

# Selection of foraging habitats by Little Terns *Sterna albifrons* at the Ebro Delta (NE Spain)

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We studied the foraging habitats of the Little Tern *Sterna albifrons* while breeding at the Ebro Delta (NE Spain). Most (95%) of the foraging terns were observed less than 4 km away from the nearest colony. Little terns preferred channels and lagoons for foraging; lagoon mouths were used in proportion to their availability, and saltmarshes were avoided. In spite of the large surface area of rice paddies sampled, this habitat was seldom used. We found that the frequency of birds observed foraging at freshwater and brackish habitats did not differ significantly from the frequencies to be expected based on the availability of these habitats. Very few birds were observed foraging in marine habitats. The presence of suitable foraging grounds within a radius of 4 km may also influence the Little Tern's selection of breeding habitat.

Key words: Little Tern, *Sterna albifrons*, habitat selection, foraging, Catalonia.

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Little is known about the biology of Little Tern *Sterna albifrons* in the Iberian Peninsula (Oro *et al.* 2004). While habitat selection of both breeding grounds and nest sites has been well studied in several different parts of Europe (Goutner 1990, Fasola & Canova 1992, Fasola 1993, Valle & Scarton 1999, Oro *et al.* 2004), selection of foraging habitats has been analysed only in Italy (Fasola *et al.* 1989, Fasola & Bogliani 1990, Bogliani *et al.* 1992, 1994). During the breeding season, foraging areas are mostly within a radius of 4–6 km from the colonies (Cramp 1985, Fasola & Bogliani 1990). Nevertheless, the Little Tern does not select prey depending on the water environment the latter occupies (fresh, brackish or salt), but rather on the availability

of these habitats in the surroundings of the colony (Bogliani *et al.* 1992).

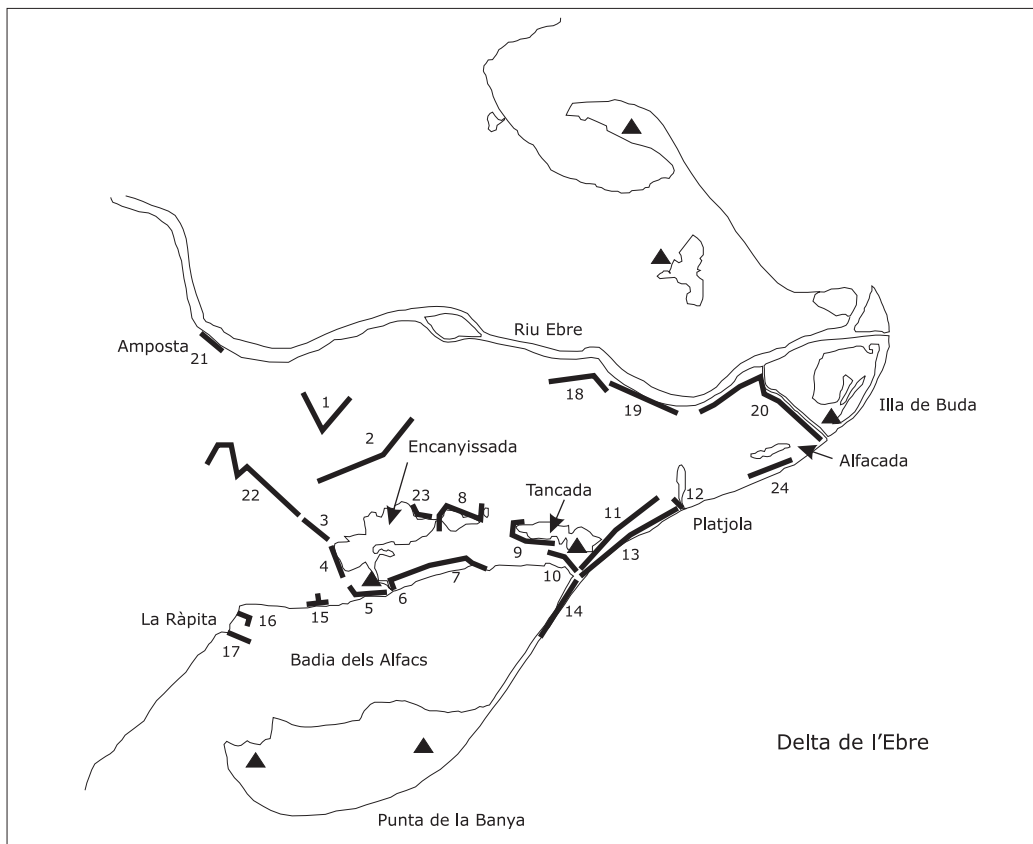
At the Ebro Delta human alterations of the habitat have been intense, making it likely that there will be a high diversity of potentially suitable foraging habitats. Nevertheless, it is unclear how the Little Tern makes use of the man-modified habitats for feeding. We do not reject *a priori* that there may be either a positive or negative selection in this use; nor the possibility that there may not be any kind of selection, and that the habitats are used according to their availability. In this paper we describe the use of foraging habitat by Little Terns during the breeding season at the Ebro Delta, in the north-western Mediterranean. Knowledge of feeding-habi-

