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RESEARCH PAPER

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Long-term trends in abundance, phenology, and morphometrics of Little Stint *Calidris minuta* during autumn migration in southern Sweden, 1946–2020

Långsiktiga trender i förekomst, fenologi och morfometri för småsnäppor Calidris minuta på höstflyttning vid Ottenby 1946–2020

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THE LITTLE STINT *Calidris minuta* is an Arctic wader species that migrates through the Baltic Sea region towards wintering areas in North and West Africa and the Mediterranean region. We use a 75-year trapping series, comprising 4,791 Little Stints on autumn migration, from Ottenby Bird Observatory in Sweden to illustrate long-term trends in abundance, phenology, and morphometrics. Numbers of trapped juveniles dropped from median 31 (mean 74) in 1946–1999 to median 1.5 (mean 3.5) birds in 2000–2020, while the number of adults was generally low and without trends. Rolling window analyses showed that the drop in juveniles started around 1984, and from 1993 onward the median never exceeded seven juveniles/year (25%-quantile: 0–1; 75%-quantile: 4–55). Moreover, adult birds advanced their passage on average 0.48 days per year, passing 26 days earlier in 2020 than in 1946. Earlier migration of adults and decreased numbers of juveniles suggest low reproductive output in recent decades. Morphometric data of recaptured birds show that Little Stints on stopover at Ottenby gain fuel

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at a speed close to the theoretical maximum, strongly indicating that the conditions at the trapping site remain favourable for foraging waders.

Keywords: population decline | climate change | stopover ecology | fat deposition | Arctic shorebirds | Charadriiformes

Introduction

Waders form one of the most prominent groups of birds breeding on the circumpolar Arctic tundra (Cramp & Simmons 1983, Lappo *et al.* 2012, Keller *et al.* 2020). There, they utilize the short but very productive summer to raise their offspring before migrating southwards to non-breeding areas in temperate and tropical areas around the globe. One such bird is the Little Stint *Calidris minuta*, whose breeding range comprises the high-Arctic tundra stretching from northernmost Norway in the west to the New Siberian Islands in the east. It prefers coastal areas, but can extend into less cold regions, and occasionally to higher elevations (Cramp & Simmons 1983, Lappo *et al.* 2012, Keller *et al.* 2020). The global population is estimated at 1,500,000–1,600,000 birds, of which 48,200–76,000 pairs breed in what is considered the European part of the range (west of the Ural Mountains and including Novaya Zemlya; Keller *et al.* 2020).

A majority of pairs lay double clutches, with each parent taking care of one of the broods (e.g. Hildén 1983, Tulp *et al.* 2002). In years with favourable conditions, large numbers of offspring may be produced. However, the time available for foraging is consequently limited for parents, and nests might be abandoned if the body condition of the parents deteriorates (Tulp *et al.* 2002). Combined with a low breeding site fidelity (Hildén 1983, Kania & Chylarecki 1992, Tomkovich & Soloviev 1994) and environmental variation in the onset of snow melt, the double clutch strategy leads to annual variation in the number of breeding birds and their spatial distribution (Keller *et al.* 2020).

Birds from the European population are thought to migrate on a broad passage across the European continent in a S–SW direction (Bakken 2003, Fransson *et al.* 2008, Delany *et al.* 2009, Barlein *et al.* 2014), with fewer birds on the European Atlantic coast, including the British Isles (Toms 2002). The variation in locations and conditions at the Arctic breeding grounds is thought to affect the spatial variation in occurrence of Little Stints also outside the breeding season. Thus, in years with increased population size and recruitment in the western part of the range, the numbers during passage in Europe should increase, possibly also in parts of the winter range (Toms 2002, Delany *et al.* 2009).

Given its biology, the long-term monitoring of Little Stints across the annual cycle is cumbersome: the breeding range is vast and in largely inaccessible parts of the Arctic. The wintering distribution is also large, comprising the Mediterranean Basin, the Middle East, and both coastal and inland localities in sub-Saharan Africa (Cramp & Simmons 1983, Delaney *et al.* 2009, Keller *et al.* 2020, Oudman *et al.* 2020). Ring recoveries are relatively scarce but suggest that European breeders occur more towards the western part of the winter range, with ring recoveries in the Mediterranean and North and West Africa (Bakken 2003, Fransson *et al.* 2008, Delany *et al.* 2009, Barlein *et al.* 2014), whereas birds wintering in East and southern Africa largely belong to the eastern breeding populations from Siberia (Pearson 1987).

Whereas systematic monitoring of Arctic-breeding waders, on their breeding grounds, has improved substantially in NW Europe in recent years (Lindström *et al.* 2019), the main breeding grounds of Little Stints are still largely out of reach. Assessment of Little Stint population trends therefore requires concerted efforts by many organizations in different areas, but still may suffer from observer errors in assessments (see Simmons *et al.* 2015). An alternative method is to use long-term data sets from single sites where data have been collected in a systematic fashion, such as constant effort trapping (Blomqvist *et al.* 2002) or via structured migration (Edelstam 1972, Meltofte *et al.* 2006) or winter counts (Oudman *et al.* 2020).

Here we use a dataset on Little Stint autumn migration from standardized bird ringing at Ottenby Bird Observatory in southeast Sweden to study patterns in abundance and phenology of Little Stint migration over a period of 75 years (1946–2020). This work follows previous studies on Arctic-breeding wader species' passage at Ottenby, including Dunlin *Calidris alpina* (Mascher & Marcström 1976, Holmgren *et al.* 1993), Broad-billed Sandpiper *Limicola falcinellus* (Waldenström & Lindström 2001), Temminck's stint *Calidris temminckii* (Hedenström 2004), Red Knot *C. canutus* (Helseth *et al.* 2005a), Ruddy Turnstone *Arenaria interpres* (Helseth *et al.* 2005b), Wood Sandpiper *Tringa glareola* (Iwamojo *et al.* 2013), Little Ringed Plover *Charadrius dubius* (Hedenström *et al.* 2013) and Ringed Plover *C. hiaticula* (Hedh & Hedenström 2016). Such studies can provide data not only on population trends and phenology for species that are usually not observed in large numbers (such as Little Stint) but can also be used for studies of stopover ecology.

Bearing in mind the rapid ongoing climate change affecting the Arctic and reports of decreasing numbers of long-distance migrant wader species that breed on the tundra (Studds *et al.* 2017, Oudman *et al.* 2020), we use a time series from Ottenby Bird Observatory that covers three quarters of a century to document changes in the passage of Little Stint during the early phase of its autumn migration. We show that Little Stints display a long-term decline in numbers during autumn migration at this site in the Baltic Sea region, manifested as a steep drop in number of trapped juvenile birds during the last 20 years, and a long-term advancement of autumn passage of adults. Additionally, we provide estimates of fuel deposition rates and trends in morphometric measurements.

Material and methods

STUDY SITE

Ottenby Bird Observatory (56°12'N, 16°24'E) is situated on the southern point of Öland, a long and narrow island in the Baltic Sea off the coast of SE Sweden. The observatory was founded in 1946 with the aim to study bird migration through observations and bird ringing (Danielsson *et al.* 1947, Edelstam 1972). The site is well suited to catch migratory Arctic waders (Charadriiformes) following the East Atlantic Flyway and especially during autumn migration, passing waders use the food-rich shorelines of Öland for stopover and refuelling (e.g. Waldenström & Lindström 2001). Trapping methods and the physical environment at the observatory have remained comparatively similar across the 75 years of study. Generally, the capture of southbound-migrating waders starts in late June–early July when the birds arrive, and continues at least until end of August, or in years with good numbers of juvenile waders, until September or October (very rarely even November).

Walk-in traps placed in combinations (sometimes singly) on the banks of decomposing seaweed that form along the shore, constituted the main methodology. The traps are designed to capture foraging birds and can be very efficient if conditions are good. The largest daily total is 1,207 waders and 27 days with more than 500 trapped birds have been recorded (up to year 2020). The most numerous species by far is the Dunlin, but more than 20 species are caught regularly. In the early years the traps varied somewhat in size, but from 1972 a standardized, approximately 120 cm long version has been used (two walk-in entrances, a collection chamber in each end, steel frame covered with chicken or nylon mesh; often referred to as the "Ottenby" funnel trap in the literature: Lessells & Leslie 1977, Bub 1991, Lindström *et al.* 2005). Since the study area is not affected by tidal water, 80–120 traps are used both day and night, and emptied every hour, except during complete darkness when wader foraging behaviour is reduced.

