Recapture rates of five passerine species wintering at a reedbed in central Spain

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We have analysed mist-net capture-recapture data of five passerine species in a reedbed in central Spain during the winters of 1982-83 to 1985-86 and 1988-89. Within- and between-winter recapture rates varied significantly among species. The Robin *Erithacus rubecula* presented high site-fidelity during the winter, showing a high within-winter recovery rate; this value was intermediate in the Water Pipit *Anthus spinoletta*, Dunnock *Prunella modularis* and Penduline Tit *Remiz pendulinus*, and low in the Reed Bunting *Emberiza schoeniclus*. Only in the Reed Bunting within-winter recapture rates varied among years, probably in association with variations in the safety of the site for this species. Reed Bunting within-winter recovery rates were not significantly influenced by sex or age, though birds recaptured within the same winter of ringing had shorter wings than birds not subsequently recaptured, which might indicate a trend for young females to exhibit higher fidelity to the roost during the winter. Between-winter recapture rates were low for all species, but were positively correlated with each species' wing length and body size, and were thus particularly low for the Dunnock and Penduline Tit. Most between-winter recapture data concerned the largest species (according to body index), the Reed Bunting. Recapture data for this species indicated a tendency to change roosting sites in different winters. Body mass and body condition were higher in males that were subsequently recaptured in successive winters after ringing than in males that were not recaptured.

Key words: Migrants, overwintering, recaptures, recovery rate, site-fidelity, central Spain.

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The importance of the Iberian Peninsula as a wintering ground for some passerines is well documented (Tellería 1988, Bueno 1998, Villarán 1999a, 2003, Villarán & Pascual-Parra 2003). At this time of the year, marshlands and reedbeds acquire special relevance as roosting sites because of their microclimatological conditions, which minimize weight loss during the night (Warrillow *et al.* 1978), and some species can exhibit high stop-over and winter site-fidelity (Cantos & Tellería 1994). Within- and between-winter site-fidelity involve several advantages and have been well documented in many habitats (Benvenuti & Ioalé 1980, 1981, Debussche & Isenmann 1984, Cuadrado 1992, 1993, 1994, Cuadrado *et al.* 1995) and taxonomic groups, such as waders (Burton & Evans 1997, Robertson & Cooke 1999, Burton 2000), geese (Wilson *et al.* 1991), raptors (Garrison & Bloom 1993), cormorants (Lekuona 2000, Frederiksen *et al.* 2002), and non-wetland passerines (Yunick 1983, Rimmer & McFarland 2001, Hoover 2003), but has not yet been studied in wetland passerines. The aim of this study was to investigate within-winter and between-winter recurrence and site-fidelity for some species of passerines in a reedbed in central Spain, in order to discover if the recapture rates, within and between years, vary among species, in relation to species size, habitat and migration pattern.

Material and methods

Recapture rates were analysed for the Water Pipit *Anthus spinoletta*, Dunnock *Prunella modularis*, Robin *Erithacus rubecula*, Penduline Tit *Remiz pendulinus* and Reed Bunting *Emberiza schoeniclus schoeniclus*, all trapped in the Carrizal de Villamejor, area of reedbeds with peripheral sites in the middle Tagus Valley, central Spain (39° 56' N, 3° 47' W). Trapping and ringing were carried out during five winters (1982-83, 1983-84, 1984-85, 1985-86 and 1988-89), from early October until late March. Ten black mist-nets (12 x 2.5 m, with 16 mm mesh) were always set up in the same situations. Birds were trapped during the four hours prior to nightfall. The sampling effort varied among winters (see Appendix 1). Altogether, 6590 birds were caught, belonging to 67 species. All the studied species use the area to overwinter (Villarán 2000), and all are present from October to March.

Recapture rate was computed as the number of birds recaptured divided by the number of birds ringed. When multiple recoveries of the same individual were obtained, only a single recapture was considered per individual per season. Recaptures during the same winter of ringing and those in subsequent winters are analysed separately. Recapture rates among species were compared both within and between winters. We used the G-test to compare recapture rates between species and between winters (Fowler & Cohen 1999). We used Spearman rank correlation to analyse the possible relationship between species size and recapture rate. We used mean body mass and mean wing length as indicators of body size for each species (without sex- or age-class distinction, since we did not distinguish recapture rate by sex or age-classes for each species). Wing length was measured according to maximum chord method (Svensson 1996) to the nearest 0.5 mm. Body mass was measured to the nearest 0.5 g using Pesola spring balances. We used mean wing length divided by cube root of mean weight to obtain a body size index (relation surface-volume) for each species.

