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# Common Kingfishers *Alcedo atthis* along the coast of northern Iberia during the autumn migration period

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Iberia receives many dispersing, migrating and wintering Common Kingfishers *Alcedo atthis*. The majority of these individuals occur in coastal marshes. Between August and mid-October 2007 and 2008, Kingfishers were mist-netted at a tidal marsh in Txingudi, northern Iberia. They were especially abundant from August to September, indicating that Txingudi receives an influx of migrants from northern Europe or local birds dispersing from nearby natal areas. The population mainly consisted of juveniles (only 5.8% adults), the sex ratio was 1:1 and the timing of passage was similar between the sexes. Body mass controlled for body size was constant with time. The stopover duration was affected by sex, date (month of first capture) and a body mass/size ratio, here used as a proxy of fuel load. Females with a lower body mass/size ratio were more likely to remain for longer than those with higher ratios, but the opposite was found in males. Kingfishers captured in August were more likely to be already settled in the area than those first captured in September. Moreover, birds with short stopovers systematically lost mass, while birds that remained in the area for longer did not. These findings are discussed in the light of possible competition between newly arriving and already settled birds.

**Key words:** fuel management, Cormack–Jolly–Seber models, wetlands, Txingudi, migratory behaviour, competition, stopover

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Wetlands in northern Iberia play a significant role as stopover and/or wintering areas for several waterbird species (e.g. Galarza & Domínguez 1989). Relatively little is known, however, about how waterbirds use these areas and how long they remain at a particular site. The Common Kingfisher *Alcedo atthis* breeds across most of the Palaearctic and the Indo-Malayan region in southeast Asia (Cramp 1985). In western Europe, it behaves as a partial migrant. Most of the species' migratory movements involve juveniles (Cramp 1985). From August to February, Iberia receives winter visitors from northern and central western Europe (Martín & Pérez 1990). It is also during this period that local birds move away from their natal areas, again involving mostly juveniles (Morgan & Glue 1977).

The majority of these migratory and dispersing Kingfishers occur along the coast (Morgan & Glue 1977, Martín & Pérez 1990). Given the decreasing population size in Europe (BirdLife 2004), the coastal marshes of Iberia have a role in Common Kingfisher conservation. Our aim was to determine to what extent the coastal marshes of northern Iberia are used by the Common Kingfisher during the autumn migration period. We chose Txingudi as study location since this area is thought to serve mainly as stopover site for Kingfishers; the species is absent from Txingudi as a breeder (Aierbe *et al.* 2001), and the number of birds during the autumn migration period is larger than in winter (Mendiburu *et al.*, unpubl.).

In this paper, (1) we analyse the temporal features of the passage and how these vary between the sexes,

and (2) we use data on within-season recaptures to estimate the staying probability and changes in body mass to explore whether the Kingfishers passing through northern Iberia are dispersing, migrating or wintering birds.

METHODS

Sampling area and protocol

Kingfishers were captured in mist nets at Jaizubia (43°21'N, 01°49'W; 2 m above sea level), a tidal stream in the estuary of the Bidasoa river mouth (Txingudi marshlands, northern Iberia). Txingudi is located in the southeastern Bay of Biscay. It is a convergence area for land-migrants (Galarza & Tellería 2003), and the main passage into Iberia through the western edge of the Pyrenees. Mist nets (204 m) were placed at the same site and opened daily for 4 h starting at dawn, from 1 August to 15 October 2007 and 2008. Each captured bird was ringed and its age and sex determined (age: EURING code; 3 = juvenile birds in their first year of life; 4 = older birds, more than one year old). Wing length ( $\pm$  0.5 mm; method III by Svensson 1996) and body mass (digital balance;  $\pm$  0.1 g) were also recorded.

Data analyses

The analyses were divided into two main sections: (1) seasonal distribution patterns of captures, proportion of recaptures, sex ratios and body size-controlled body mass, and (2) the estimation of staying probability and changes in body mass. Only six adults were caught (Table 1), and therefore only juveniles were considered.