DATA ON RINGED BIRDS

In total, 4,791 Little Stints were trapped during autumn migration (June–October) in 1946–2020. Of these, 228 birds were registered as adults, 3,840 as juveniles, and 723 were not specified to age. The unaged category is largely comprised of birds trapped in the first three decades. Given that 592 of unaged birds were trapped during late autumn passage (September–October) they were most likely strongly dominated by juvenile birds, as adults are rarely caught during this time (one out of 964 ringed birds in late autumn). Generally, ageing Little Stint is easy in summer and autumn based on differences in wear and colour of the plumage. While aging becomes harder when birds attain winter plumage (e.g., Prater *et al.* 1977), very few birds passing through Ottenby have attained winter plumage. The species is generally considered monomorphic: while females are on average slightly larger than males in structural measurements, the overlap is substantial (Niemc *et al.* 2018).

Structural size measurements were available in the form of wing length measured as maximum flattened chord from carpal joint to tip of wing to the closest millimetre (1,222 birds, years 1977–2020), and total head length measured from tip of bill to back of head (with a calliper to closest mm, Green 1980) for 96 individuals (years 2007–2020). Body mass was recorded for 869 birds (years 1977 and 1986–2020), using either a spring balance or a digital scale, in most cases to 0.1 g accuracy. In the most recent years (2004–2020), a fat score measurement on a scale from 0–9 was recorded for 113 birds (Pettersson & Hasselquist 1985, cf. Lindström 1998).

ABUNDANCE

The number of Little Stints trapped at Ottenby varied greatly between years, especially for juveniles, for which numbers ranged from 0 to 613 individuals captured in the autumn migratory season. We assessed potential changes in abundance using a rolling window approach. Using a window size of 15 years, we calculated rolling medians, as well as the 25% and 75% quantile for each 15-year window. To provide a quantitative estimate over the changes in abundance of juvenile and adult Little Stints over the entire study period, we additionally fit a linear regression model with abundance as response variable, and age class and years since 1945 (so years range from 1 to 75) as independent predictors. We included an interaction term between year and age to estimate the effect of year on abundance for both age classes separately, and further included a dispersion model to account for differences in variance between the abundances for adults and juveniles. We log-transformed abundance as ln(abundance + 1) to approximate a normal error distribution for the model. Individuals of unknown age were excluded from the analysis.

Estimates of trapping effort were not available for the entire 75-year period and could thus not be controlled for. Both trapping effort and trapping efficiency have always varied with the local weather situation, since long spells of warm and dry weather dry out the seaweed banks, making them less attractive for feeding waders. In contrast, passages of rain fronts and cooler weather normally attract large numbers of waders to the shores. However, the effort has been standardized in the sense that "if there are waders around, the traps should be out". Therefore, we argue that the large variation in trapping numbers between years is primarily dependent on true variations in the number of birds on stopover, and much less on trapping efforts.

PHENOLOGY

We investigated whether passage dates of Little Stints changed over the 75 years at Ottenby. We fitted a linear regression model with date of capture (as days since 1 January) as dependent variable, and number of years since the start of the trapping series (i.e. 1–75), age class, and their interaction as independent covariates. As captures within a year cannot be assumed to be entirely independent, we further included the actual year of trapping as a random effect term. A visual assessment of the data suggested that variance of arrival dates differed between years and age class, so we additionally included a dispersion model to estimate variance for each age class separately, in interaction with year of record. Individuals of unknown age were excluded from the model. We assessed the distribution of residuals and decided that a normal error distribution was appropriate.

MORPHOMETRICS, CONDITION, AND FUEL DEPOSITION RATE

We determined the mean and standard deviation (SD) for body mass, wing length, and total head length for all individuals with available measurements. We then evaluated the relationship between body mass and fat score as two indicators of body condition during passage, using a generalised linear mixed-effects model (R package *lme4* v. 1.1-23; Bates *et al.* 2015). The model contained body mass as the dependent variable and fat score and wing length as independent covariates. We further included an interaction term between fat score and wing length, and the ringers' signatures as random effect term to account for any consistent differences between ringers. After assessment of model residuals, we determined that a normal error distribution was appropriate. We fitted two alternative models since fat score is scaled ordinally, with differences in average mass between the different scores not necessarily being consistent. In one of the alternative models, we treated fat score as a continuous predictor, whereas

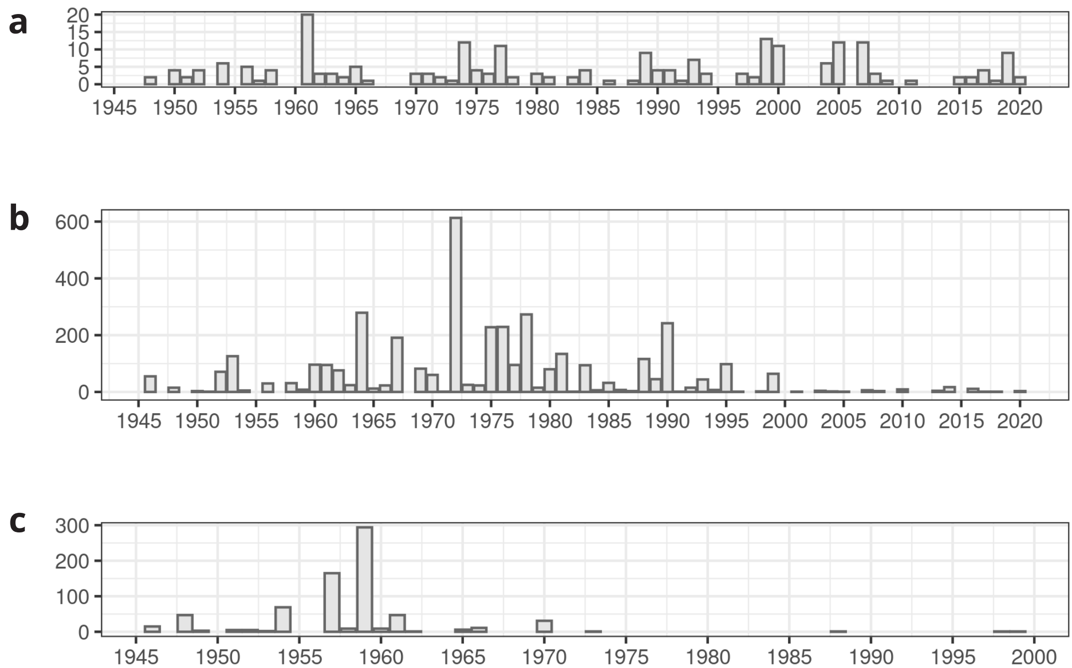

FIGURE 1. Number of ringed (**a**) adult, (**b**) juvenile and (**c**) unaged Little Stints *Calidris minuta* at Ottenby Bird Observatory 1946–2020. — *Antalet ringmärkta (**a**) adulta, (**b**) juvenila och (**b**) icke åldersbestämda småsnäppor* Calidris minuta *vid Ottenby fågelstation 1946–2020.*

in the second alternative fat score was included as an ordinally ranked covariate. We here present the second alternative for interpretability but included the results for the first model in the Supplementary Information (see *Data availability*).

The lean body mass (LBM) of Little Stint has been estimated to 20.0 g (Pearson 1987, Lindström 1998), which fits the data presented here; only 8 birds (all juveniles) weighed less than 20 g, including one (most likely erroneous) mass of 15.3 g. We used individuals that were recaptured within the same season to estimate fuel deposition rates. In total, 23 juvenile individuals were recaptured within 1–7 days of their initial capture. We estimated fuel deposition rates using a linear mixed-effects model, with change in body mass, in grams, between the initial capture and recapture as dependent variable. We included the number of days that had passed between captures as a continuous independent predictor, and further accounted for potential differences in overall condition between years by including year as a random effect term.

ANALYSES

Descriptive statistics on variation in trapping numbers, phenology and morphometrics was extracted from the data and visualized using Microsoft Excel, IBM SPSS v. 27.0 and R v. 4.0.3 (R Core Team 2020).

Results

ABUNDANCE

The number of trapped Little Stints showed considerable annual variation (Figure 1). This was most evident for juvenile birds, where the range spanned from 0 to 631 in different years (average 51 birds per year 1946–2020). Also the number of adult birds varied between years, albeit with a lower amplitude (average 3 birds per year 1946–2020, range 0–20). Peak years with more than 100 trapped juveniles occurred in 1953, 1964, 1967, 1972, 1975, 1976, 1978, 1981, 1988, and 1990. If including the unaged birds in the juvenile category (see methods), also the years 1957 and 1959 qualified as peak years.