A larger sample size allowed an independent analysis of the recapture rates for the Reed Bunting. We considered wing length, body mass and body condition of each individual in order to determine possible biometrical differences among recaptured and non-recaptured birds. Body condition was estimated using the residuals of a regression of body mass on wing length. We used a one-way ANOVA to compare means of wing length, body mass and body condition among recaptured and non-recaptured birds. In order to compare recovery rate among sex and age-classes, we used chi-square tests with Yate's correction.

Results

Significant differences were found among species in within-winter recovery rates ($G_4 = 52.08$; $p < 0.01$) and between-winter recovery rates ($G_3 = 7.51$; $p < 0.05$) (Table 1). Within the same winter the recovery rate was highest for Robins, intermediate for Water Pipits, Dunnocks and Penduline Tits, and lowest for Reed Buntings. The Reed Bunting showed significant differences in within-winter recovery rates among different

Table 1. Number of ringed and recaptured birds in the same winter and in the winter subsequent to ringing. In "subsequent winters", we indicate the number of ringed birds which were available for recapture in the winter following their ringing, taking into account that in winters 1986-87 and 1987-88 the area was not visited.
Nombre d'ocells anellats i recuperats en el mateix hivern o en hiverns posteriors a l'anellament. A "subsequent winters" s'indica el nombre d'ocells anellats que eren susceptibles de ser recapturats en el següent hivern després del seu anellament, tenint en compte que no es va poder anellar a la zona durant els hiverns 1986-87 i 1987-88.

	Within the same winter		Subsequent winter	
	Ringed	Recaptured	Ringed	Recaptured
Anthus spinoletta	62	7 (11.3%)	34	3 (8.8%)
Erithacus rubecula	73	17 (23.3%)	28	1 (3.6%)
Prunella modularis	58	5 (8.6%)	22	0 (0.0%)
Remiz pendulinus	335	26 (7.8%)	100	1 (1.0%)
Emberiza schoeniclus	2408	72 (3.0%)	917	47 (5.1%)

Table 2. Number of ringed (RI) and recaptured (RE) birds in different winters. Only recaptures within the same winter of ringing are considered.
Nombre d'ocells anellats (RI) i recapturats (RE) en diferents hiverns. Només es consideren les recaptures efectuades dintre del mateix hivern d'anellament.

	1982-83		1983-84		1984-85		1985-86		1988-89		1992-93	
Ringing days	6		16		19		20		9		1	
	RI	RE	RI	RE	RI	RE	RI	RE	RI	RE	RI	RE
Anthus spinoletta	0	0	9	1	25	3	14	2	14	1	0	0
Erithacus rubecula	2	0	14	2	12	4	28	8	14	3	3	0
Prunella modularis	2	0	14	3	6	0	35	2	1	0	0	0
Remiz pendulinus	22	0	68	5	10	2	118	11	117	8	0	0
Emberiza schoeniclus	116	0	329	11	472	17	954	40	525	4	12	0

winters, with a very low value in 1988-89 (0.76%) ($G_3 = 16.62$; $p < 0.01$), while the other species presented similar within-winter recapture rates in all winters considered ($G_3 = 0.32$, $p > 0.05$ for Water Pipit; $G_3 = 1.03$, $p > 0.05$ for Robin; $G_3 = 3.18$, $p > 0.05$ for Dunnock; and $G_3 = 1.55$, $p > 0.05$ for Penduline Tit, Table 2). Though within-winter recovery rates were slightly higher for female and juvenile Reed Buntings than for males and adults, no significant sex or age differences appeared (Table 3). However, wing length was significantly shorter in Reed Buntings recaptured within the same winter of ringing ($\bar{X} = 74.7 \pm 2.8$ mm) than for individuals that were not recaptured ($\bar{X} = 76.0 \pm 3.4$ mm) ($F_{1,1094} = 5.125$; $p = 0.024$). Body condition and body mass were slightly higher in non-recaptured Reed Buntings than in those that were recaptured, but the differences were not significant. Within-winter recapture rates in Reed Buntings followed a significant seasonal pattern ($\chi^2_1 = 16.65$; $p = 0.005$), with maximum recapture rates from November to January, the central wintering period (Table 4).