Seasonal patterns

Data were pooled into five-day periods (1 = 1–5 August) to describe the seasonal patterns of captures, proportion of recaptures and body size-controlled body mass. In this analysis, we considered each bird only once per time unit and year.

The overall sex ratio was tested for deviation from parity using a  $\chi^2$ -test. Possible sex-associated variation in timing of passage was studied using U-tests, by comparing the median date of the first capture between sexes. Because detecting differential migration is sensitive to sample size (Arizaga & Barba 2009), we additionally calculated the effect size (i.e. the proportion of variance due to the difference between mean values; calculated as the difference between means divided by the pooled standard deviation).

The residual values of both body mass and wing length fitted a normal distribution (Kolmogorov test:  $P > 0.05$ ), so parametric procedures (ANCOVA on body mass with sex and five-day periods as factors, year as a random factor and wing length as a covariate) were used to test for seasonal variation in body mass controlled for body size (Gosler *et al.* 1998).

Fuel management, stopover duration

Within-season recaptures were used to estimate body mass gain per unit time (g/day). The residual values of body mass change fitted a normal distribution (Kolmogorov test,  $P > 0.05$ ), so parametric procedures were used in this case (Univariate Linear Models, ULM).

To estimate the staying probability we used Cormack–Jolly–Seber (CJS) models (Schaub *et al.* 2001). In comparison with the minimum stopover duration (Kaiser 1999), CJS models assume that migrants at a stopover locality are likely to be there before being first captured, as well as to remain for some time after their last capture (Schaub *et al.* 2001). CJS models estimate ‘survival’ (staying probability  $\Phi$ ; probability that a bird caught at time  $t$  will be at that site at time  $t+1$ ), seniority ( $\gamma$ ; probability that a bird caught at time  $t$  was in the area at time  $t-1$ ) and recapture probability ( $p$ ). Because true survival from one day to the next is virtually 1 (Schaub *et al.* 2001), ‘survival’ is here equivalent to the probability of remaining in the area for one day longer. We considered for the analysis a matrix of 89 rows (individuals)  $\times$  54 columns (sampling days).

**Table 1.** Number of Kingfishers ringed at Jaizubia (Txingudi marshlands, northern Iberia) during the autumn migration periods of 2007 and 2008.

Age Sex	Unknown			Juvenile			Adult		
	Unknown	Male	Female	Unknown	Male	Female	Unknown	Male	Female
2007	0	1	0	1	26	26	0	2	1
2008	0	0	0	1	17	26	0	2	1
Total	0	1	0	2	43	52	0	4	2

October was not included in this analysis since only four birds were then captured (i.e. the sample was too small). Kingfishers were lumped into four groups, according to the sex and date (months: August/September) when birds were first captured. Before selecting models, we explored the fit of the data set to CJS assumptions with a goodness-of-fit (GOF) test, for which U-CARE software (Choquet *et al.* 2001) was used. A global GOF test for the data set was not significant ( $\chi^2_{78} = 15.878$ ,  $P = 0.999$ ), nor were the specific GOFs used to test for the presence of trap-dependence and transients ( $P > 0.05$ ), so our data set did not violate CJS assumptions (Pradel *et al.* 1997). We tested the effect of sex, date and fuel load (here assessed with a mass/size ratio; g/mm of wing length) at first capture event on  $\Phi$  and  $\gamma$ . Because the sample sizes were small (in September:  $n = 10$  for males;  $n = 22$  for females), sexes were grouped to test for date effects and dates were grouped to test for sex effects on  $\Phi$  and  $\gamma$  models. The mass/size ratio was included as a covariate in the models.

Means are given  $\pm$  SE. SPSS 18.0, MARK 4.3 (White & Burnham 1999) and GPower 3.1 software were used.