tat use in a transformed area is important for the management and conservation of the species, not only in the study site, but also in other colonies.

## Methods

To determine the importance of the various foraging habitats (Table 1), we performed several transects covering rice paddies; saltmarshes; the lagoons of L'Encanyissada and La Tancada; the bay of Els Alfacs; the River Ebro; "goles" (a local term defining the mouths of lagoons and the discharge channels connecting to the sea); irrigation channels; and the fishing port of Sant Carles de la Ràpita (Fig. 1). Also, we classified

each habitat according to its water characteristics (fresh, brackish or salt water). In all, we designed 24 transects with a 100 m band to either side covering all these areas. Transects were covered between June and August 1998 by car at a constant speed (25 km/h) between 13:00 h and 18:30 h GMT. Transects covered in total 64.4 km and each transect was performed three to six times (mean=3.96; SD=0.91). For each transect we calculated the mean density of Little Terns (birds/ha). A total of 254.7 km were covered by the end of the study. Each tern observed was located on a map (1:25,000), and the distance to the nearest colony was calculated afterwards. The distances were grouped at intervals of 250 m. We also recorded the habitat where the individual was observed, and the



**Figure 1.** Location of transects (thick black lines with numbers) and of the breeding colonies (triangles) of the Little Tern at the Ebro Delta.

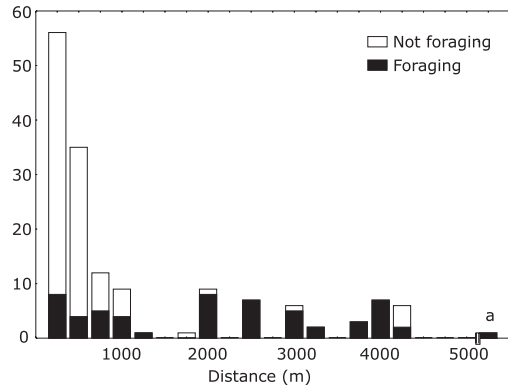
*Localització dels transectes (línies grosses negres numerades) i de les colònies de cria del Xatruc Menut (triangles) al Delta de l'Ebre.*

bird's activity. We defined the following activity patterns: 1) resting, when individuals were on the ground or on a perch; 2) movement, when the individual was flying but without showing food-searching behaviour; and 3) foraging, when the individual was fishing, carrying a fish in the bill, or performing flights in search of food. To find out which areas were used most by Little Terns we used maps to calculate the total area of each habitat type sampled, while preferences were calculated by means of a  $\chi^2$  test, following Neu *et al.* (1974). This methodology tests two null hypotheses: 1)  $H_{01}$ , usage of one habitat occurs in proportion to availability, considering all habitats together; and 2)  $H_{02}$ , usage occurs in proportion to availability, considering each habitat separately. In this aim, this work constructs confidence intervals for the proportion of times an animal uses each type of habitat. If the confidence interval includes the proportion of the habitat sampled ( $h_i$ ), then there is no trend; if  $h_i <$  the lower limit, then that habitat is actively selected; if  $h_i >$  the upper limit, then that habitat is avoided.

## Results and Discussion

Little Terns were seen in only 54% of the transects (transects 3, 4, 5, 6, 7, 8, 10, 11, 13, 14, 20, 21 and 23), and these were generally the ones located closer to the colonies (Figure 1). The mean number of individuals per hectare for each transect oscillated between 0 and 0.417 (all transects mean=0.037; SD=0.089). If we considered only those transects with observations, the number of individuals per hectare and transect increased to  $0.069 \pm 0.113$  (mean  $\pm$  SD; range: 0.005–0.417). The mean number of Little Terns observed per transect was not correlated to the length of the transect (Spearman rank correlation  $r_s = 0.166$ ,  $p = 0.588$ ).