TABLE 1. Results of a linear model estimating the effect of year on the log-transformed annual number of captures for adult and juvenile Little Stints *Calidris minuta* at Ottenby, Sweden, from 1946 to 2020. The table shows the estimate, standard error (SE), and 95% confidence intervals (CI) for the effect of the independent predictors on capture day (days since 1 January), as well as adjusted R^2 and total sample size.
— Resultaten från en linjär modell som uppskattar effekten av år (tid) på det logaritmerade årliga antalet adulta och juvenila småsnäppor Calidris minuta *som fångats vid Ottenby 1946–2020. Tabellen visar skattning, standardfel (SE) och 95 % konfidensintervall (CI) för effekten av de oberoende variablerna som påverkar fångstdag (dagar sedan 1 januari) samt det justerade R^2-värdet och provstorlek.*

	Log-transformed annual abundance of Little Stints *Logaritmerade årliga antal av småsnäppor*			
Variable *Variabel*	Estimate *Skattning*	SE	95% CI	*t* statistic t-*värde*
Predictors *Prediktorer*				
Mean abundance of adults (intercept, log-transformed) *Genomsnittligt antal adulta fåglar (skärningspunkt, log-transformerad)*	1.48	0.35	0.79–2.18	4.23
Mean abundance of juveniles (intercept, log-transformed) *Genomsnittligt antal ungfåglar (skärningspunkt, log-transformerad)*	4.22	14.98	3.59–4.85	13.35
Year (effect on adults) *År (effekt på adulter)*	0	0.01	–0.02 to –0.02	0.04
Year (effect on juveniles) *År (effekt på ungfåglar)*	–0.03	0.01	–0.05 to –0.01	–2.98
Other model components/output *Andra komponenter/utdata från modellen*				
R^2 | adjusted R^2 *R^2 | justerat R^2*	0.820 | 0.814			
Sample size *Stickprovsstorlek*	112 annual abundances *årliga antal*			

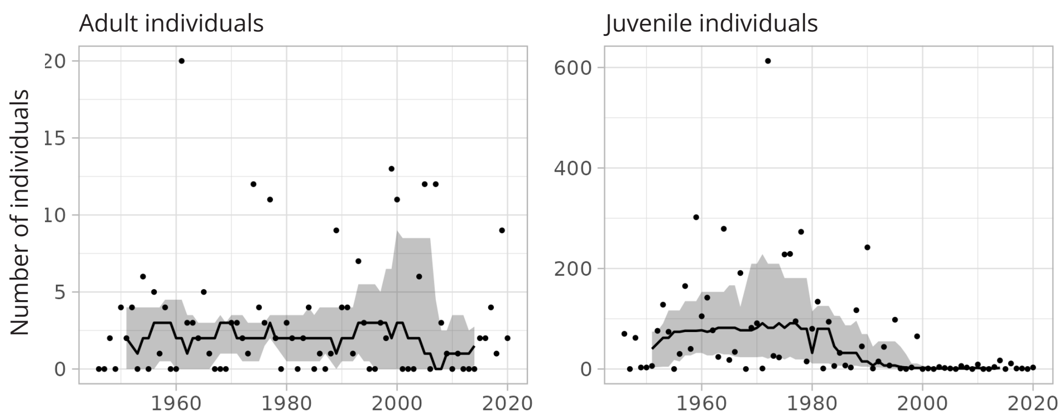

FIGURE 2. The results from the rolling window approach over the number of adult (left panel) and juvenile (right panel) Little Stints *Calidris minuta* captured at Ottenby Bird Observatory over the study period 1946–2020. The line shows the 15-year median and the shaded area shows the interquartile range of individuals trapped for the same period. Estimates at the lower and upper range of years are based on at least 10 years of data, and the first and last five years were excluded. Points show the raw data, i.e., the actual number of birds trapped during the respective year.
— Resultaten av en tidsserieanalys med ett rullande fönster av 15-årsmedianer över fångstsiffor av småsnäppor Calidris minuta *vid Ottenby fågelstation 1946–2020 (adulta fåglar i den vänstra panelen, ungfåglar i den högra panelen). Linjen visar 15-årsmedianen och den skuggade ytan interkvartilvärdena. Estimaten för början och slutet av tidsserien baseras på 10 års data, och de första och sista 5 årens data är exkluderade. Punkterna visar rådata, det vill säga antalet fångade fåglar varje år.*

In the last 20 years, however, very few juvenile Little Stints have been caught at Ottenby (median 1.5, mean 3.5, range 0–17, years 2001–2020). The rolling window approach showed that over the period from 1955 to 1979, the median number of juveniles ranged from 74 to 91 (25%-quantile: 15–32; 75%-quantile: 117–229). From 1984 and onward, the 15-year median dropped rapidly to less than ten individuals, and from 1993 onward, the median never exceeded seven juveniles captured in a year (25%-quantile: 0–1; 75%-quantile: 4–55). Over the entire study period, the 15-year median of adults caught in a season ranged from 0 to 3 (25%-quantile: 0– 2; 75%-quantile: 2–9; Figure 2).

This impression was corroborated by the regression model fitted to the log-transformed abundance for adult and juvenile Little Stints (see Table 1, Figure 3). The estimates from the supplementary regression model indicate that the number of adults trapped across the years was more or less constant, with an effect of year on log-transformed abundance of adults of 0 (95% confidence interval: −0.02 to 0.02), whereas it corroborated the impression of a distinct negative trend on the log-transformed abundance of juveniles with an effect size of −0.03 (95% confidence interval: −0.05 to −0.01).

PHENOLOGY

Adult Little Stints advanced their passage at Ottenby over the 75-year observation period, with average date of capture changing from August 31 in 1946 to July 28 in 2020. This means that on average, adult birds advanced their passage through Ottenby by 0.48 days per year (see Table 2, Figures 4–5). While the model also suggested a non-zero effect of year on the mean capture date of juvenile Little Stints, this effect was rather negligible (see Table 2, Figures 4–5). The fitted model explained about 21.3% of mean capture date (marginal R^2: 0.213; fixed and random effects together contribute to conditional R^2 of 0.579). We found that mean capture date of juveniles (estimated SD: 4.14 days) showed less variance than adults (estimated SD: 5.48 days; see Table 2).

TABLE 2. Results of a linear model of changes in timing of autumn migration for Little Stints *Calidris minuta* captured at Ottenby 1946–2020. The table shows the estimate, standard error (SE), and 95% confidence intervals (CI) for the effect of the independent predictors on capture day (days since January 1), as well as R^2 values and total sample size. SD = standard deviation.
— Resultaten från en linjär modell för småsnäppors Calidris minuta *förändrade höstflyttningsperiod vid Ottenby 1946–2020, baserat på fångstdata. Tabellen visar skattning, standardfel (SE) och 95 % konfidensintervall (CI) för effekten av de oberoende variablerna som påverkar fångstdag (dagar sedan 1 januari) samt R^2-värden och provstorlek. SD = standardavvikelse.*

	Capture day (days since 1 January) *Fångstdag (dagar sedan 1 januari)*			
Variable *Variabel*	Estimate *Skattning*	SE	95% CI	*z* statistic *z-värde*
Predictors *Prediktorer*				
Mean passage day (adults) *Genomsnittlig passagedag (adulta fåglar)*	238.21	3.14	232.05–244.37	75.82
Mean passage day (juveniles) *Genomsnittlig passagedag (ungfåglar)*	244.52	2.30	240.01–249.02	106.35
Year (effect on adults) *År (effekt på adulter)*	-0.48	0.07	−0.42 to −0.28	−6.66
Other model components/output *Andra komponenter/utdata från modellen*				
SD of adult passage date (dispersion model) *SD för adulters passagedatum (spridningsmodell)*	5.48	0.10	5.29–5.68	54.73
Effect of juvenile age class on SD (dispersion model) *Effekt av åldersklassen årsunge på SD (spridningsmodell)*	−1.34	0.10	−1.54 to −1.14	−12.96
Marginal R^2 | conditional R^2 *Marginellt R^2 | betingat R^2*	0.213 | 0.579			
Sample size *Stickprovsstorlek*	4,068 individuals *individer*			

