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Brief report

Habitat selection by the Common Sandpiper (*Actitis hypoleucos*) in west-central Spain.

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1. Introduction

Riparian birds can be useful as indicators of water quality (Eriksson 1987, Buckton & Ormerod 1997), because they are generally easier to identify and count than other organisms such as diatoms or invertebrates. With this aim, the Dipper (*Cinclus cinclus*), the Grey Wagtail (*Motacilla cinerea*) and the Kingfisher (*Alcedo atthis*) have been studied in several European countries (Ormerod & Tyler 1993, Peris & Rodriguez 1997). However, a potential bioindicator could be the Common Sandpiper (*Actitis hypoleucos*), a cosmopolitan wader species which occurs in a wide range of water bodies (Del Hoyo *et al.* 1996). In Spain, the species inhabits a large variety of habitats (Martínez 1997), being more abundant in the northern half of the country (Velasco & Alberto 1993). Knowledge of the movements of the native Spanish population is scarce but it seems to be sedentary. According to ringing recoveries, migrants from central Europe and Scandinavian countries are present from July to April (Arcas 1999), with peaks from July to October (Díaz *et al.* 1996).

Some authors (Marchant & Hyde 1980a,b, Holland *et al.* 1982a, b, Yalden 1986a, Roché & d'Andurain 1995) have studied the relationship between some freshwater environmental factors and abundance of the wader, although authors do not agree among themselves with respect to the density of common sandpipers and stream pH (Vickery 1991, Buckton & Ormerod 1997). In this paper, we analyze the habitat selection of the Common Sandpiper through the year in Spanish freshwaters and assess the possible role of the bird as an indicator of water quality.

2. Material and methods

2.1. Study Area

Five natural state rivers were sampled in the Province of Salamanca (west-central Spain), where 27 sampling points were chosen at random (Fig. 1) in order to have a good representation of all the principal types of watercourses in central Spain. Most of the rivers (Agueda-AB, Huebra-HB, Guareña-GB and Camaces-MB) are tributaries of the Duero, whereas the Alagón and its tributaries (Francia and Cuerpo de Hombre-LB) belong to the Tajo basin. All these watercourses exhibit a considerable annual oscillation in their water volume, due to seasonal variation in rainfall (Velasco *et al.* 1997). Rainfall occurs mainly during November to January, with minimal rainfall in August. Normally, the rivers do not freeze in winter,

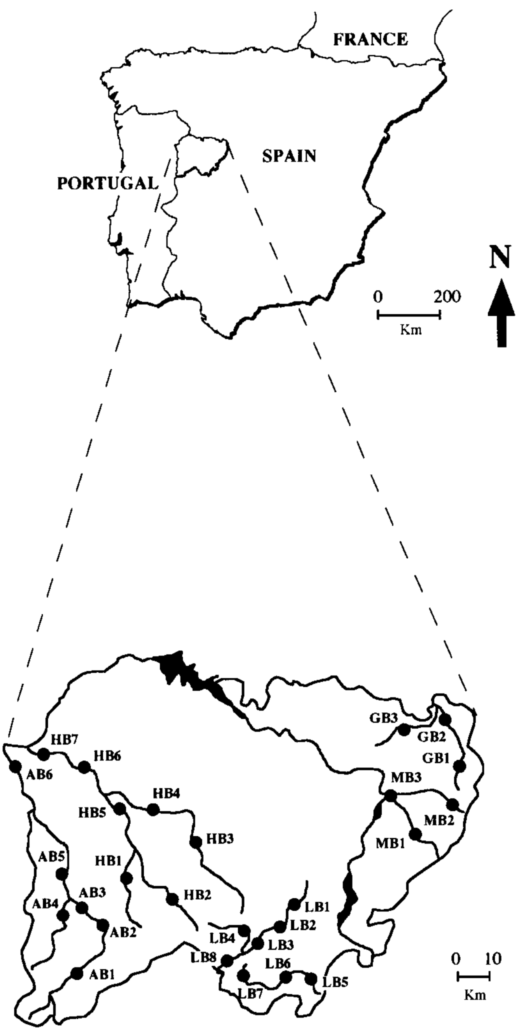

Figure 1. Map of the study area indicating location of the sampling points. AB = Agueda basin, HB = Huebra basin, GB = Guareña basin, MZ = Mazores basin, LB = Alagón basin.

but every summer some of them, such as the Guareña, Camaces and Huebra rivers are reduced to small ponds, because of the extremely hot and dry Mediterranean summer.

