Foraging Ecology and Conservation of Feeding Habitats of Little Egrets (*Egretta garzetta*) in the Axios River Delta, Macedonia, Greece

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Abstract.—From 1988 to 1990, Little Egrets (*Egretta garzetta*) used all available feeding habitats in the study area, i.e., saltmarshes, freshwater habitats and rice fields (breeding season primarily). Freshwater habitats were preferred during pre-breeding, breeding and post-breeding periods. However, foraging success there was generally lower than in other habitats; a considerable part of the Little Egret population simply used this habitat type without feeding possibly due to manmade habitat alterations that took place during the study period. Saltmarshes were an important habitat: Little Egrets foraged exclusively there in March, and in the pre- and post-breeding periods foraging success was generally higher than in other freshwater habitats. In rice fields, Little Egrets had a generally greater foraging success than in the other habitats in two of the three study years. Conservation of feeding habitats should include prey management and protection from further habitat degradation.

Key Words.—Axios River, *Egretta garzetta*, feeding habitats, foraging ecology, Greece, Little Egret, Macedonia, wetland.

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About 500 pairs of Little Egrets (*Egretta garzetta*) breed in a single mixed-species heronry of approximately 1500 nests, in the Axios River estuary in Macedonia, Greece. The rest of the colony consisted of Black-crowned Night-Herons (*Nycticorax nycticorax*) (600 pairs), Great Cormorants (*Phalacrocorax carbo*) (150 pairs), Squacco Herons (*Ardeola ralloides*) (150 pairs), Eurasian Spoonbills (*Platalea leucorodia*) (50 pairs), Glossy Ibis (*Plegadis falcinellus*) (30 pairs), and Pygmy Cormorants (*Phalacrocorax pygmeus*) (5-10 pairs). Since the present nesting area has not faced major threats so far, conservation of the Little Egret breeding population in the area depends mainly on the preservation of its feeding habitats. The importance of conservation and management of feeding habitats for the preservation of breeding populations of Little Egrets and other herons in the Mediterranean has been documented in a variety of studies in this region (Hafner *et al.* 1986, Fasola and Alieri 1992, Hafner and Fasola 1992, among such studies). Information on feeding habitat use has mainly focused on the breeding season (Fasola 1982, Fasola and Ghidini 1983, Fasola 1986).

The aim of this study is to provide data on the feeding ecology of Little Egrets at the Axios Delta and to evaluate the importance of the feeding habitats during the period when the breeding population of Little Egrets is present in the area. Conservation to promote the preservation of these feeding habitats of Little Egrets and other waterbirds will be discussed.

STUDY AREA AND METHODS

The study was carried out in the delta of the Axios River (40°30'N, 22°13'E), a Ramsar wetland which is part of the wetland complex formed by the estuaries of four rivers discharging along the west coast of the Gulf of Thessaloniki, Macedonia. The study area, was about 36 km^2 representing 52% of the total wetland complex. The Axios Delta includes a variety of habitats such as salt- and freshwater marshes, lagoons, vegetated coastal islets, limited sandy shores, forested river banks, extensive tamarisk (*Tamarix* sp.) bushland and open sea. A considerable proportion (47%) of the study area included manmade habitats such as rice fields (16.8 km^2) and drainage canals (0.2 km^2). The human activities in the region, i.e., agriculture, herd grazing, fishing, aquaculture, hunting (in winter), sand extraction, building, garbage and sewage dumping, are intense, resulting in coastal pollution.

From 1988 to 1990, the study area was censused from March to October (in 1988 only until August) every 9-11 days during mornings (0600-1200 h) along a standard route. We recorded the number of Little Egrets present in each habitat. Observations of their feeding activity were made once or twice a week from a car used as a hide. During the early morning and in the afternoon, individual foraging adult birds only (randomly selected) were observed continuously from 5 to 15 minutes. For each feeding bird, the number of suc-

cessful and unsuccessful pecks were recorded on a small tape recorder.