A total of 155 observations of Little Terns were noted, mostly (63%) involving non-foraging individuals. Many observations were made close to a colony, 59% of them less than 500 m away, 72% less than 1000 m away, and 96% less than 4000 m away (Fig. 2). When considering only foraging individuals and grouping the observations in sections of 1000 m, the trend to concentrate near colonies disappeared ( $G = 2.71$ ,  $df = 3$ ,  $p = 0.439$ ). Nevertheless, 95%



**Figure 2.** Number of Little Terns observed depending on the minimum distance (in m) to the nearest colony for foraging and non-foraging individuals. <sup>a</sup> one observation at 11 km from the nearest known colony. *Nombre de xatracs menuts observats alimentant-se i no alimentant-se segons la distància mínima (en m) a les colònies de cria.* <sup>a</sup>una observació a 11 km de la colònia de cria més propera coneguda.

of the foraging observations were still made less than 4000 m away from the nearest colony. Thus, our results are similar to those of Fasola & Bogliani (1990), who recorded 90% of feeding observations occurring within the same range. However, there are several biases, such as the paucity of observations of foraging terns, or the impossibility of assessing the breeding status or colony of origin of each individual, and these factors precluded a stronger conclusion regarding foraging range of breeding birds (see also Fasola *et al.* 1989). On the other hand, the individuals with no foraging behaviour were found clearly within 1000 m of colonies ( $G_{adj} = 47.76$ ,  $df = 1$ ,  $p < 0.0001$ ; Fig. 2), mainly in bays and saltmarshes. When analysing only the habitats with presence of terns and grouping the observations made at channels with those at lagoons and the river, we found spatial segregation between the foraging and non-foraging areas ( $G = 99.6$ ,  $df = 5$ ,  $P < 0.01$ ).

The foraging habitats preferred by Little Terns were channels and lagoons, while lagoon mouths were used in proportion to their availability, and saltmarshes were avoided ( $\chi^2 = 54.356$ ,  $df = 3$ ,  $p < 0.001$ ; only four habitats with sufficient sample size, Table 2). Although saltmarshes occupied a large surface area (Table 1), most of them were dry during the summer, and were thus not available for foraging

**Table 1.** Number of Little Terns observed in each habitat. The surface area (ha) sampled by habitat and water characteristics is also shown.

*Densitat de xatracs menuts observats segons els hàbitats. S'indica la superfície (ha) de cada hàbitat mostrejat i el seu tipus d'aigua.*

Habitat	Water	Surface area	Number of terns		Total
			Foraging	Not foraging	
1 Rice paddies	fresh	2600	3	15	18
2 Saltmarsh	brackish	906.1	4	53	57
3 Lagoons	brackish	517.1	26	4	30
4 Bay	salt	351	2	21	23
5 Lagoon mouths	brackish	184.7	10	5	15
6 Unsuitable land	-	158.8	0	0	0
7 River	fresh	117	1	0	1
8 Channels	fresh	93.7	11	0	11
9 Port	salt	72	0	0	0
10 Spring pools	fresh	1.5	0	0	0
Total		5001.9	57	98	155
7+8	fresh	160.7	11	0	12
3+5	brackish	701.8	36	9	45

terns, which were observed feeding exclusively over water. A similar situation occurred with rice paddies. Even though this is a habitat that is completely flooded, the growing rice plants form a continuous mass of plant matter, which create an inappropriate habitat for tern feeding during the months of the study. When these habitats, as well as the transects found more than 4 km from colonies, were not included in the analysis, we found that the frequency of foraging observations according to the kind of water (fresh water *vs* brackish water) was not different from the frequencies to be expected depending on their availability ( $\chi^2=1.284$ ,  $df=1$ ,  $p=0.257$ ; Table 1). Likewise, Bogliani *et al.* (1992) found that the choice of prey did not depend on the type of water (fresh, brackish,

salt), but on the availability of each habitat within the colony range. The selection of foraging habitats may be based on the features of the water mass (open or vegetated waters), prey density, and/or accessibility by means of surface-plunging. Contrary to what Bogliani *et al.* (1992) recorded, very few terns were observed foraging in marine habitats, although these were available near the breeding colonies and accessible by means of surface-plunging. In this habitat, Little Terns probably avoid interspecific competition (through predation and kleptoparasitism) with larger gulls and terns (see also Sadoul *et al.* 1996, Oro 1996, Fasola *et al.* 2002, Sánchez 2003).