## RESULTS

### Seasonal patterns of captures, sex ratios and fuel load

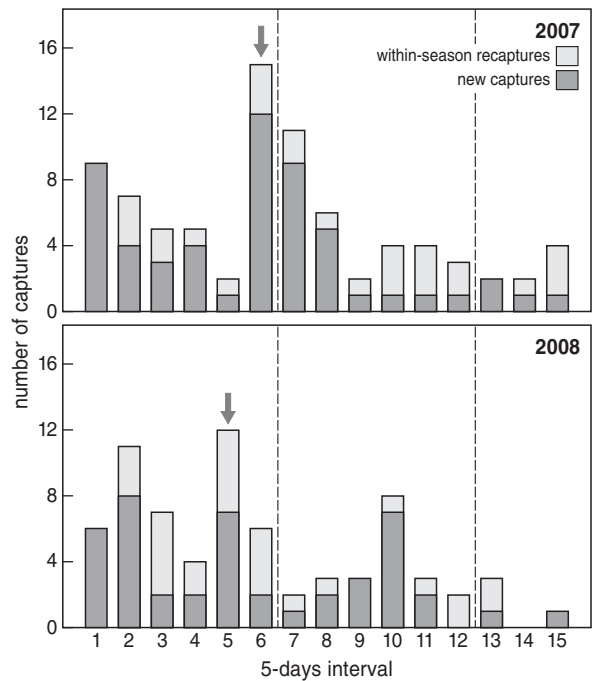
We captured 104 different Kingfishers, of which 93.3% were juveniles (Table 1). Hereafter all analyses will concern only juveniles. We obtained 78 within-season recaptures (2007:  $n = 43$ ; 2008:  $n = 35$ ) involving 27 different individuals. One individual captured in 2007 was recaptured in 2008.

The peak passage occurred during late August (Fig. 1) without significant difference between the two years ( $U = 1146.0$ ,  $P = 0.885$ ; effect size = 0.03).

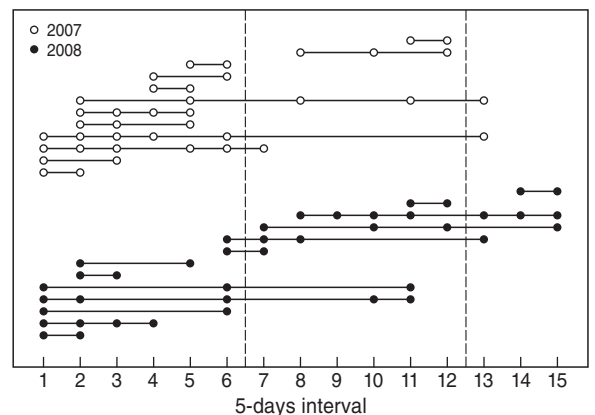
Most (68.0%) within-season recaptures were obtained less than 30 days after the first capture event (Fig. 2), although considerably longer stopovers were also detected. Three out of six recaptures from October were of birds that had been captured in August (Fig. 2).

There was no difference between sexes in timing of passage (2007:  $U = 248.0$ ,  $P = 0.099$ ; 2008:  $U = 195.5$ ,  $P = 0.526$ ; effect size < 0.35; Fig. 3), and the overall sex ratio did not differ from 1:1 ( $\chi^2_1 = 0.853$ ,  $P = 0.356$ ).