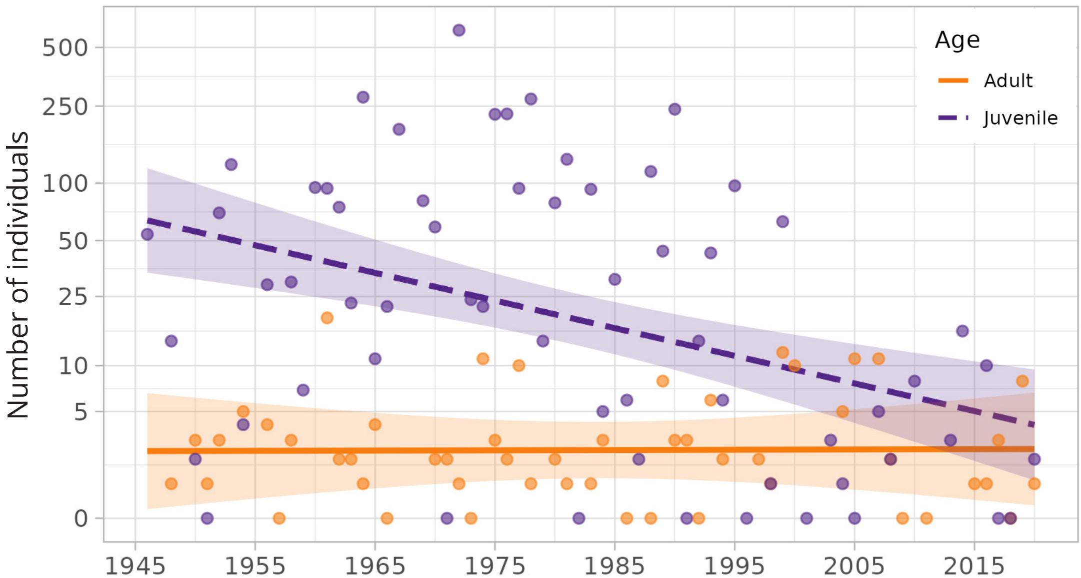

FIGURE 3. Change in trapping numbers of adult (orange) and juvenile (purple) Little Stints *Calidris minuta* at Ottenby Bird Observatory 1946–2020, drawn on a logarithmic scale. Trendlines show the regression lines over time with 95% confidence interval presented as shadows. *— Förändringen i antalet ringmärkta adulta (orange) och juvenila (lila) småsnäppor* Calidris minuta *vid Ottenby fågelstation 1946–2020, visade på en logaritmisk skala. Trendlinjerna visar regressionslinjen över tid. De skuggade områdena visar 95 % konfidensintervallen för respektive trendlinje.*

TABLE 2. Results for the model explaining change in body mass between initial capture and recapture of juvenile Little Stints *Calidris minuta* at Ottenby, as a function of days between captures. The table shows the estimate and 95% confidence intervals (CI) for the effect of days between captures on change in body mass, as well the variance and random intercept variance for the random effect of trapping year. The table further reports marginal and conditional R^2 (according to Nakagawa *et al.* 2017) and total sample size.
— Resultaten från modellen som förklarar juvenila småsnäppors Calidris minuta *förändring i kroppsvikt mellan första fångst och återfångst vid Ottenby, som en funktion av antalet dagar mellan fångsttillfällena. Tabellen visar skattning och 95 % konfidensintervall (CI) för effekten som antal dagar mellan fångsttillfällen har på kroppsviktens förändring samt varians och slumpmässig skärningspunktsvarians för den slumpmässiga effekten av fångstår. Vidare rapporterar tabellen marginella och betingade R^2-värden samt provstorlek.*

	Change in body mass between recaptures *Förändring i kroppsvikt mellan fångsttillfällena*		
Variable *Variabel*	Estimate *Skattning*	95 % CI	*t* statistic *t-värde*
Intercept *Skärningspunkt*	–1.92	–4.13–0.29	–1.70
Predictor *Prediktor*			
Each day since capture *Varje dag sedan fångst*	1.44	0.85–2.02	4.77
Random effects *Slumpmässiga effekter*			
Variance *Varians* σ^2	4.01		
Random effect variance for year *Varians för den slumpmässiga skärningspunkten med år*	3.38		
N_{year} *Stickprovsstorlek (år)*	7		
Other components/output *Andra komponenter/utdata från modellen*			
Marginal R^2 | conditional R^2 *Marginellt R^2 | betingat R^2*	0.425 | 0.688		
Observations *Observations*	23		

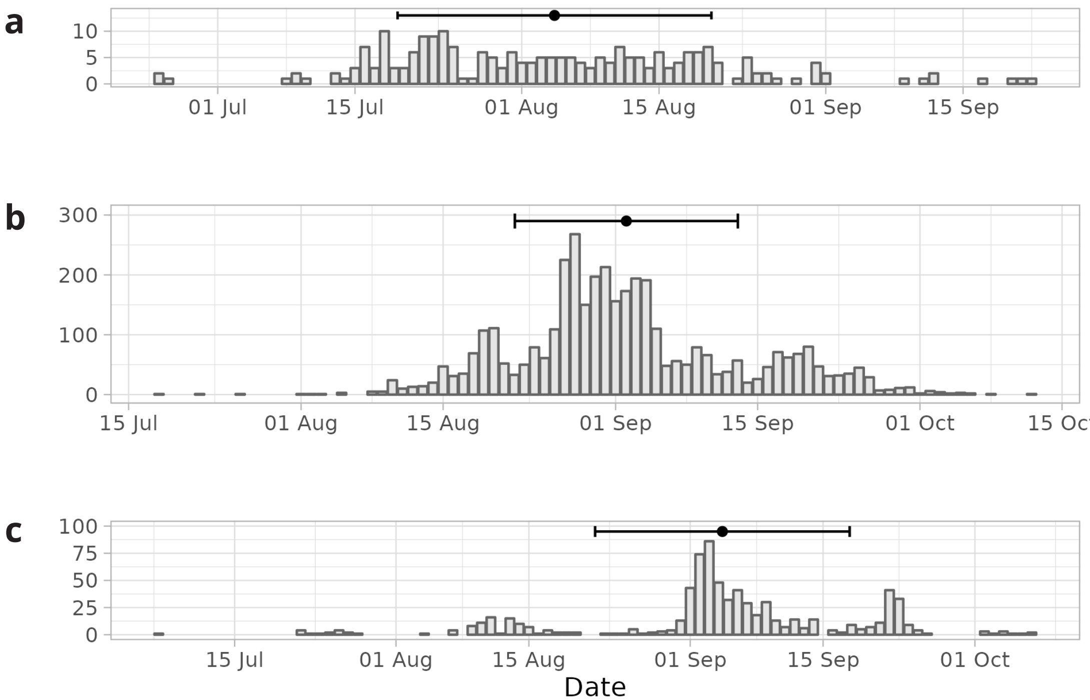

FIGURE 4. Phenology of captured (**a**) adult, (**b**) juvenile and (**c**) unaged Little Stints *Calidris minuta* (number of individuals) at Ottenby Bird Observatory 1946–2020. The error bar depicts the mean and the 95% confidence interval.
*— Fenologin av ringmärkta (**a**) adulta, (**b**) juvenila och (**c**) icke-åldersbestämda småsnäppor* Calidris minuta *(antal individer) vid Ottenby fågelstation 1946–2020. Överst i varje panel visas det skattade medelvärdet och tillhörande 95 % konfidensintervall.*

BODY SIZE

We estimated, using simple linear regression, that adults had a mean wing length of 98.93 mm (SD: 3.4 mm; 95% confidence interval for the mean: 98.44–99.42; Figure 6a). The wings of juvenile individuals were on average 0.84 millimetres longer, with a mean of 99.77 mm (SD: 2.8 mm; 95% confidence interval for the mean: 99.60–99.94; Figure 6b).

BODY MASS, FAT SCORES, AND FUEL DEPOSITION

We found that wing length and fat score could explain about 44% of the variation in body mass of captured individuals (marginal R^2: 0.448; conditional R^2: 0.479; see Supplementary Information). With every increase in fat score, body mass increased on average by 1.1 g (95% confidence interval: 0.8–1.4; Figure 7), whereas wing length, as a structural measurement, had an effect of 0.4 g for every mm increase (95% confidence interval: 0.2–0.5; see Supplementary Information).

Despite having shorter wings, adults were on average heavier than juveniles, with a mean body mass of 26.4 g (SD: 3.2 g; see Figure 8a) compared to a mean of 25.9 g among juveniles (SD: 3.8 g; see Figure 8b). This corresponds to average fuel loads of 30% and 25% of LBM.