2.2. Census

In order to register the relative density of Common Sandpipers along sections from each sampling point, transect surveys were conducted along the rivers, counting the average number of birds detected in each kilometre; similar to the B.T.O. Waterways Bird Survey (Marchant & Hyde 1979). In the breeding season, censuses were taken one hour after sunrise and during the first half of each month. Birds were counted as individuals but not as territories because of irregular oscillations of water volume in the rivers, although the latter approach is possible in other latitudes with more homogeneous watercourses (Yalden & Holland 1993). Line transects were conducted by four observers, two on each transect, and covering ca. 2.5 km upstream and ca. 2.5 km downstream from each point, to give an Abundance Kilometer Index (AKI) or average number of birds per kilometre (Table 1). Return trips were not made, in order to avoid double-counting, and care was taken with birds flying back for this reason. About 88.9 km was surveyed from October (1987) to September (1989), with 9 surveys each season in the two study years.

2.3. Habitat data

The average altitude (m a.s.l.) and slope (m/km) were obtained using the 1:50 000 maps of the Spanish National Geographical Institute. The average quality of the habitat (HAB) was determined using five habitat classes depending on water (Keller *et al.* 1989). Thus, class 1 includes very poor sites, whereas class 5 includes the potential best sites for riparian birds. A Vegetation Coverage Index (CVI) was established, defining six classes of riparian vegetation; thus class 0 includes sites with no riparian vegetation, whereas class 5 has 100% coverage. Human population density (HPD) was obtained from the electorate roll of 1988. Agricultural land use intensity (LAU) was established as a relative estimate based on the amount of pesticides and fertilizers used in the study area according to statistics from the Spanish Ministry of Agriculture. These values are a good indication of waste discharged to local freshwaters. The domestic animal density was taken from censuses of the Spanish Ministry of Agriculture, based on total animal biomass (TAB) (MAPA 1984); a heavier animal, e.g. a cow, has a value of 1, whereas a sheep has a value of 0.5.

Measurements of river parameters (Table 1) (altitude, slope, width and depth of the river in m,

Table 1. Values of the variables considered in the study. Transect survey (TS), Abundance Kilometer Index in the breeding season (AKI b) and in the non-breeding period (AKI nb), Altitude (ALT), Slope (GRD), Habitat quality (HAB), Depth (D), Riverside width (RW), Vegetation Coverage Index (VCI), Width (W), pH, Nitrogen (N), Phosphates (P), Turbidity (T), Human Population Density (HPD), Land Agricultural Use (LAU), Total Animal Biomass (TAB) and Carbonates (CARB). For initials see material and methods.