The following types of habitat were distinguished: saltmarshes (tidal, non-tidal saltmarshes and seashore); freshwater habitats (canals, permanent and temporary freshwater marshes and river banks); and rice fields, the most important manmade freshwater wetland habitat in the region, for which data were treated separately. The data from each study season were compiled in three periods and compared. These periods were: (a) pre-breeding: from mid-March to late April, (b) breeding: from late April to mid-July, and (c) post-breeding: from mid-July to late September. This separation coincided with the availability of the rice fields in the breeding period. Comparisons related to the foraging success were made with ANOVAs using the Scheffe test to locate differences, or t-tests (where appropriate performed on log-transformed data to achieve data normality) and χ^2 tests to test differences in habitat distribution and habitat preferences of Little Egrets.

RESULTS

Population fluctuation (Fig. 1)

Low numbers of birds encountered in early March probably represented individuals wintering in the region. The first migrating birds arrived after mid-March and the population increased by birds arriving during the spring. Afterwards, until the end of June, population changes were mainly due to breeding birds. The increase of the population observed in July and August was due to the appearance of young birds raised in the Axios colony and in other wetlands of the region (Kazantzidis, unpubl. data, Tsachalidis 1990). Later, in August, numbers decreased due to migration. The population that remained after October probably overwintered in the region.

Distribution and habitat preferences

The pattern of distribution of Little Egrets in the foraging habitats (Fig. 1) was significantly different among study years during the pre-breeding period (χ^2_2= 305.55, P<0.001) and also during the breeding (χ^2_4= 980.55, P<0.001) and post-breeding period (χ^2_2= 728.23, P<0.001). The low number of birds present in early March were observed only in saltmarshes in all three years. From March onwards, the population enlarged with the arrival of birds that used both salt- and freshwater habitats (Fig. 1). In proportion to their availability, freshwater habitats were preferred (χ^2= 37.65, P<0.001) in contrast to the saltmarsh (χ^2= 13.31, P<0.01) although the latter attracted the highest proportion of Little Egrets (Fig. 2). Rice fields were flooded in late April (the date varying and depending on water management). In May, and occasionally in June, rice fields attracted the highest numbers of foraging Little Egrets (Fig. 1), but, in general, during the breeding period, rice fields and saltmarshes were used in relation to their availability (χ^2_4= 1.41, n.s. and χ^2_4= 1.00, n.s. respectively), whereas freshwater marshes were again preferred (χ^2_4= 15.94, P<0.001, Fig. 2). When rice grew too tall to allow foraging (end of June to the beginning of July), the birds shifted to saltmarshes and freshwater habitats (Fig. 1). After the breeding period, assemblages of birds in the two available habitats varied between study years (Fig. 1), but, overall, both saltmarshes and freshwater habitats were preferred (χ^2_2= 24.17, P< 0.001 and χ^2_2= 55.98, P<0.001, respectively, Fig. 2). Young Little Egrets mainly gathered in freshwater marshes during their first dispersal movements in the wider region.

Foraging success

The foraging success of Little Egrets (expressed as successful pecks per minute) varied among habitats within years, and among years within habitats. The highest foraging success occurred during the breeding period (Table 1). Comparing among habitats within years, foraging success was higher in ricefields during the breeding period than in the other habitat types and the difference was significant in two of the three study years (Table 1). No Little Egrets were foraging in freshwater habitats during the pre-breeding period whereas the small sample sizes during the other periods in all study years were due to the unwillingness of Little Egrets to feed there, despite the occurrence of aggregations in this habitat (see Fig. 1) especially during the post-breeding period. A comparison of foraging success between periods of each study year within saltmarshes indicated no significant difference in 1990 ($F_{2,128}$=