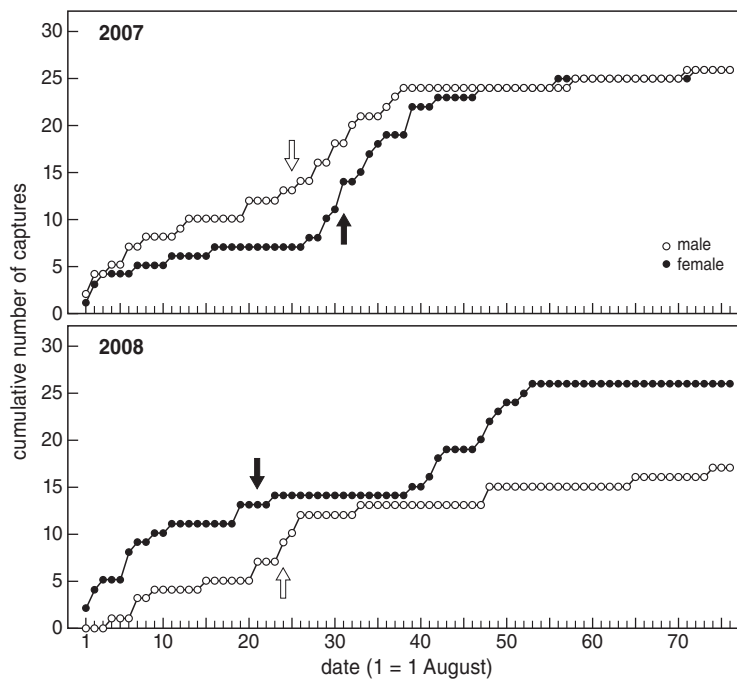
Body mass did not differ by 5-day periods after controlling for body size, sex and year (5-days period:  $F_{14,144} = 1.539$ ,  $P = 0.222$ ; wing length:  $F_{1,144} = 3.697$ ,  $P = 0.058$ ; sex:  $F_{1,144} = 2.786$ ,  $P = 0.325$ ; year:  $F_{1,144} = 1.102$ ,  $P = 0.450$ ; interactions:  $P > 0.05$ ).



**Figure 1.** Number of captures and within-season recaptures of juvenile Kingfishers in the Txingudi marshlands. Days have been lumped into five-day periods (1 = 1–5 August; 15 = 11–15 October; period 26–31 August has six days) Arrows indicate the median values and broken lines separate the months of August, September and October. Each individual was considered once per five-day period.



**Figure 2.** Individual recapture histories of juvenile Kingfishers captured more than once ( $n = 25$ ) in Txingudi during the autumn migration period (1 = 1–5 August; broken lines separate the months of August, September and October). Each individual was considered only once per five-day period, so multiple recaptures within a five-day period were considered once. Thus, of 27 Kingfishers with within-season recaptures, only 25 have been here included (the other two were recaptured within the same five-day period of ringing).

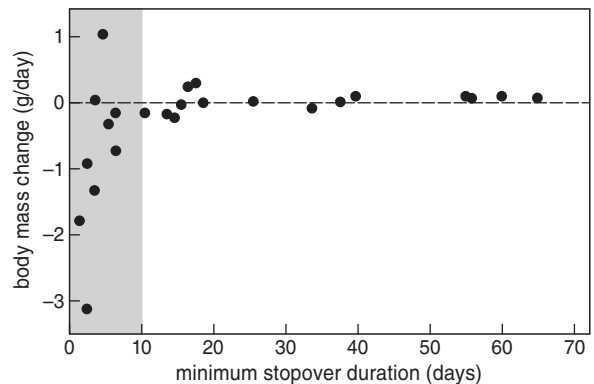


**Figure 3.** Sex-related arrival of juvenile Kingfishers at Txingudi during the autumn migration period (1 = 1 August; 76 = 15 October). Each individual was considered once per year (first capture event; 2007:  $n = 52$ ; 2008:  $n = 43$ ). Arrows show the median values.