Rates of recapture in subsequent winters (Table 1) were very small in most species, especially for Dunnocks and Penduline Tits. Between-winter recapture rate was positively correlated with mean wing length ($r_s = 0.90$; $p = 0.037$; $n = 5$) and with body size index ($r_s = 1.00$; $p < 0.0001$; $n = 5$) of each species (Table 5). In the Reed Bunting, higher weight and superior body condition were found in males recaptured in the winter subsequent to their ringing (Table 6).

Table 3. Number of Reed Buntings recaptured and not recaptured within the same winter of ringing, by sex and age-class.
Nombre de Repicatalons recapturats i no recapturats en el mateix hivern del seu anellament, segons edats i sexes.

	Males	Females	Juveniles	Adults
Not recaptured	601	1701	707	825
Recaptured	12	60	34	25
χ^2_1	2.775		2.565	
P	0.096		0.109	

Discussion

Site-fidelity during winter

High within-winter recapture rates in Robins and Water Pipits seem to indicate a lack of nomadic movements during winter in these species. The territorial behaviour of Robins in winter has already been mentioned by several authors (Adriaensen & Dhondt 1990, Ioalé & Benvenuti 1995, Cuadrado 1997, Johnstone 1998) and our results suggest that the same behaviour is exhibited in wetland habitats (reedbeds and surroundings), where the Robin can find adequate food and refuge during the winter. Water Pipits are also known to have a strong tendency to remain at the same site during winter, and within-winter movements are scarce (Villarán 1999b). The Penduline Tit and Dunnock also show site-faithfulness during the winter, though in the latter species, within-winter recapture rates were lower than those reported in other Mediterranean habitats (Benvenuti & Ioalé 1981, Cuadrado 1993), which may indicate that reedbed habitat is less suitable for it (Pons 2001). Results for the Reed Bunting indicate a strong tendency to move

Table 4. Number of Reed Buntings ringed and recaptured within the same winter of ringing, by months. Percentages of recapture shown in brackets.
Nombre de Repicatalons anellats i recapturats el mateix hivern del seu anellament, al llarg de diferents mesos. Entre parèntesis es mostren els percentatges de recaptura.

	OCT	NOV	DEC	JAN	FEB	MAR
Not recaptured	73	347	595	562	555	181
Recaptured	2 (2.7%)	14 (4.0%)	24 (4.0%)	25 (4.4%)	6 (1.1%)	1 (0.5%)

between roosts within the same winter. This is confirmed by some recaptures in other reedbeds next to the study area (Appendix 2). In central England, the number of roosting birds in reedbeds was low during periods when high wind prevailed and local movements between alternative roost sites were recorded (Fennell & Stone 1976). Severe winters affect both distribution and overall population levels of Reed Buntings (Prys-Jones 1984).

Different species use reedbeds and their peripheral zones in differing ways, depending upon their wintering strategies and habitat preferences. The Robin and Water Pipit tend to be sedentary in winter, especially the former, with a high percentage of recaptures, and multiple recaptures of the same individual; this strategy may be related to anti-predatory behaviour (Cuadrado 1997). The Reed Bunting is the opposite, with clear nomadic behaviour, and frequent changes of roosting sites during the winter. This species is the most abundant in the reedbed studied, its flocks arriving to the roost in the evening, after foraging in neighbouring farmland. An intermediate tendency is observed in the Penduline Tit and Dunnock. It appears that within-winter recapture rates are directly related to the degree of winter territoriality of the species and inversely related to gregarious behaviour: the more territorial species have a high recapture rate, despite being scarce in the reedbed, while gregarious species have a very low recapture rate. However, many other factors, such as individual annual survival rates, length of stay in the area and foraging behaviour, may also affect the observed interspecific differences in within-winter recovery rates.

