with WATLAS-tags (A. Bijleveld, NIOZ; Bijleveld *et al*. 2022), which should give us more insight into the life of the Curlew Sandpiper in the Dutch Wadden Sea and beyond.

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