#### Body mass change and stopover duration

Mean change in body mass did not differ between sexes and years ( $P > 0.05$ , with wing length as covariate:  $F_{1,25} = 2.764$ ,  $P = 0.111$ ). Body mass for the first and the last capture days was  $34.0 \pm 0.4$  and  $33.4 \pm 0.6$  g, respectively ( $n = 26$ ; recapture weight not available for one bird). Mean change in body mass was negative ( $-0.37 \pm 0.17$  g/day) and significantly different from zero ( $t_{25} = 2.259$ ,  $P = 0.033$ ). Change in body mass was positively correlated with the minimum stopover duration ( $r = 0.439$ ,  $P = 0.025$ ). Most Kingfishers with a minimum stopover duration  $\leq 10$  days ( $n = 10$ ) lost mass, while those with a minimum stopover duration of more than 10 days ( $n = 16$ ) neither gained nor lost mass ( $-0.94 \pm 0.37$  g/day vs.  $-0.02 \pm 0.04$  g/day;  $t_{9,160} = 2.503$ ,  $P = 0.033$ ) (Fig. 4). The body size-controlled body mass at first capture did not differ between birds with a minimum stopover duration of  $\leq 10$  days or  $> 10$  days ( $F_{1,25} = 0.016$ ,  $P = 0.901$ ; wing length:  $F_{1,25} = 7.899$ ,  $P = 0.010$ ).

Before including body mass/size ratio into the models used to estimate the staying probability  $\Phi$  and seniority  $\gamma$ , models that best fitted to data were those with constant  $p$  (recapture probability; Table 2). Thus, we considered  $p$  to be constant in models including the body mass/size ratio. The  $p$  values ranged from  $0.08 \pm 0.01$  for the first  $\Phi$  model in the ranking and  $0.07 \pm 0.01$  for the two first  $\gamma$  models. The models that best fitted the data included a significant effect of (1) body



**Figure 4.** Relationship between the minimum stopover duration and the body mass change per day of juvenile Kingfishers captured in Txingudi during the autumn migration period (data from 2007 and 2008). The shadowed area includes Kingfishers with a minimum stopover duration  $\leq 10$  days.

mass/size ratio and sex on  $\Phi$ , with an interaction between these factors, and (2) body mass/size ratio and date on  $\gamma$  (Table 2; Fig. 5). In  $\gamma$  models, the difference in  $AIC_c$  values between the top two models was  $< 2$ . Females with body mass/size ratios below  $0.45$  g/mm were more likely to remain for longer than those with higher ratios, but the opposite was observed for males (Fig. 5A). Kingfishers captured in August were more likely to be already settled in the area than those first captured in September (Fig. 5B).

**Table 2.** Cormack–Jolly–Seber models used to estimate the stopover duration of juvenile Kingfishers in Txingudi.  $\Phi$ ,  $p$  and  $\gamma$  are the probability of staying in Txingudi, and the recapture and seniority probabilities, respectively; fuel refers to a body mass/size ratio used here as a proxy of fuel reserves, date refers to the month of first capture (August/September);  $AIC_c$ , corrected Akaike’s Information Criterion;  $\Delta AIC_c$ , difference in  $AIC_c$  in relation to the  $AIC_c$  of the first model.

Model	$AIC_c$	$\Delta AIC_c$	$AIC_c$ weight	NP <sup>a</sup>	Deviance
$\Phi(\text{fuel} \times \text{sex}), p$	554.620	0.000	0.892	5	544.218
$\Phi(\text{fuel} \times \text{date}), p$	559.507	4.886	0.078	5	549.104
$\Phi(\text{sex}), p$	563.641	9.021	0.010	3	557.483
$\Phi, p$	565.065	10.445	0.005	2	560.986
$\Phi, p(\text{date})$	563.963	9.342	0.008	3	557.804
$\Phi(\text{fuel} + \text{date}), p$	565.190	10.569	0.005	4	556.923
$\Phi(\text{fuel} + \text{sex}), p$	565.236	10.616	0.004	4	556.970
$\Phi(\text{date}), p$	565.385	10.765	0.004	3	559.226
$\Phi(\text{fuel}), p$	566.414	11.794	0.003	3	560.255
$\Phi, p(\text{sex})$	567.094	12.473	0.002	3	560.935
$\gamma(\text{fuel} + \text{date}), p$	529.311	0.000	0.511	4	521.046
$\gamma(\text{fuel} \times \text{date}), p$	529.434	0.123	0.480	5	519.034
$\gamma(\text{date}), p$	537.470	8.159	0.009	3	531.312
$\gamma, p(\text{date})$	543.085	13.774	0.001	3	536.927
$\gamma(\text{fuel} \times \text{sex}), p$	549.960	20.649	0.000	5	539.560
$\gamma, p$	552.310	22.999	0.000	2	548.232
$\gamma(\text{sex}), p$	552.777	23.466	0.000	3	546.619
$\gamma, p(\text{sex})$	554.250	24.939	0.000	3	548.092
$\gamma(\text{fuel}), p$	554.376	25.064	0.000	3	548.218
$\gamma(\text{fuel} + \text{sex}), p$	554.877	25.565	0.000	4	546.612