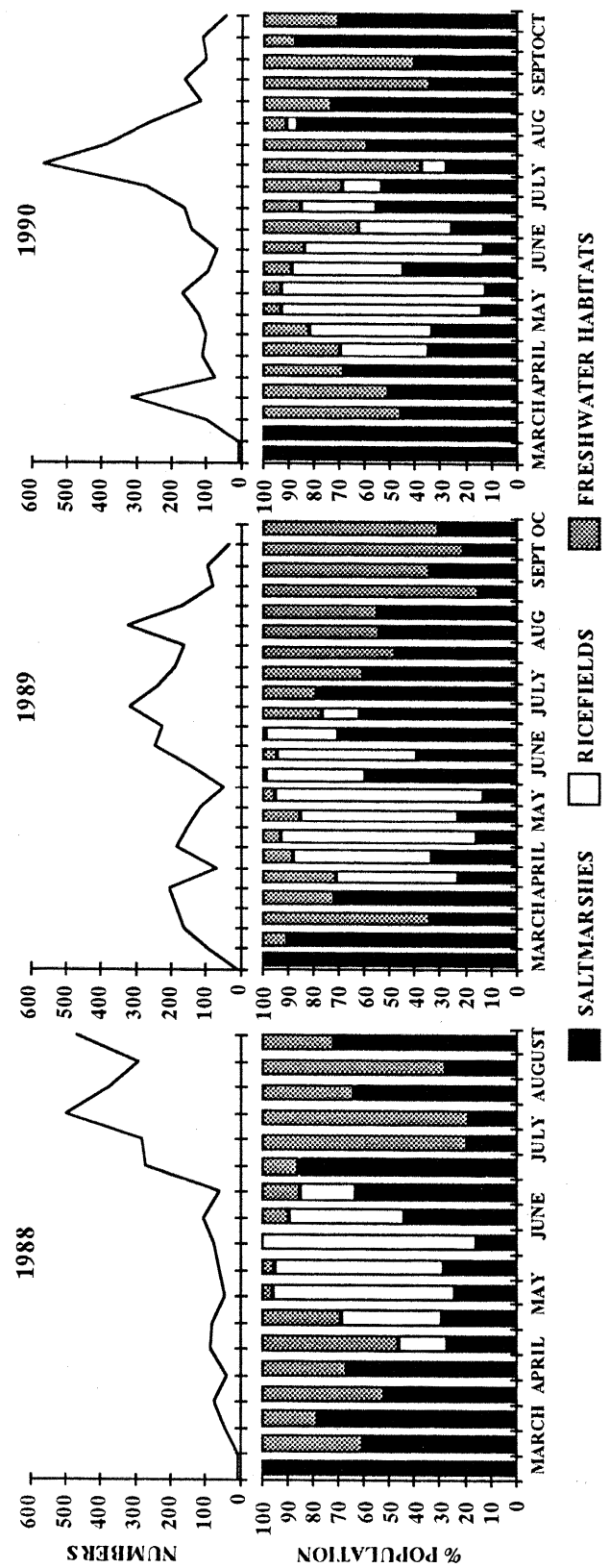

Figure 1. Population trends (upper diagrams) and proportions (histograms) of Little Egrets using the three main habitat types in the Axios Delta from 1988 to 1990.