TS	AKI b (birds/km)	AKI nb (birds/km)	ALT (m.a.s.l.)	GRD (m/km)	HAB	D (m)	RW (m)	VCI	W (m)	pH	N (mg/l)	P (mg/l)	T (mg SiO2/l)	HPD (People/km2)	LAU	TAB	CARB (mg/l)
MB1	0.25	0.26	860	2.5	2	0.56	68	3	4.08	7.8	1.93	636.5	25.25	18.71	0.933	605	0.57
MB2	0.5	0.4	880	2.85	2	0.66	87.5	1	6.6	7.7	0.7	307.57	30.42	18.71	0.933	578	0.48
MB3	0	0.08	800	2.66	3	1	6.75	4	13	7.9	1.85	612.71	20	18.71	0.933	515	0.46
GB1	0	0	800	–	2	–	–	0	1.75	–	–	–	–	25.83	1.142	327	–
GB2	0	0	760	2.5	3	0.5	1.75	1	3	7.9	0.4	117	12.5	25.83	1.142	435	0.63
GB3	0	0	790	–	1	0.2	31.5	0	2.5	7.8	0.24	94.66	8.66	25.83	1.142	466	2.04
LB1	0	0.14	880	8	2	0.55	10.33	2	8.7	9.02	0.37	17.75	7.5	30.19	0.473	5375	3.87
LB2	0	0	640	40	2	5.5	8	3	8	7.6	0.26	16.75	6.25	30.19	0.473	3137	0.04
LB3	0	0	840	6.66	3	0.93	6.66	4	10.6	7.5	0.16	26	4.25	30.19	0.473	1804	0.07
LB4	0	0	600	20	4	0.57	3.33	4	6.87	6.8	0.21	42.8	5.25	30.19	0.473	554	0
LB5	0	0	1000	20	2	0.75	1.75	4	7.16	7	0.25	16.75	4.75	30.19	0.473	411	0
LB6	0	0	750	20	2	1.11	7.5	4	10.75	7.1	1.25	337.7	36.6	30.19	0.473	1876	0.01
LB7	0	0.42	400	0.55	3	1.7	12.5	2	18.5	7.4	0.54	235.75	10	30.19	0.473	6582	0.02
LB8	0	0.83	400	0.52	2	–	29.16	2	37.5	7.2	0.4	168.5	11	30.19	0.473	844	0.02
HB1	0	0.13	750	2.85	3	0.32	10	1	8.37	7.5	0.49	25	9.5	10.43	0.359	1305	–
HB2	0.28	0.14	850	6.66	3	0.63	41.9	1	9.25	7.4	0.51	101.71	10.85	10.43	0.359	445	–
HB3	0	0.21	780	2.22	3	0.55	83.3	1	7	8	1.11	73.3	8	10.43	0.359	1440	–
HB4	0	0.52	710	1.14	3	0.55	46	2	10.35	8	0.55	150.71	11	10.43	0.359	730	–
HB5	0	0.5	670	2.35	2	1.07	26.25	3	11.7	7.6	0.62	52	9	10.43	0.359	1669	–
HB6	0	0.54	600	3.33	2	0.93	23.41	2	16.12	7.8	0.59	80	13.4	10.43	0.359	1650	–
HB7	0	0	380	4	3	1.83	11.25	2	15	7.9	0.5	73.75	16	10.43	0.359	1013	–
AB1	0	0.1	760	4	3	1.31	10.62	4	13.16	6.97	1.41	12.25	5.5	14.06	0.399	2915	0
AB2	0.33	0	640	1.66	5	1.9	44.25	4	36	6.95	0.42	26.5	6.75	14.06	0.399	1920	0
AB3	0	0.88	620	1.81	3	–	100	3	60	7.18	0.3	100.28	8.25	14.06	0.399	10962	0.01
AB4	0.5	0.64	600	1.81	3	0.97	18.12	1	62	7.97	0.44	83.25	36.75	14.06	0.399	2506	0.53
AB5	0.75	0.64	580	2.85	3	2.03	31.25	1	44.71	7.41	1.05	50.28	7.62	14.06	0.399	469	0.01
AB6	1.2	0	140	0.64	4	–	7.66	3	63.33	7.32	1.6	38	14	14.06	0.399	772	0.01

habitat quality, vegetation coverage index) and water parameters (turbidity, pH), were measured directly at survey points or analysed in the Department of Analytical Chemistry of Salamanca University (total nitrogen, phosphates and carbonates). Samples were collected in breeding and non-breeding seasons coinciding with the bird counts, and the annual average is depicted as a mean in Table 1.

2.4. Statistics

Each river parameter was correlated with the Abundance Kilometer Index (AKI) of the wader through the Spearman Rank Correlation Coefficient. A two-tailed Mann-Whitney U-test (adjusted for high samples), was carried out in order to compare the medians of each parameter in sample points with and without birds. The statistically significant p-values observed were modified to z-values (JMP-Mac program 1994) and adjusted according to a modified Bonferroni procedure following Rice (1989) and Wright (1992). The breeding season and non-breeding period were tested separately.

3. Results

3.1. Habitat selection during the breeding season

Although a significant correlation ($r = -0.421$, $P < 0.05$, $n = 27$), was found between the presence of birds in the breeding season (May–June) and altitude, there was no significant difference between the median altitude of sample points with birds and places where the wader was absent (Table 2).