No significant difference in body mass or body condition was found between Reed Buntings that were recaptured within the same winter and those not recaptured. However, Reed Buntings that were recaptured had shorter wings than those that were not recaptured. Since females and juveniles have shorter wings than males and adults (Walton & Walton 1999), this might suggest that juvenile females are the most recaptured class.

Year-to-year site-fidelity

Recaptures in subsequent winters suggest high year-to-year winter site-fidelity by Water Pipits (Villarán 1999b), which showed similar recapture rates among and within winters. In spite of the Reed Bunting's nomadic behaviour and use of several roosting sites within the same winter, this species also showed relatively high interannual fidelity to the wintering site. However, the Dunnock and Robin showed a

Table 5. Mean wing length (and standard deviation), mean body mass (and standard deviation) and mean body size index (wing length/cube root of weight) of different species wintering in Carrizal de Villamejor.
Longitud alar mitjana (i desviació típica), pes mitjà (i desviació típica) i índex de mida corporal (longitud alar/arrel cúbica del pes) de diferents espècies invernants al Carrizal de Villamejor.

Species	Wing length ($\bar{X}$±sd)	Body mass ($\bar{X}$±sd)	Wing length/ cube root of body mass
Anthus spinoletta	87.3 ± 3.9	24.4 ± 2.0	30.1
Erithacus rubecula	72.0 ± 1.9	17.0 ± 1.5	28.0
Prunella modularis	68.0 ± 2.5	20.2 ± 1.6	25.0
Remiz pendulinus	53.8 ± 1.9	9.4 ± 0.8	25.5
Emberiza schoeniclus	76.0 ± 3.4	19.3 ± 2.1	28.4

Table 6: Results of a one-way ANOVA comparing the mean of biometrics and body condition of Reed Buntings recaptured and not recaptured after the winter of ringing.
Resultats de l'ANOVA d'una via aplicat per a la comparació de mesures biomètriques i condició física de Repicatalons no recapturats i recapturats en hiverns posteriors al del seu anellament.

	x ± SD			
	Recaptured	No recaptured	F	P
		MALES		
Wing length	80.2 ± 3.08	80.3 ± 2.6	$F_{1,291}$ = 0.001	0.985
Body mass	22.1 ± 1.93	20.7 ± 1.8	$F_{1,100}$ = 4.207	0.043
Body condition	2.0 ± 1.91	0.3 ± 1.9	$F_{1,99}$ = 4.380	0.039
		FEMALES		
Wing length	74.4 ± 1.9	74.4 ± 2.1	$F_{1,791}$ = 0.007	0.935
Body mass	18.4 ± 1.8	18.8 ± 1.9	$F_{1,271}$ = 0.625	0.430
Body condition	-0.5 ± 1.8	-0.15 ± 1.8	$F_{1,271}$ = 0.368	0.545

very low recapture rate, which is in agreement with results of Cuadrado (1993). This very low site-fidelity between successive winters could indicate high mortality, possibly associated with a particular age-class (i.e. juveniles). The Penduline Tit also showed a very low recapture rate from winter to winter, which could be related to low survival or to the selection of different wintering sites among years, since this species is subject to geographical range expansion, in which females and juveniles play a determinant role (Valera *et al.* 1993, Alcántara *et al.* 1997). The capture of four Penduline Tits two or more years after ringing indicates a degree of regular recurrence at the study site. All five species considered show some degree of migratory behaviour, although wintering populations of Water Pipits are probably from nearby mountain areas of the Sistema Central (Villarán 1999b). This short migratory distance can explain the higher between-winter recapture rates compared to those of the Robin and Dunnock, whose migratory movements are probably longer. The small size of Penduline Tits makes this species more susceptible to meteorological hazards, which could explain the low recapture rate in the winter subsequent to ringing. The fact that recapture rate in subsequent winters is positively correlated with the body size of the species seems to point to higher mortality in smaller species, since these species would be more affected by meteorological conditions and the rigors of winter. Moreover, in these species, migratory risks would be higher. However, higher year-to-year recurrence is also associated with the two species (Water Pipit and Reed Bunting) most typically tied to reedbeds during winter. This may point to habitat selection as a main cause for the higher site fidelity observed (Cantos & Tellería 1994). Male Reed Buntings with higher weight and better body condition (when ringed), seem to be more frequently recaptured the year after than are males with lower weight and inferior body condition, maybe as a result of their higher ability to survive the winter.