We used mass gain in individuals recaptured during their stopover at Ottenby to estimate fuel deposition rates. All individuals that were weighed also at recapture were juveniles. Individuals recaptured within one or two days from the initial capture showed a change in mass ranging from −10.0% to +4.8% of LBM per day, but later recaptures showed consistent positive changes in body mass ranging from 1.0–14.3% of LBM per day. The largest and fastest increase in mass was 8.6 g over three days, corresponding to 14.3% of LBM per day, in a juvenile bird in August. Using a linear mixed-effects model, we found that over period of 1–7 days after their initial capture, individuals gained about 1.44 g per day on average, or 7.2% of LBM per day (95% CI: 0.85–2.02 g, or 4.25–10.10% of LBM). Day since capture could ex-

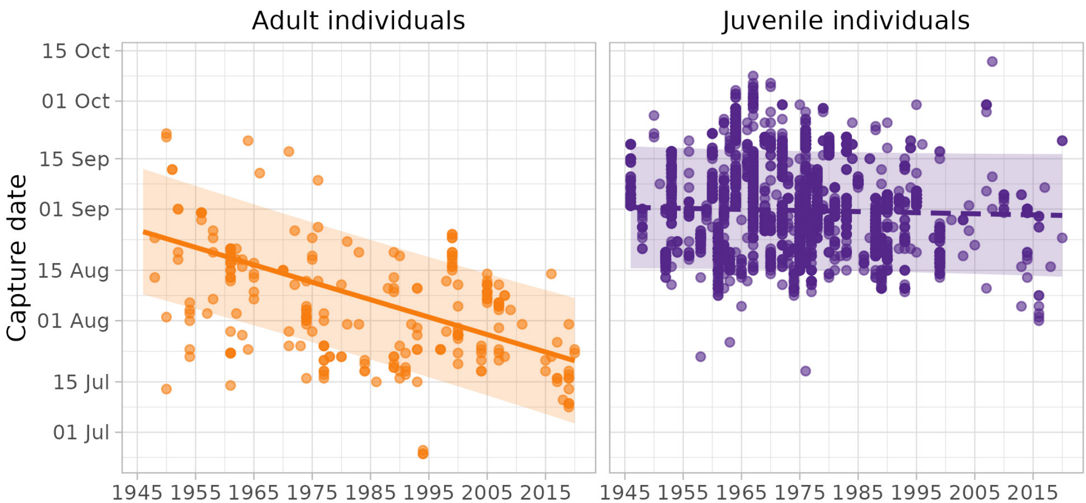

FIGURE 5. Capture date of Little Stints *Calidris minuta* at Ottenby over the entire study period 1946–2020, with adults shown on the left-hand panel (orange points), and juveniles on the right (purple points). The line indicates the mean model estimate for change in passage date over the years, and the shaded area indicates the 95% confidence interval of the model estimate. The points show the raw data.
— *Fångstdatum för småsnäppor* Calidris minuta *ringmärkta vid Ottenby fågelstation under studieperioden 1946–2020. Den vänstra panelen visar adulta småsnäppor (orange) och den högra panelen ungfåglar (lila). Linjerna illustrerar förändring i fångstdatum över tid och de skuggade områdena tillhörande 95 % konfidensintervall. Punkterna är rådata.*

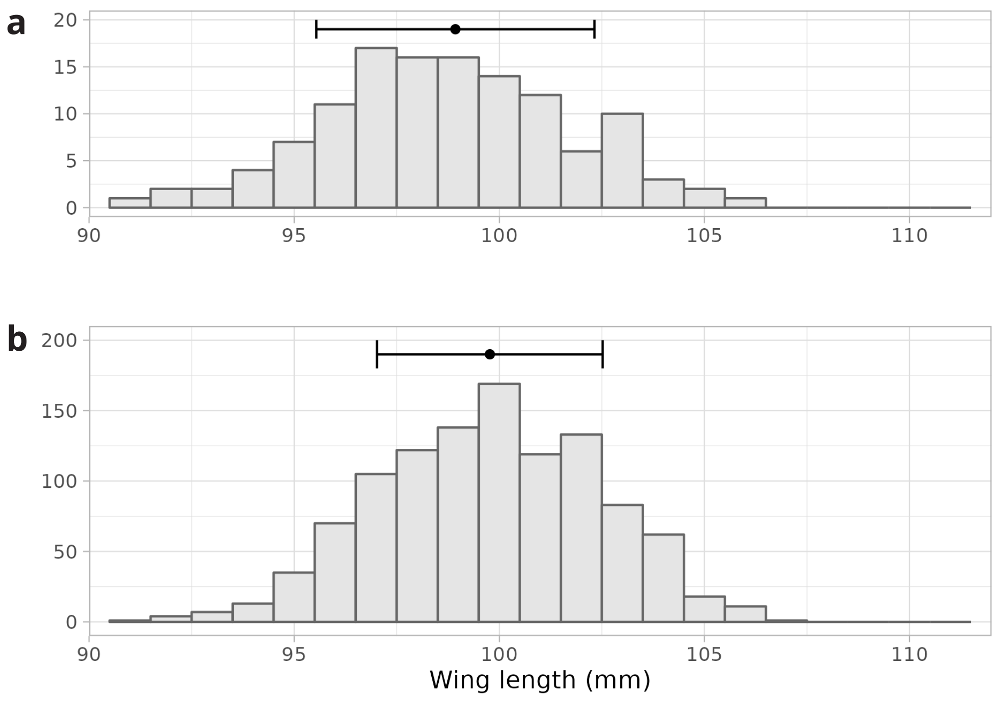

FIGURE 6. Recorded wing lengths of (**a**) adult and (**b**) juvenile Little Stints *Calidris minuta* ringed at Ottenby Bird Observatory 1946–2020 (N=1,093). The error bar depicts the mean and the 95% confidence interval.
— *Vinglängdsfördelning av ringmärkta (**a**) adulta och (**b**) juvenila småsnäppor* Calidris minuta *vid Ottenby fågelstation 1946–2020 (N=1093). Överst i respektive panel visas det skattade medelvärdet och tillhörande 95 % konfidensintervall.*

plain 42.5% of the observed variation in mass changes between recaptures (marginal R^2: 0.425; conditional R^2: 0.69; for details, see Table 3 and Figure 9).

Discussion

CHANGES IN ABUNDANCE AND PHENOLOGY

We found that over the 75 years of trapping of Little Stints at Ottenby, the number of juvenile Little Stints captured per year has changed from a pattern of recurrent peak years in the period 1946–1999, to low numbers without any peak years from 2000 onwards (Figure 1). This change is so dramatic that in the last two decades only 63 juvenile Little Stints were captured in total. This represents less than 1.6% of the total number of juveniles captured during the entire trapping period from 1946 to 2020 (Figures 2–3). There are severable possible explanations for the change in juvenile abundance at Ottenby, and the important question to ask is whether this negative trend reflects true changes in breeding output of Little Stints, or if they result from changes in trapping efforts, changes in local site use of birds, or larger-scale changes in migratory routes.

While our analyses cannot account for trapping effort, the observatory aims to conduct the trapping as standardised as possible. This means that since 1972 the type and number of traps have remained constant (80–120 traps), as has the trapping period, which runs from the start of wader autumn migration in late June to at least late August, and longer in years with large number of juveniles. Even in earlier years, wader trapping was an important part of the annual routine at the station, and the peak years in Little Stint trapping numbers in the period 1946–1999 certainly represent biological peak years. Vice versa, the absence of peak years in the trapping numbers reflect low abundance at the site. This is supported by the trapping numbers of other wader species at Ottenby, which show varying trends. For instance, Dunlins (the overall most numerous *Calidris* species in autumn), which has a large distribution in the Arctic at lower latitudes, still show peak years also during the last 20 years including an all-time high in 2020 with 9,928 birds (average 2,968 birds per season 2001–2020). However, other investigated high-Artic waders—such as Curlew Sandpiper (Barshep *et al.* 2011) and Ruddy Turnstone (Helseth *et al.* 2005b)—show trends similar to that of Little Stints. Taken together, this suggests that the methods used to trap waders are still effective, and that changes in trapping numbers reflects abundance at the site.