Another significant correlation ($r = 0.625$, $P < 0.01$, $n = 27$) between bird abundance and river width was found in this season, but as with altitude, the median river width of sample points with birds does not differ from the median width measured at points without birds (Table 2).

Finally, the bird abundance in the breeding season was independent of other parameters such as the slope ($r = -0.246$, $P > 0.05$, $n = 25$); habitat quality ($r = 0.358$, $P > 0.05$, $n = 27$); depth ($r = 0.062$, $P > 0.05$, $n = 23$); riverside width ($r = 0.105$, $P > 0.05$, $n = 26$); vegetation coverage index ($r = -0.104$, $P > 0.05$, $n = 27$); chemical parameters such as pH ($r = -0.096$, $P > 0.05$,

Table 2. Mean of each considered variable (with number of measurements and standard deviations) in sample points occupied and not occupied by the Common Sandpiper in the breeding season, and results of the two-tailed Mann-Whitney U-test applied to compare the medians of each variable between both mentioned places. No statistically significant differences are observed.

	Sample Points, occupied			Sample Points, not occupied			
	n	$\bar{x}$	SD	n	$\bar{x}$	SD	U-test
Altitude	7	650	259.67	20	696.5	162.52	Z = 0.11 P > 0.05
Slope	7	2.71	1.909	18	7.921	10.457	Z = 1.11 P > 0.05
Habitat quality	7	3.142	1.069	20	2.55	0.686	Z = 1.18 P > 0.05
Depth	6	1.125	0.666	17	1.139	1.21	Z = 0.77 P > 0.05
Width	7	32.281	25.822	20	13.501	13.332	Z = 1.06 P > 0.05
Vegetation Coverage Index	7	2	1.29	20	2.4	1.353	Z = 0.77 P > 0.05
Riverside width	7	42.668	27.728	19	22.634	27.11	Z = 1.93 P > 0.05
pH	7	7.507	0.342	19	7.587	0.512	Z = 0.40 P > 0.05
Nitrogen	7	0.95	0.604	19	0.605	0.463	Z = 1.70 P > 0.05
Phosphates	7	177.687	223.857	19	118.613	146.364	Z = 0.72 P > 0.05
Turbidity	7	18.805	11.939	19	10.916	7.383	Z = 1.58 P > 0.05
Human Population Density	7	14.87	2.939	20	21.421	8.926	Z = 1.21 P > 0.05
Land Agricultural Use	7	0.545	0.264	20	0.554	0.281	Z = 0.33 P > 0.05
Total Animal Biomass	7	1042.142	824.427	20	2200.5	2650.293	Z = 0.77 P > 0.05
Carbonates	6	0.266	0.286	13	0.551	1.147	Z = 0.04 P > 0.05

n = 26); total nitrogen (r = 0.361, P > 0.05, n = 26); phosphates (r = –0.03, P > 0.05, n = 26); turbidity (r = 0.261, P > 0.05, n = 26); carbonates (r = –0.166, P > 0.05, n = 19); land agricultural use (r = –0.09, P > 0.05, n = 27) and domestic animal density (r = –0.196, P > 0.05, n = 27). We have also compared the median of each of these parameters between the places with and without birds, and no statistically significant differences were found (Table 2).

3.2. Habitat selection during the non-breeding period

A significant correlation (r = –0.436, P < 0.05, n = 25) between the Common Sandpiper abundance and the slope was found in this season (July–April). But the median slope of the sample points with birds was not different from the median obtained in the points without them (Table 3).

Sandpiper abundance was found to be correlated with the riverside width (r = 0.492, P < 0.01, n = 27). But again this result is not statistically supported by the differences in the mean riverside width between the sample points with and without birds (Table 3).

Another factor that seems to be significantly correlated with the bird abundance is the river width (r = 0.526, P < 0.01, n = 27). But in spite of the mean river width of those sample points with birds being higher than in places without birds, this difference was not enough to obtain significant differences between their medians (Table 3).

We have found a significant correlation between the AKI results and the domestic animal density (r = 0.398, P < 0.05, n = 27). Nevertheless, the median of this parameter in places where the species is observed, was not different from places without it (Table 3).