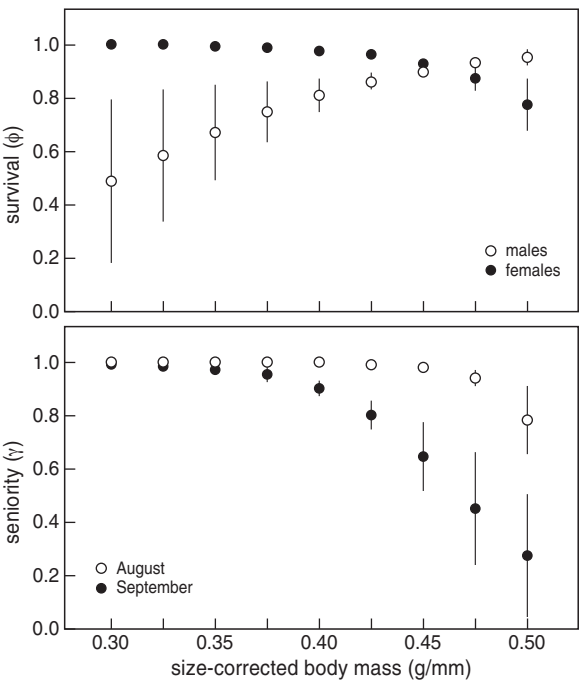
<sup>a</sup>Number of parameters.

DISCUSSION

Timing and sex ratios

The Common Kingfisher is a common bird in Txingudi during the autumn migration period, from August to mid-October. Compared with the relatively low number of birds found during the winter (Mendiburu *et al.*, unpubl.), this indicates that Txingudi is probably an important area for the Common Kingfisher during the autumn migration period, but less important during winter. Txingudi probably receives an influx of migrants from northern and central-western Europe and/or dispersing birds from nearby river basins (Morgan & Glue 1977, Martín & Pérez 1990). Unfortunately, estimating the relative proportions of birds from these two sources in Txingudi was not possible.

The population at Txingudi consisted mainly of juveniles (only 5.8% adults), supporting the hypothesis



**Figure 5.** The probability of remaining at Txingudi (survival  $\pm$ SE) and the probability of being at Txingudi before being first caught (seniority  $\pm$ SE) in relation to a body mass/size ratio here used as a proxy of fuel load, according to the models best fitting the data (see Table 2). Seniority values were calculated after averaging the first two models for  $\gamma$  in Table 2.

that juveniles are involved in most of the species’ migratory and dispersal movements (Martín & Pérez 1990). The sex ratio was 1:1 and the timing of passage was similar between the sexes. Our results thus suggest that both sexes have a similar migratory pattern.

Fuel management and stopover duration

Mean body mass (controlled for body size) stayed constant during the entire study period, so this measurement could not be used to distinguish between individuals of groups with potentially different migratory behaviour. Both local dispersing birds and migrants from northern or central-western Europe arriving in or near their wintering areas would be expected to show a relatively low body mass (Alerstam & Lindström 1990), especially if they move in short steps along their route of migration. This behaviour is considered to be particularly advantageous when adequate stopover localities



are abundant along a given migration route (Delingat *et al.* 2006), which could be a strategy adopted by migrant Kingfishers.