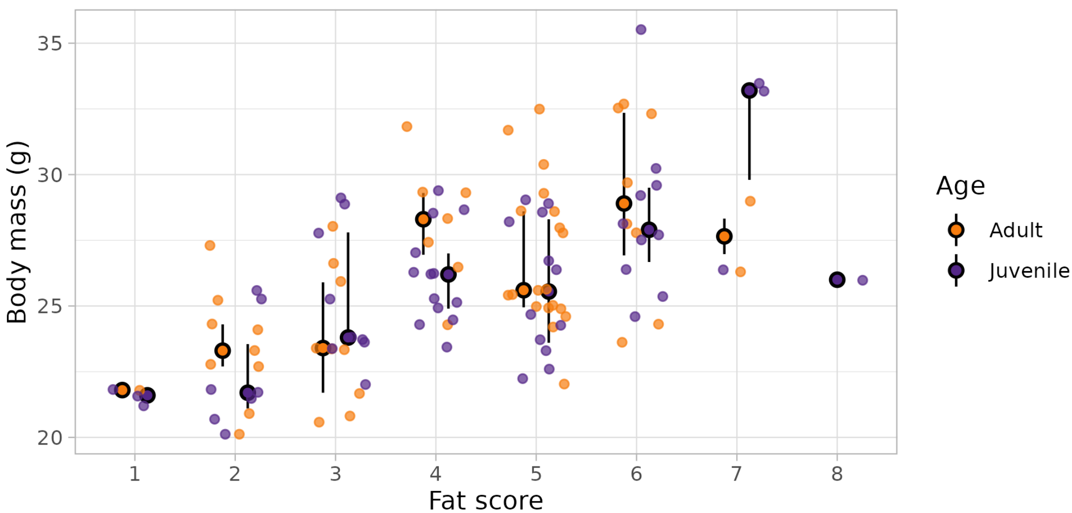

FIGURE 7. The relationship between body mass and fat score of adult (orange) and juvenile (purple) Little Stints *Calidris minuta* ringed at Ottenby Bird Observatory 2004–2020 (N=113). Median and interquartile range is shown per fat score and age class.
— *Förhållandet mellan kroppsvikt och fettvärde för adulta (orange) och juvenila (lila) småsnäppor* Calidris minuta *vid Ottenby fågelstation 2004–2020 (N=113). Median och interkvartilvärde visas per fettvärde och ålderskategori.*

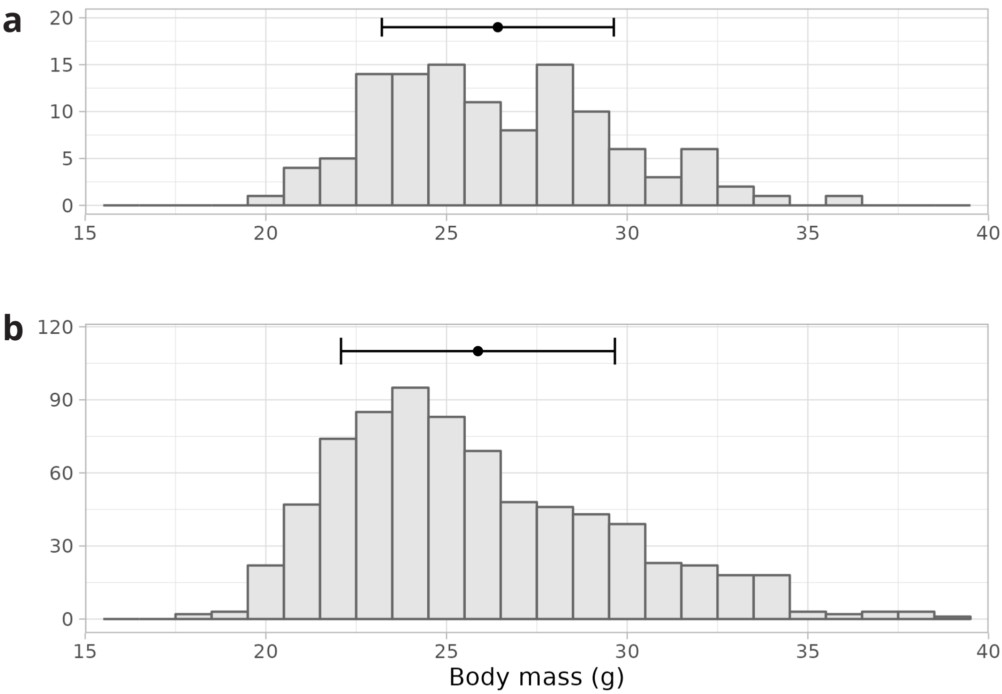

FIGURE 8. Body mass distribution of (**a**) adult and (**b**) juvenile Little Stints *Calidris minuta* ringed at Ottenby Bird Observatory 1946–2020 (N=866, of which 116 adults and 750 juveniles). The error bar depicts the mean and the 95% confidence interval.
— *Kroppsviktsfördelning av ringmärkta (**a**) adulta och (**b**) juvenila småsnäppor* Calidris minuta *vid Ottenby fågelstation 1946–2020 (N*=866, varav 116 adulta och 750 juvenila fåglar). Överst i respektive panel visas det skattade medelvärdet och tillhörande *95% konfidensintervall.*

Similarly, we are not aware of any drastic changes in the local stopover habitat. The whole trapping area is within a nature reserve and has been maintained as grazed coastal meadow during the whole study period, with only minor changes in habitat, such as slightly shifted shoreline after storm uplifts. One notable long-term change is the eutrophication of the Baltic Sea, which has affected the species composition of algae. This has led to an increase in filamentous green algae (e.g. Rönnberg & Bonsdorff 2004) that hypothetically could have affected the quality of the shore as foraging habitat for Little Stints. However, earlier studies on refuelling rate of waders at the site, together with the data on Little Stint presented here, show that birds refuel fat stores close to the theoretical maximum (Lindström 1998, 2003, Waldenström & Lindström 2001). Moreover, Little Stints normally occur in mixed species flocks dominated by Dunlins, a species that does not show the same negative trend. In our view, the habitat quality at the trapping site should be considered as suitable for Little Stints also in the period between 2000 and 2020.

The question whether large-scale shifts in migration pathways have occurred is harder to answer. Due to the broad-front migration and less westerly route used compared to other *Calidris* species, Little Stints do not appear in large numbers along the western coasts of Europe, and long-term count data is scarce from autumn migration throughout the continent. The exceptions to this include two long-term count surveys from western Denmark. The first is from Blåvandshuk, where Little Stints increased at an autumn migration staging site by 3.1% per year 1963–2003, but where better binoculars and field identification skills in later decades likely also affected the long-term trend (Meltofte *et al.* 2006). The second study was carried out at Tipperne, where staging waders were counted 1929–2014, and in a more standardised manner from 1973. During the latter period, most autumns saw maximum numbers below 120 Little Stints at Tipperne, but in peak years, such as in

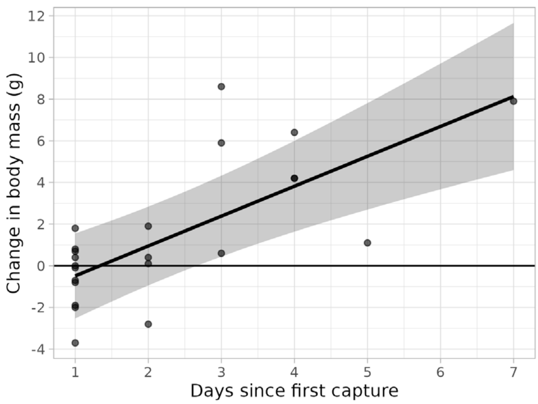

FIGURE 9. Fuel deposition rate of Little Stints *Calidris minuta* ringed at Ottenby Bird Observatory 1946–2020 expressed as change in body mass from initial capture to recapture.
— *Fettupplagringshastigheten för småsnäppor* Calidris minuta *vid Ottenby fågelstation 1946–2020 uttryckt som förändringen i kroppsvikt som en funktion av antalet dagar sedan första fångsten.*

1978 (coinciding with the third-largest number of juvenile Little Stints at Ottenby), more than a thousand juveniles were observed (Meltofte & Clausen 2016). The last true peak year recorded at Tipperne (up to 2014) occurred in 1998, but apart from very low numbers in 2004–2006 it was concluded that there were no clear short-term trends (Meltofte & Clausen 2016). However, in the long term the species shows an increase in numbers at Tipperne, with higher counts over the last 50 years than during the first decades of the study, but similarly to Blåvand it was concluded that local conditions, such as increased muddiness of the shallow flats from water level management, and better field identification skills and equipment, may have contributed to this increase (Meltofte & Clausen 2016).

The newly published European Bird Breeding Atlas indicates that the westernmost breeding range of Little Stints in northern Norway has contracted in the last decade (Keller *et al.* 2020), but the underlying data for the rest of the European breeding areas are too scant to draw firm conclusions. From the winter season, counts conducted in the vast coastal mudflat areas of Banc d'Arguin in Mauritania 1980–2017 show decreasing trends for Little Stints and other *Calidris* waders, albeit not significantly so for Little Stint (Oudman *et al.* 2020). Little Stints in Mauritania likely stem from the European breeding population, but negative trends in winter have been seen also in Namibia, in the southern part of the wintering range for the Siberian Little Stint population. This suggests a decrease in the order of 60–90% of wintering Little Stints in two important coastal mudflats in the period 1990–2013 (Simmons *et al.* 2015). In the East Atlantic flyway perspective, international organisations have described the long-term trend (1980–2017) of Little Stints as a moderate decline, and the short-term trend (2008–2017) as a steep decline (van Roomen *et al.* 2018). In this perspective, using standardised trapping efforts at a staging site in autumn, the Ottenby data offers important insight into the overall trends seen in the species.