Interannual variation in within-winter recapture rates

Within-winter recapture rates varied from one year to the other in the Reed Bunting, which may be related to changes in the safety of the site. Very low within-winter recovery rates were recorded in 1988-89. During that winter, a Barn Owl *Tyto alba* was captured at the site. It visited the roost systematically to capture birds. Also, the reedbed dried out somewhat, so access to predators became easier. During that winter, all mist-nets were placed on dry ground, whereas in the previous years, three or four mist-nets were in flooded sections of reedbed. Our data suggest a higher mobility of the species during that year, probably associated with reduced safety of the roosting sites. However, water management has been proven to affect food availability for passerines in reedbeds during the breeding season (Poulin *et al.* 2002) and it is also likely to affect bird survival in winter, through variations in predation risks or an indirect effect on food availability.

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Sumari

Taxes de recaptura de cinc espècies de passeriformes hivernants en un canyissar del centre d'Espanya

S'analitzen les dades de captura-recaptura en xarxa japonesa de cinc espècies de passeriformes capturats al Canyisar de Villamejor, al Tajo mitjà, centre d'Espanya (39° 56' N, 3° 47' W), durant els hiverns de 1982-86 i 1988-89. Es van utilitzar 10 xarxes japoneses que van funcionar 4 hores abans de la posta del sol, sempre als mateixos llocs, per bé que amb un esforç de captura variable entre anys (Apèndix 1). En total es van capturar 6.590 ocells de 67 espècies diferents. Les cinc espècies estudiades utilitzen la zona d'estudi regularment entre octubre i març. Les taxes de recaptura durant l'hivern (G_4 = 52,08; $p<0,01$) i entre hiverns successius (G_3 = 7,51; $p<0.05$) variaren significativament entre espècies. El Pit-roig *Erithacus rubecula* presenta una gran fidelitat al lloc durant l'hivern i, per tant, una elevada taxa de recaptura durant l'hivern, la qual és intermèdia en el Grasset de Muntanya *Anthus spinoletta*, el Pardal de Bardissa *Prunella modularis* i el Teixidor *Remiz pendulinus*, i baixa en el Repicatalons *Emberiza schoenichus* (Taula 1). La taxes de recaptura dels repicatalons van ser particularment baixes l'hivern de 1988-89 (0.76%) (G_3 = 16,62; $p< 0,01$), mentre que en les altres espècies no s'observaren diferències entre anys (G_3 = 0,32; $p> 0,05$ per al Grasset de Muntanya; G_3 = 1,03 ; $p> 0,05$ per al Pit-roig; G_3 = 3,18; $P > 0,05$ per al Pardal de Bardissa i G_3 = 1,55; $p > 0,05$ per al Teixidor, Taula 2). Les taxes de recaptura durant l'hivern de Repicatalons no es trobaren significativament associades ni al sexe ni a l'edat (Taula 3). Tanmateix, la longitud alar fou inferior per als exemplars recapturats ($\bar{X}$ = 74,7 ± 2.8 mm) que per als no recapturats ($\bar{X}$ = 76,0 ± 3,4 mm) ($F_{1,1094}$ = 5,125; P = 0.024) durant el mateix hivern, fet que podria indicar que es tracta preferentment de femelles joves, les quals mostrarien més fidelitat al lloc d'hivernada al llarg d'un mateix any. La condició corporal i el pes foren lleugerament, però no significativa, superiors en els repicatalons no recapturats que en els racapturats durant el mateix hivern. Les taxes de recaptura dels repicatalons al llarg de l'hivern presenten un clar patró estacional (χ^2_1 = 16,65; P = 0,005), i són màximes entre novembre i gener (Taula 4). Les taxes de recaptura entre hiverns successius va ser baixa per a totes les espècies (Taula 1), i es va trobar positivament correlacionada amb la llargada de l'ala (r_s = 0,90; P = 0,037; n = 5) i la seva mida corporal (r_s = 1,00; P < 0,0001; n = 5). Per tant, va ser particularment baixa per a Pardal de bardissa i el Teixidor. La major part de recaptures entre hiverns successius van correspondre al Repicatalons, l'espècie més gran. Aquestes dades indiquen una certa tendència d'aquesta espècie a canviar de lloc d'hivernada entre hiverns successius, fet que es veu recolzat per la recaptura d'alguns dels exemplars anellats a l'àrea d'estudi en canyissars veïns en anys posteriors (Apèndix 2). El pes i la condició corporal dels mascles recapturats en hiverns successius van ser superiors a les dels mascles no recapturats (Taula 6).