The Common Sandpiper abundance was not found to be correlated with human population density (r = –0.294, P > 0.05, n = 27) and neither did we find a difference between the mean density of sample points with and without birds (Table 3).

Finally, the Sandpiper abundance was not associated with such parameters as the habitat quality (r = –0.126, P > 0.05, n = 27), depth (r = –0.083, P > 0.05, n = 23), vegetation coverage index

Table 3. Mean of each considered variable (with number of measurements and standard deviations) in sample points occupied and not occupied by the Common Sandpiper, in the non-breeding period, and results of the two-tailed Mann-Whitney U-test applied to compare the medians of each variable between both mentioned places with sequential Bonferroni procedure adjusted to Z values. ri is the sequentilly adjusted Z-value using Bonferroni's procedure. No statistically significant differences are observed.

	Sample Points, occupied			Sample Points, not occupied				
	n	x̄	SD	n	x̄	SD	U-test	ri
Altitude	16	696.25	154.267	11	667.272	235.63	Z = 0.17	< 1.95
Slope	16	2.881	1.986	9	12.828	13.174	Z = 1.83	< 2.86
Habitat quality	16	2.625	0.500	11	2.818	1.167	Z = 0.24	< 2.24
Depth	14	0.916	0.486	9	1.476	1.614	Z = 0.53	< 2.39
Width	16	20.69	19.198	11	14.996	18.618	Z = 1.38	< 2.73
Vegetation Coverage Index	16	2.062	1.062	11	2.636	1.629	Z = 1.15	< 2.57
Riverside width	16	37.818	30.682	10	12.365	14.096	Z = 2.74	< 2.93
pH	16	7.678	0.477	10	7.387	0.411	Z = 1.47	< 2.77
Nitrogen	16	0.803	0.518	10	0.529	0.49	Z = 2.23	< 2.91
Phosphates	16	169.222	194.777	10	78.991	97.153	Z = 1.47	< 2.80
Turbidity	16	14.002	9.178	10	11.501	9.734	Z = 1.21	< 2.63
Human Population Density	16	16.595	7.401	11	24.271	7.632	Z = 2.09	< 2.89
Land Agricultural Use	16	0.498	0.219	11	0.631	0.33	Z = 1.80	< 2.82
Total Animal Biomass	16	2411.875	2898.218	11	1155.909	906.359	Z = 1.08	< 2.49
Carbonates	10	0.597	1.176	10	0.339	0.647	Z = 1.24	< 2.69

(r = –0.211, P > 0.05, n = 27), pH (r = 0.047, P > 0.05, n = 26), total nitrogen (r = –0.083, P > 0.05, n = 26), phosphates (r = 0.058, P > 0.05, n = 26), turbidity (r = 0.135, P > 0.05, n = 26), land agricultural use (r = –0.284, P > 0.05, n = 27) and carbonates (r = –0.136, P > 0.05, n = 19). Also no significant differences (Table 3) were found between places with and without birds in the median of all these parameters.

4. Discussion

As far as we know, no authors (Marchant & Hyde 1980a,b, Holland *et al.* 1982a, b, Cramp & Simmons 1983) have found any relationship between the abundance of the Common Sandpiper and the altitude. In Eastern Spain, the species breeds up to 1500 m a.s.l. and is common between 1000–1500 m a.s.l., whereas in Northern Spain it prefers lower altitudes in the slopes of mountains (Martínez 1997). The negative correlation observed here in the breeding season shows only that altitude has a negative correlation with the river margin width (r = –0. 634, P < 0.01, n = 27) and wider margins sustain more breeding and non-breeding birds, as also occurs on British rivers (Yalden 1986). As the river width is not correlated with any other important parameter for the species distribution, it is possible that wider rivers provide a larger variety of habitat, food resources and specially more gravel shores as nest sites (Roché & d'Andurain 1995). Also, a wider river may be more resistant to an unpredictable flood in the breeding season.