The probability of staying in the area was associated with fuel load (assessed with a mass/size ratio) and sex, whilst the probability of being in the area before being captured was affected by fuel load and date. Our models predict that females with low to medium body fuel loads were more likely to remain in the area than males. The opposite was true for birds with higher fuel load. However, we were not able to include the possible interactions of sex, date and fuel load into our models, mainly due to the low sample size of males in September. Accordingly, the results should be cautiously interpreted. Future analyses with larger data sets and more variables potentially affecting the staying probability are necessary for better understanding the factors determining the temporal use of the marshlands from northern Iberia by Kingfishers.

The causes underlying the difference in staying probability between the sexes are unknown. Variation in the rate of body mass accumulation does not seem to be a major cause, since it did not differ between the sexes. Perhaps one sex is dominant over the other, which might affect the ability of individuals to settle at a given site in a sex-specific manner. Such a hypothesis needs to be tested in future investigations.

The birds first captured in August were more likely to be already settled in the area than those first captured in September. This supports the idea that some Kingfishers, in particular those captured in August, would reach northern Iberia in July. Migrants from northern and central-western Europe arrive in Iberia mainly from August onwards (Martín & Pérez 1990), so Kingfishers occurring in the study area in July were theoretically more likely to be dispersing birds from nearby areas than migrants from regions further north. 50% of Kingfishers recaptured in October had been ringed in August, suggesting that some birds captured in August overwintered in or near the area. In contrast, birds arriving later (in September) seemed to stopover for shorter periods. Although this estimate may have been biased by our truncated sampling period (ending in mid-October), it is known that only small numbers of Kingfishers overwinter in Jaizubia (Mendiburu *et al.*, unpubl.). Thus, most Kingfishers captured in October would be expected to leave the study area before November. Presumably, the space was already fully occupied by the time latecomers arrived, making them more likely to depart the area. It is possible that early and late arriving birds differ in migratory behaviour, the former being mainly local birds that tended to

remain in the area for a long period and the latter migrants from further north still moving toward their wintering areas.

Kingfishers present in the study area for shorter periods lost mass, while birds that remained in the area for longer did not. One explanation for the drop in body mass is that birds lost mass due to catching and handling. However, this is unlikely since no mass loss was observed in the birds that stayed for a longer period. We suggest therefore that the observation is due to strong competition for territories, in which newly arriving birds were expelled by the already settled territory owners. Those unable to defend a territory would fail to keep a balanced energy budget and would depart from the area.

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## SAMENVATTING

In augustus arriveren relatief grote aantallen IJsvogels *Alcedo atthis* in de moerassen aan de noordkust van Spanje. Of het hier gaat om broedvogels uit nabijgelegen gebieden of om trekvogels uit noordelijker streken is onduidelijk. In de winter verblijven er in ieder geval maar weinig IJsvogels in deze moerassen. Om meer te weten te komen over deze doortrek werden in de nazomer en vroege herfst van 2007 en 2008 IJsvogels gevangen en geringd in Txingudi. De doortrekkende IJsvogels bleken vrijwel allemaal eerstejaars vogels te zijn. De timing van de doortrek verschilde niet tussen mannen en vrouwen. De tijd die werd doorgebracht in het gebied, varieerde nogal tussen individuen. Aan de hand van terugvangsten kon worden vastgesteld dat vogels die langere tijd in Txingudi bleven hun lichaamsgewicht constant hielden, terwijl de vogels die maar kort bleven in die tijd in gewicht achteruitgingen. Bij de mannetjes waren het vooral de zwaardere vogels die in het gebied bleven. Bij de vrouwtjes was dit juist andersom. Verder bleken laatkomers korter te blijven. De resultaten van dit onderzoek duiden erop dat de beschikbare habitat wordt bezet door de eerste vogels die arriveren, terwijl laatkomers elders een goed heenkomen moeten zoeken. (KK)

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