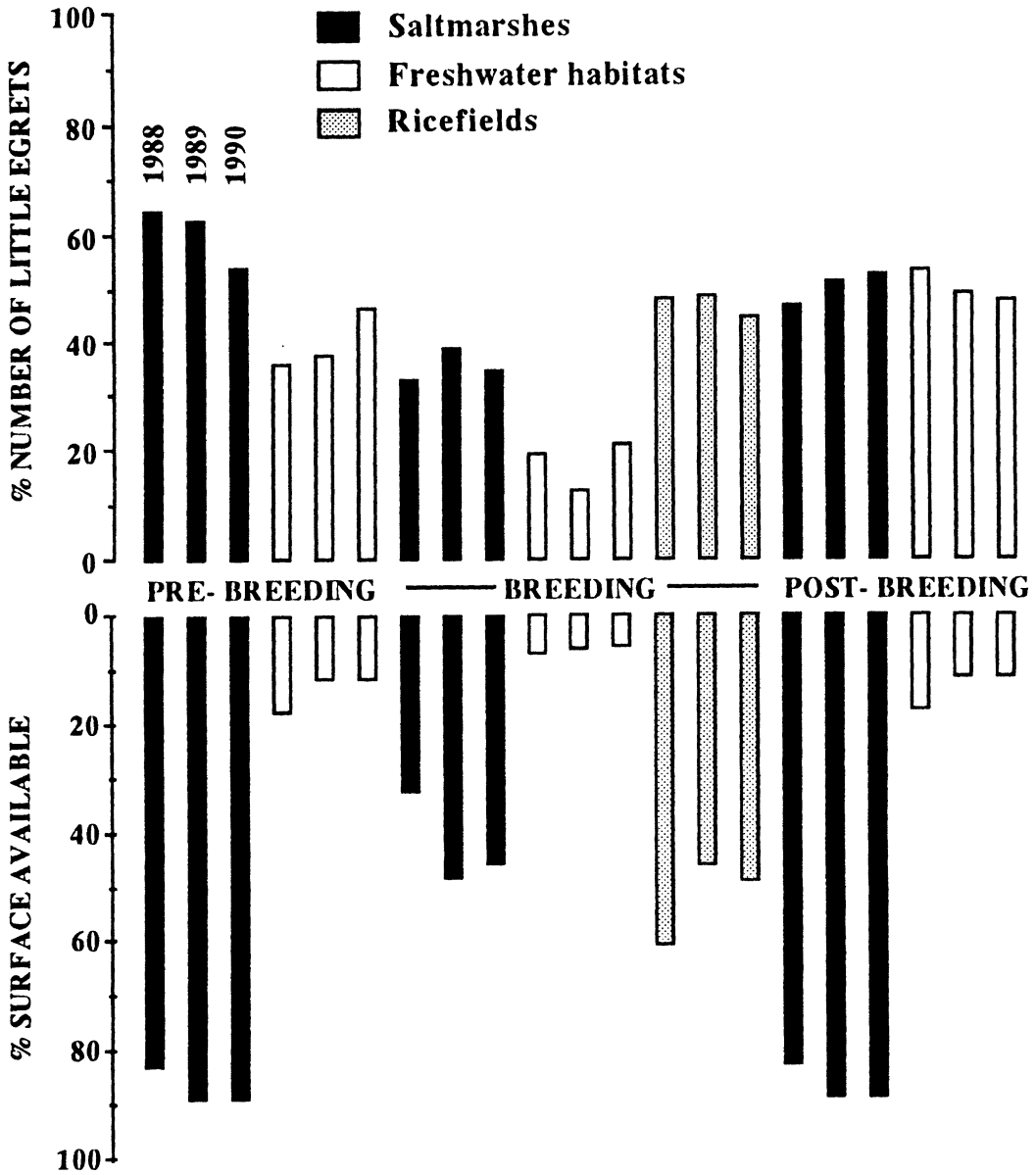

Figure 2. Preferences of Little Egret population (upper histogram) to the main habitat types available in the Axios Delta during pre-breeding, breeding and post- breeding periods from 1988 to 1990.

1.90, n.s.) but significantly higher values during the breeding season in 1989 ($F_{2,215}$= 9.19, P<0.001) due to difference between pre-breeding and breeding periods (Scheffe Test). In this habitat in 1988, foraging success was higher during the post-breeding period (t_{65}= 2.32, P= 0.023); however, the percentage of successful pecks was higher during the breeding period (Table 1) suggesting a greater success in saltmarshes in this period. Additionally, in two of the three study years, foraging success was higher in saltmarshes than in freshwater habitats in the post-breeding period except in 1990 (Table 1). Saltmarshes were used exclusively for foraging in two of the three study years during the early March period (data are lacking for 1988). In 1988 in freshwater habitats, there was significantly higher foraging effort

Table 1. Foraging success (mean number of successful pecks per min ± 1 SD) and percentage of the successful pecks (%) during the three periods (pre-breeding: A, breeding: B, and post-breeding: C) in the feeding habitats in the three study years.

	Saltmarshes			Rice fields			Freshwater			
Year	Foraging success	N[1]	%	Foraging success	N	%	Foraging success	N	%	Comparison
A 1988	no data						no data			
A 1989	0.71 ± 0.73	32	49.01				—			—
A 1990	0.48 ± 0.53	20	49.65				—			—
B 1988	1.48 ± 2.65	26	66.13	1.87 ± 3.35	25	69.10	1.42 ± 1.09	27	49.10	$F_{2,77}$=1.15ns
B 1989	2.75 ± 5.16	159	70.52	4.77 ± 6.40	146	79.72	4.10 ± 2.96	2[2]	73.84	t_{304}=5.18*
B 1990	0.76 ± 0.81	82	46.15	2.57 ± 2.44	71	70.14	—			t_{152}=7.89*
C 1988	2.08 ± 2.71	40	56.00				0.70 ± 0.39	30	45.61	t_{69}=3.96*
C 1989	1.09 ± 0.9	25	52.16				0.34 ± 0.3	4[2]	27.27	
C 1990	0.56 ± 0.41	27	47.60				1.53 ± 0.72	16	75.81	t_{42}=5.45*

[1]Number of different feeding individuals.