According to Holland *et al.* (1982a, b), the species breeds in a wide range of gradients, although in Britain and Ireland (Marchant & Hyde 1980) it shows a tendency to select places with lower slopes. In our study, we did not find any significant correlation between slope and bird abundance during the breeding season, although it does appear at one point with a slope higher than 2.85 m/km (Table 1), showing a tendency to breed on fast-moving water as in France (Roché & d'Andurain 1995). In the non-breeding period, the species is more associated with places having lower slopes but the data are not statistically significant.

Some authors (Buckton & Ormerod 1997) reported that the bird prefers open areas, avoiding wooded ones. Nevertheless, according to our results, the abundance of the species is independent of the vegetation coverage index throughout the year.

The Common Sandpiper often feeds by picking invertebrates from mammal faeces (Yalden 1986b). A predilection for this kind of food in the non-breeding period could help to explain the preference observed for points with higher numbers of domestic animals in extensive grazing habitats, which is a common practice in western Spain, althought we not have enough data to support availability of dung with bird abundance. Although not statistically significant, in this period the bird was more observed in places with higher total nitrogen and this could be related to mammal excreta.

In the neighbourhoods of points where the species was detected in the non-breeding period, the median human population density was lower than the points without birds. However, as with the above-mentioned observations, our data were not significant.

A broad riverside width, with low human population density and high levels of nitrogen dissolved in water could be possible parameters correlated with the abundance of the bird in the non-breeding season, but in order to yield the statistical of the sequential Bonferroni procedure more data must be available. Anyway, as no clear correlations were found between Sandpiper abundance throughout the year and the non-biotic water parameters measured, this species appears to be unsuitable as an indicator of the water quality of the Spanish Mediterranean watercourses.

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Selostus: **Rantasipin elinympäristönvalinta Keski-Espanjassa: onko rantasipistä vesielinympäristöjen indikaattorilajiksi?**

Rantavyöhykkeessä pesivät linnut voivat toimia vesielinympäristön laadun indikaattoreina. Rantasipi voisi olla yksi näistä indikaattorilajeista. Kirjoittaja havainnoi rantasipin pesimäaikaista ja pesimäajan ulkopuolista esiintymistä viidellä luonnontilaisella jokivarrella Keski-Espanjassa. Espanjassa pesivät rantasipit ovat paikkalintuja. Lisäksi Espanjaan saapuu rantasipejä Keski-Euroopasta ja Skandinaviasta heinäkuun ja huhtikuun välisenä aikana. Kirjoittaja kartoitti sipien esiintymistä jokivarsilla ja vertasi rantasipien esiintymispisteitä paikkoihin, joissa rantasipejä ei havaittu (= satunnaispisteet). Tutkimuspisteistä mitattiin veden laatua kuvaavia muuttujia (esim. typpipitoisuus, pH), joen rakennetta kuvaavia muuttujia (esim. joen leveys ja syvyys) ja joen ympäristöä kuvaavia muuttujia (esim. rantaalueilla asuvien ihmisten määrä ja rantakasvillisuuden määrä). Rantasipin esiintymispisteiden ja satunnaispisteiden välillä ei havaittu merkitseviä eroja yhdessäkään taustamuuttujassa pesimäaikana. Tosin rantasipin esiintyminen korreloi positiivisesti joen leveyden kanssa. Rantasipin esiintymispisteiden ja satunnaispisteiden välillä ei havaittu merkitseviä eroja yhdessäkään taustamuuttujassa myöskään pesimäajan ulkopuolella. Korrelaatio-analyysissä havaittiin, että rantasipien esiintyminen korreloi positiivisesti joen leveyden, rantakasvillisuusvyöhykkeen leveyden, jokirannan kaltevuuden ja karjaeläinten määrän kanssa pesimäajan ulkopuolella. Yleensä paikoissa, missä rantavyöhyke oli leveämpi, oli enemmän sekä pesiviä että pesimättömiä rantasipejä. Leveämpi rantavyöhyke voi tarjota enemmän ravintoa tai sopivia pesimäpaikkoja rantasipille. Myös tulvan mahdolliset negatiiviset vaikutukset voivat leveämmällä joella jäädä pienemmiksi kuin kapealla joella. Artikkelissa esitettyjen tulosten mukaan rantasipi ei Espanjassa ole kovin hyvä indikaattorilaji vesiympäristön tilan mittariksi.

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