At the Ebro Delta foraging Little Terns used flooded areas with extensive stretches of open

**Table 2.** Foraging-habitat selection by the Little Tern at the Ebro Delta. <sup>a</sup> number of terns observed foraging. <sup>b</sup> proportion of the total habitat sampled. <sup>c</sup> proportion of locations in each habitat. <sup>d</sup> Bonferroni confidence intervals. If BIC includes  $h_i$ , then no trend; if  $h_i <$  lower limit, then habitat preferred; if  $h_i >$  upper limit, then habitat avoided.

*Hàbitats d'alimentació seleccionats pel Xatrac Menut en el Delta de l'Ebre. <sup>a</sup>nombre de xatracs observats alimentant-se. <sup>b</sup>proporció de cadascun dels hàbitats mostrejats. <sup>c</sup>proporció de localitzacions en cadascun dels hàbitats. <sup>d</sup>interval de confiança de Bonferroni. Si BIC inclou  $h_i$ , llavors no hi ha selecció; si  $h_i <$  límit inferior, llavors l'hàbitat és preferit; si  $h_i >$  límit superior, llavors l'hàbitat és evitat.*

Habitat	$n^a$	$h_i^b$	$h_i^c$	BIC <sup>d</sup>	selection
Saltmarsh	4	0,5325	0,0784	-0,0059 - 0,1628	avoid
Lagoon mouths	10	0,1085	0,1961	0,0715 - 0,3207	no trend
Channels	11	0,0551	0,2157	0,0866 - 0,3448	prefer
Lagoons	26	0,3039	0,5098	0,3529 - 0,6667	prefer

water. No clear preferences were found for any kind of water, which probably allowed terns to exploit fresh and brackish waters, although they seemed to avoid the marine habitats. As Bogliani *et al.* (1992) pointed out, this plasticity in the selection of foraging habitat may be a consequence of the local population dynamics, with high extinction-colonization turnover (Oro *et al.* 2004). Thus, breeding-habitat selection could be influenced by the presence of suitable foraging habitats within a range of 4 km. It is not known whether the negative population trend of Little Terns recorded at the Ebro Delta (Oro *et al.* 2004) is partially related to changes in habitat structure and availability in recent decades. While high numbers of irrigation channels and large stretches of shallow lagoons still occur in the area, rice paddies occupy a large area with full-grown plants during June and July, presumably hampering the Little Tern's foraging and making this an unsuitable foraging habitat for this species during the breeding season.

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### Resum

#### Selecció dels hàbitats d'alimentació del Xatrac Menut *Sterna albifrons* al delta de l'Ebre

Es van estudiar els hàbitats d'alimentació del Xatrac Menut *Sterna albifrons* durant l'època de reproducció al delta de l'Ebre. La major part de les observacions d'alimentació (95%) es van fer a menys de 4.000 m de la colònia de cria més propera. Els xatrac van preferir alimentar-se als canals i a les llacunes mentre que van emprar les goles de les llacunes en la mateixa proporció que eren disponibles i van evitar alimentar-se als sosars. Malgrat la gran superfície d'arrossars disponibles, aquest hàbitat només va ser emprat ocasionalment per a l'alimentació. Les freqüències d'ocells observades alimentant-se en aigües dolces o salobres no van ser significativament diferents de les freqüències esperades segons la disponibilitat de

cada tipus d'aigua. D'altra banda, el nombre d'aus alimentant-se en els hàbitats marins va ser molt reduït. Possiblement la presència d'hàbitats adequats d'alimentació en un radi de 4 km influeix en la selecció que fa el Xatrac Menut de les zones de nidificació.

### Resumen

#### Selección de los hábitats de alimentación del Charrancito Común *Sterna albifrons* en el delta del Ebro

Se estudió la selección del hábitat de alimentación en el Charrancito Común *Sterna albifrons* durante la época de reproducción en el delta del Ebro. La mayor parte de las observaciones de alimentación (95%) se registraron a menos de 4.000 m de la colonia de cría más cercana. Los charrancitos prefirieron alimentarse en los canales y las lagunas mientras que utilizaron las desembocaduras de las lagunas en la misma proporción en que fueron disponibles y evitaron alimentarse en los salobres. A pesar de la gran superficie de arrozales disponibles, este hábitat sólo fue utilizado ocasionalmente para la alimentación. Las frecuencias de aves observadas alimentándose en aguas dulces o salobres no fueron significativamente diferentes de las frecuencias esperadas según la disponibilidad de cada tipo de agua. Por otra parte, el número de aves alimentándose en los hábitats marinos fue muy reducido. Posiblemente la presencia de hábitats adecuados de alimentación en un radio de 4 km influye en la selección que hacen los Charrancitos Comunes de las zonas de nidificación.

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