In contrast to the decrease in juveniles, the number of trapped adult Little Stints was fairly stable over the 75 years, but at a much lower level (Figures 2–3). While it is surprising that our data suggest no change in the abundance of adults, the overall lower number of adults captured per year might obscure a potential trend. Adult birds did, however, show a clear trend of progressively earlier passage during autumn migration (Figure 5), with a change in median passage of 26 days over 75 years. This is a remarkable shift given that spring passage of Little Stints in Sweden peaks as late as end of May (median 25 May, Blomqvist & Lindström 1995), indicating that the available time for breeding is short. Juvenile passage time was also advanced, but only by 9 days compared to the 1940s, and with larger uncertainty in the estimate. We are not aware of any significantly earlier spring passage, and our interpretation of the data at hand is that an increased proportion of the adults caught at Ottenby represent birds for which breeding has failed, thereby causing an earlier onset of migration. This, together with low number of juvenile Little Stints captured, suggest changes in the breeding grounds. Importantly, a similar decline in juvenile numbers has been noted for other high-Arctic species at Ottenby, such as Curlew Sandpiper, where the number of years with poor reproduction doubled in 1976–2005 compared to 1946–1975 (Barshep *et al.* 2011), and for Ruddy Turnstone, where both juveniles and adults decreased in numbers 1947–2003 (Helseth *et al.* 2005b). For Curlew Sandpiper, trapping numbers of both adult and juvenile sandpipers at Ottenby have previously been correlated with lemming cycles on the tundra: in years with high lemming abundance result in reduced predation on breeding birds and increased number of juveniles in passage (Blomqvist *et al.* 2002).

So, what are the factors that drive these changes? Currently, the Arctic faces the highest rate of climate change on the planet (e.g. Tingley & Hubert 2013), affecting large regions inhabited by Little Stints and other Arctic wader species. The effects of an increased mean temperature in the Arctic are expected to include an earlier onset of spring, potentially causing a mismatch between arrival of birds and peak food availability on the breeding grounds (e.g. van Gils *et al.* 2016), but could also increase frequency of extreme weather events, or affect predator–prey dynamics (Kubelka *et al.* 2018). At the same time, long-distance Arctic waders are also exposed to changed conditions along the migratory flyways and in the non-breeding areas, thereby potentially exacerbating effects. The loss of peak years for juvenile Little Stint and Curlew Sandpiper in the last decades at Ottenby and co-occurring advancement of autumn migration in adult birds (Barshep *et al.* 2011, this study) suggest negative trends in breeding output occurring over large parts of the Arctic tundra. It is hard to pinpoint the underlying reasons for this change from our data alone, but in a global dataset, Arctic breeding waders showed a threefold increase in daily nest predation rate in 1944–2016, which was associated with an increase in ambient temperatures, temperature variations in the breeding grounds, and less pronounced lemming cycles (Kubelka *et al.* 2018). Collectively, the overall lack of data and the mixed trends in the few recent studies, together with the projected large climatic changes in the Arctic, warrant a strong need for targeted breeding surveys for Little Stints and other waders in the tundra biome.

FUEL DEPOSITION

As expected, the visible deposition of fat measured in fat scores explained much of the variation of body mass in Little Stints (cf. Lindström & Piersma 1993). The average fuel load at Ottenby of adults and juveniles was around 25–30% of LBM (approximately 25 and 26 g, respectively). This is largely within the range of what other studies have found for this species, but lower than observed for birds preparing for long-distance departures in spring (Table 4). For instance, Little Stints in Kenya seemed to leave with fuel stores of around 60% of LBM (Pearson 1987) and Zwarts *et al.* (1990) found average departure fuel loads of 43% of LBM in Mauritania. However, the autumn birds at Ottenby are a mix of recently arrived birds with depleted fuel loads, birds in the middle of their fuel deposition, and those ready for departure. A more appropriate comparison for an evaluation of fuel loads of Little Stints departing from Ottenby may be to look at the highest fuel loads

TABLE 4. Body mass (g) of Little Stints *Calidris minuta* from various parts of the non-breeding season.
— *Småsnäppans* Calidris minuta *kroppsvikt (g) under olika delar av årscykeln utanför häckningssäsongen.*

Region	Age/sex *Ålder/kön*	Mean (± SD) *Medelvärde (± SD)*	Range *Spann*	N *Antal*	Reference *Referens*
Autumn *Höst*					
Arctic Russia *Arktiska Ryssland*	juv.	23.5 (± 2.5)	17.9–32.1	233	Lindström (1998)
SE Sweden *Sydöstra Sverige*	ad.	26.4 (± 3.2)	20.1–35.7	116	This study *Denna studie*
SE Sweden *Sydöstra Sverige*	juv.	25.9 (± 3.8)	15.3–39.0	750	This study *Denna studie*
September–April					
S Africa *Södra Afrika*	♀	24.5 (± 3.7)		162	Niemc *et al.* 2018
S Africa *Södra Afrika*	♂	22.0 (± 2.4)	Max 43.5	185	Niemc *et al.* 2018
Spring *Vår*					
Kenya		32	Max 41.0		Pearson 1987
Spring departure *Våravfärd*					
Mauritania *Mauretanien*		~28–29			Zwarts *et al.* 1990

recorded. When considering only individuals with the highest fuel loads, Little Stints at Ottenby have a body mass that is comparable to other places. Indeed, putting on very high fuel loads makes sense at a place where the fuel deposition rate is very high, such as at Ottenby, where Little Stints had fuel deposition rates close to the expected maximum (Lindström 2003).

For a species that is heading for wintering grounds in Africa, Ottenby is still at the beginning of a long journey. In a westward expedition along the Arctic coast from the Laptev Sea to the Barent Sea, Little Stints showed an increase in mass westwards, indicating that birds in the western range prepared for a longer migration leg (Lindström 1998). Highest mean body mass was recorded at the Kola Peninsula (31 August), with 28.0 g, corresponding to fat stores of 40% of LBM, deemed sufficient to reach southern Baltic stopover sites, such as Ottenby (Lindström 1998).

Data availability

Ringing and morphometric data is available as Supplementary Information deposited at Zenodo (https://doi.org/10.5281/zenodo.7901512), along with an annotated R-script for rerunning analyses.

Acknowledgements

This manuscript came to life because of an unexpected trans-Atlantic recovery of an Ottenby-ringed Little Stint, observed by a birder in South Carolina, USA, during Christmas 2020. When discussing the vagrancy of this bird we concluded that we did not really understand the regular passage of the species, and needed to do our homework, which in this case meant documenting 75 years of Little Stint data from the observatory. We would like to extend our heartfelt gratitude to the scores of volunteer staff at Ottenby Bird Observatory from 1946 to the present, that collectively have put in countless hours catching birds at the site. Without their perseverance this study would not have been possible. Economic support for trapping waders at Ottenby has been received from the Swedish Environmental Protection Agency. The manuscript was improved thanks to comments from two reviewers. This is contribution no. 323 from Ottenby Bird Observatory.

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Svensk sammanfattning

Småsnäppan *Calidris minuta* har ett stort utbredningsområde på tundran i Arktis, från Norge i väster till Nysibiriska öarna i öster (Cramp & Simmons 1983, Keller m. fl. 2020). Likt många andra arktiska vadare är småsnäppan en långdistansflyttare och förekommer under vintern i stora delar av Afrika, Medelhavsområdet och Mellanöstern. I Sverige ses den framför allt under höststräcket i blandflockar med andra vadare, exempelvis kärrsnäppa *Calidris alpina*.

Det stora och svåröverskådade häckningsområdet, samt variationer i utbredning kopplat till väderbetingelser och häckningssystem (Hildén 1983, Kania & Chylarecki 1992, Tomkovich & Soloviev 1994), har gjort det svårt att övervaka de häckande bestånden. Även vinterkvarteren är stora och kunskapen om eventuella sträckdelare mellan populationer dåligt utredd (Cramp & Simmons 1983, Delaney m. fl. 2009, Keller m. fl. 2020, Oudman m. fl. 2020). Vidare flyttar arten på bred front i sydlig och sydvästlig riktning över Eurasien (Bakken 2003, Fransson m. fl. 2008, Delany m. fl. 2009, Barlein m. fl. 2014), vilket gör att den i lägre utsträckning ansamlas längs västra Europas kuster jämfört med andra arktiska vadare (Toms 2002). Med dessa osäkerheter i skattningarna i beaktande är den samlade bedömningen att småsnäppan minskat både på kort och lång sikt, och att den största minskningen skett på senare år (van Roomen m. fl. 2018). Globalt skattas populationen till 1,5–1,6 miljoner individer, varav 48 200–76 000 par i den europeiska delen av utbredningsområdet (väster om Uralbergen och inklusive Novaja Zemlja; Keller m. fl. 2020).