Resumen

Tasas de recaptura de cinco especies de paseriformes invernantes en un carrizal del centro de España

Se analizan los datos de captura-recaptura en red japonesa de cinco especies de paseriformes en un carrizal del centro de España durante los inviernos de 1982-86 y 1988-89. Las tasas de recaptura dentro de un mismo invierno y entre inviernos sucesivos variaron significativamente entre especies. El Petirrojo *Erithacus rubecula* mostró una elevada fidelidad al dormidero durante el invierno y, por lo tanto, presentó una elevada tasa de recaptura durante el mismo invierno, la cual fue intermedia en el Bisbita Ribereño Alpino *Anthus spinoletta*, el Acentor común *Prunella modularis* y el Pájaro Moscón *Remiz pendulinus*, y baja en el Escribano Palustre *Emberiza schoenichus*. Las tasas de recaptura dentro de un mismo invierno solamente variaron entre años en el caso del Escribano Palustre, probablemente en relación a variaciones en la seguridad del carrizal. Las tasas de recaptura del Escribano Palustre dentro de un mismo invierno no se relacionaron significativamente con el sexo o la edad de los ejemplares, pero se observó que las aves recapturadas a lo largo de una misma estación presentaron alas más cortas que las aves no recapturadas, lo que podría indicar una mayor fidelidad de las hembras jóvenes al lugar de invernada. Las tasas de recaptura entre inviernos

sucesivos fueron bajas para todas las especies, aunque estuvo significativamente correlacionada con la longitud alar y el tamaño de cada especie, siendo, pues, particularmente baja para el Acentor Común y el Pájaro Moscón. La mayor parte de recapturas entre inviernos sucesivos implicaron al Escribano Palustre, la especie de mayor tamaño. Las tasas de recaptura entre inviernos sucesivos para esta especie indican una cierta tendencia a cambiar de sitio de invernada entre años sucesivos. El peso y la condición corporal de los machos de Escribano que se recapturaron en inviernos sucesivos fueron mayores que los de los machos no recapturados.

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Appendix

Appendix 1. Sampling effort (nets x hours) in the different winters.
Esforç de mostreig (xarxes x *hores), en els diferents hiverns.*

Winter	Days	Mist-nets	Hours	Nets x Hours
1982-83	6	10	24	240
1983-84	16	10	64	640
1984-85	19	10	76	760
1985-86	20	10	80	800
1988-89	9	10	36	360
1992-93	1	10	4	40

Appendix 2. Recorded movements of Reed Buntings captured in the roost site in Carrizal de Villamejor and trapped in other neighbouring reedbeds.
Movimients enregistrats pels Repicatalons capturats en el dormidor del Carrizal de Villamejor i capturats en canyissars propers.

Capture date in Villamejor	Capture date in another reedbed	Coordinates	Site	Distance
11.02.84	01.07.85	39.54N 03.51W	Algodor	7 km
16.11.85	06.11.88	40.47N 03.41W	Guadalix S.	95 km
28.01.89	20.11.88	40.02N 03.37W	Las Infantas	18 km
28.01.89	26.12.88	40.02N 03.37W	Las Infantas	18 km
28.01.89	26.02.88	40.08N 03.26W	Chinchón	37 km
08.03.86	29.12.88	40.02N 03.37W	Aranjuez	18 km
26.12.88	22.11.86	40.00N 03.40W	Las Infantas	12 km
06.10.85	21.02.87	40.02N 03.37W	Las Infantas	18 km
10.11.85	17.12.85	40.02N 03.37W	Las Infantas	18 km
21.12.85	16.11.85	40.02N 03.37W	Aranjuez	18 km
21.12.85	01.12.85	40.02N 03.36W	Aranjuez	19 km