Ett alternativt sätt att skatta populationsförändringar är att använda långtidsdata under flyttningsperioden. I Sverige har Ottenby fågelstation på Ölands södra udde bedrivit fångst av vadare varje år sedan 1946, vilket skapar möjligheter att sammanställa data på olika arters antalsförändringar över tid och förändringar i flyttningens förlopp. I den är artikeln sammanställs sådana data för småsnäppa över en 75-årsperiod, 1946–2020.

STUDIEN

Vid Ottenby fångas vadarfåglar under höststräcket, från slutet av juni till augusti månads utgång, men vid år med större antal ungfåglar kan fångsten fortsätta även i september och oktober (sällsynt november). Sedan starten 1946 har fåglarna fångats med olika typer av vadarfällor som sätts i kombinationer längs stranden, i de tångbankar vadarna nyttjar till födosök (t. ex. Waldenström & Lindström 2001). Sedan 1972 är vadarfångsten standardiserad och ca 80–120 fällor av så kallad Ottenby-typ används (Lessells & Leslie 1977, Bub 1991, Lindström m. fl. 2005).

Sammanlagt 4 791 småsnäppor fångades under perioden 1946–2020, varav 228 noterades som adulta fåglar, 3 840 som ungfåglar och 723 som obestämda (figur 1). Antalet fångade småsnäppor varierade stort mellan åren. För ungfåglar fångades mellan noll och 613 individer per år (medel 51 fåglar), med tydliga toppår med >100 fångade fåglar 1953, 1964, 1967, 1972, 1975, 1976, 1978, 1981, 1988 och 1990 (samt 1957 och 1959 om man antar att obestämda fåglar mestadels var ungfåglar). För gamla fåglar var antalet betydligt lägre med ett snitt om tre fångade fåglar per år och ett spann om 0–20 individer (figur 1).

Tidsserien visar att allt färre unga småsnäppor fångats under senare delen av perioden (figur 2–3). De sista 20 åren fångades i medeltal endast 3,5 ungfåglar per år (median 1,5, spann 0–17, åren 2001–2020) och det senaste toppåret ligger så långt tillbaka som 1990. Med hjälp av en tidserieanalys med rullande 15-årsmedianer syns en tydlig förändring i antalet ungfåglar runt 1984 (figur 2). Innan dess var de rullande medianerna i spannet 74–91 ungfåglar (25 %-kvantil: 15–32; 75 %-kvantil: 117–229; perioden 1955–1979), men från 1984 och framåt minskade 15-årsmedianen till mindre än 10 individer, och från 1993 och framåt var median aldrig mer än 7 individer (25 %-kvantil: 0–1; 75 %-kvantil: 4–55; figur 2). För adulta fåglar visade en liknande analys inte några större förändringar i antal.

Över hela perioden varierade 15-årsmedianen mellan 0 och 3 individer (25 %-kvantil: 0–2; 75 %-kvantil: 2–9; figur 2). Trenderna var likartade i en regressionsanalys av data (se figur 3, tabell 1).

Både unga och gamla fåglar uppvisar en allt tidigare passage vid Ottenby under perioden (figur 5). En regressionsanalys med fångstdatum (dag efter 1 januari) som responsvariabel och ålder, år (räknat från 1945, spann 1–75) och interaktionen år och åldersklass som oberoende faktorer illustrerar detta (tabell 2), där ungfåglar i genomsnitt passerar 9 dagar tidigare i slutet av perioden än vid inledningen av perioden (95 % konfidensintervall: 3–14 dagar). Motsvarande skillnad för adulta fåglar är hela 26 dagar (95 % konfidensintervall: 21–32 dagar; tabell 2).

I samband med ringmärkning har även olika storleksmått, som vinglängd (1 222 fåglar, åren 1977–2020) och näbb-huvudlängd (96 fåglar, åren 2007–2020; enligt Green 1980), samlats in. Vidare finns viktdata från 869 fåglar (åren 1977, 1986–2020) och fettvärde från 113 fåglar (åren 2004–2020, skala 0–9 enligt Pettersson & Hasselquist 1985, modifierat av Lindström 1998). Adulta småsnäppor hade i genomsnitt något kortare vinglängd än ungfåglar (figur 6) och var något tyngre (figur 8). En regressionsanalys med vikt som beroende variabel visade att vinglängd och fettvärde förklarade omkring 44 % av variation i vikter hos de fångade småsnäpporna. För varje steg i fettvärdeskalan ökade kroppsvikten med i genomsnitt 1,1 g (95 % konfidensintervall: 0,8–1,4 g; figur 7), och för varje ökning med 1 mm i vinglängd ökade kroppsvikten med i genomsnitt 0,4 g (95 % konfidensintervall: 0,2–0,5 g).

Från litteraturen (Pearson 1987, Lindström 1998) och från de viktdata som erhölls i den här studien bedömdes den fettfria vikten hos småsnäppa vara 20,0 g. Medelvikten för ungfåglar och adulta fåglar var 25,9 g och 26,4 g, respektive. Det motsvarar en bränslemängd om vardera 25 % och 30 % av den fettfria vikten. Genom att analysera viktförändringar hos fåglar (varav samtliga var ungfåglar) som återfångades under rastningen vid Ottenby kunde fettupplagringshastigheten bestämmas till 1,44 g per dag, eller 7,2 % av den fettfria vikten per dag (95 % konfidensintervall: 0,85–2,02g, eller 4,25–10,10 % av den fettfria vikten; se tabell 3 och figur 9).

Sammantaget visar analyserna på stora förändringar i småsnäppans uppträdande vid Ottenby, både vad gäller antalet fångade fåglar och tidpunkten för sträckets passage. Från att ha uppvisat återkommande toppår med stora antal ungfåglar fångas idag väldigt få. För att sätta det i relation kan sägas att under de senaste 20 åren har endast 63 unga småsnäppor fångats, vilket utgör 1,6 % av alla fåglar under hela perioden. De adulta fåglarna visar inte samma nedåtgående trend, men har generellt sett aldrig fångats i stora antal. Däremot uppvisar de adulta fåglarna en tidigarelagd passage, som sett över hela tidsperioden motsvarar 26 dagars tidigare medelpassage. Kombinationen av en minskad mängd ungfåglar och en tidigarelagd passage av adulta fåglar antyder att häckningsframgången eller utbredningen av småsnäppa i upptagningsområdet förändrats. Adulta fåglar som anländer tidigt till Ottenby på sommaren har mer stor sannolikhet misslyckats med häckningen.

Alternativa hypoteser till den observerade minskningen kan vara förändrade förhållanden på fångstplatsen som gjort den mindre lämplig som rastlokal, eller ändrade fångstmetoder. Hela fångstområdet ligger i ett naturreservat vars skötsel varit relativt oförändrad över perioden, med betesdjur som håller strandängarna kortbetade. Vidare visar återfångstdata att småsnäpporna kan göra en fettupplagring nära det teoretiska maximumet, vilket antyder att habitatets kvalitet är god för rastande småsnäppor, något som också visats för andra vadararter vid Ottenby (Lindström 1998, 2003, Waldenström & Lindström 2001). Själva fångstförfarandet har ändrats i så måtto att fångstredskapen varierat över perioden (dock standardiserade sedan 1972), men vår bedömning är att fångsten reflekterar den faktiska förekomsten av vadare och att avsaknaden av stora mängder ungfåglar av småsnäppa och en del andra högarktiska vadare är reell.

Ytterligare en alternativ hypotes är att flyttvägarna förändrats, så att populationerna som tidigare passerade via Öland nu passerar annorstädes. Denna hypotes är svår att testa, men befintliga studier visar inte på någon stor ökning i andra delar av Europa. Tvärtom är mönstret generellt att arten minskar både på de västligaste häckningsområdena (Keller m. fl. 2020) och på flera övervintringsområden i Afrika (Oudman m. fl. 2020, Simmons m. fl. 2015, van Roomen m. fl. 2018).

De mönster som denna studie visar påkallar ett behov av att undersöka orsakerna till att småsnäppan minskar. Likande mönster ses för andra högarktiska arter, som spovsnäppa och roskarl, men inte lika tydligt för kärrsnäppa som fortfarande fångas i stora antal vid Ottenby.

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