[2]Data not used in the analysis; —, no egrets feeding, *, P<0.001.

in the breeding than in the post-breeding period (t_{51}= 3.49, P<0.001).

Comparing among years within habitats, in saltmarshes foraging success was significantly different in the breeding period ($F_{2,266}$= 14.86, P<0.001) due to the difference between 1989 and 1990 (Scheffe Test); and in the post-breeding period ($F_{2,91}$= 12.17, P<0.001) due to difference between 1988 and 1990. There was no difference in the pre-breeding period in saltmarshes (t_{51}= 1.21 n.s.). In freshwater habitats, there was a significant difference during the post-breeding period (t_{45}= 4.51, P<0.001) but no other analyses were possible due to the type of data (Table 1). In rice fields (breeding season), the foraging effort was significantly different among years ($F_{2,241}$= 7.91, P<0.001) due to differences between 1988 and 1989.

DISCUSSION AND CONSERVATION PROPOSALS

The distribution of Little Egrets among habitats indicated contradictory patterns in relation to their value as feeding habitats. Thus, although freshwater habitats were preferred during all periods (except early March), foraging success of adult birds in this habitat was generally lower than in other habitats. This suggests that an important part of the Little Egret population, especially during the post-breeding period, when numbers increase (Fig. 1), aggregated at freshwater marshes primarily for roosting. We attribute the gradual deterioration of this feeding habitat for Little Egrets to manmade habitat alterations; part of the freshwater feeding area along the river banks has been destroyed by sand extraction, while other areas experienced a rise in water level due to a small dam construction in early 1989. This resulted in an increased water depth, hindering the foraging of Little Egrets. Additionally, there has been an increase of disturbance along the banks of the river due to herd grazing, road construction, automobiles and human presence.

The population patterns of Little Egrets showed a sharp increase in the post-breeding period followed by a sudden decrease (Fig. 1). This indicates that the birds do not remain long in the area. They may simply congregate at the freshwater habitats as roost or staging sites and then disperse out of our study area (Kazantzidis, unpubl. data). Freshwater habitats are the best feeding habitats for Little Egrets in other parts of the range, at least during the breeding season (Hafner *et al.* 1986, Hafner and Fasola 1992). The fact that, in this study, freshwater habitats were of limited value does not preclude the possibility that they may be improved by appropriate management measures such as regulation of water level and protection and restoration of existing habitats.

In saltmarshes, which were mostly used (Fig. 1) in the pre- and post-breeding periods, foraging success was generally greater than in freshwater habitats. Additionally, Little Egrets were observed feeding exclusively in saltmarshes during the pre-breeding period. This suggests that saltmarsh is a very important feeding habitat for Little Egrets at the Axios Delta. Because of their limited value for man, extensive parts of saltmarshes (especially of tidal ones) have not yet experienced serious direct alterations. Protection from building and rubbish dumping is needed for these areas.

This research indicated that rice fields played an important role as a feeding habitat for Little Egrets. Rice fields were used in proportion to their availability (Fig. 2), indicating that Little Egrets take the opportunity to use this source of food when it is available (during the breeding period). The high foraging efficiency in rice fields may be related to the abundance of available food. In the other feeding habitats, where other types of prey were available (Kazantzidis, unpubl. data), foraging was less intense, probably because of prey scarcity. Differences in feeding activity and success of Little Egrets in different habitats frequently reflect differences in prey density and availability in the relevant habitats (Erwin *et al.* 1985). Prey behavior also plays a role (Fasola and Ghidini 1983, Kersten *et al.* 1991). Such differences in prey availability, abundance and behavior varying in a habitat within or among seasons, may account for the differences we observed in the foraging activity among different periods in

the same year and within the same period of different years. These differences were greater in the breeding season of 1989 in saltmarshes and rice fields probably denoting a particularly productive year. The use of rice fields provides birds with the opportunity to use complementary habitats during breeding, which has been found to be beneficial to foraging success in the herons breeding in the Camargue (Hafner and Fasola 1992). The main type of management of rice fields in our study area includes flooding of fields and later, when seedlings appear, use of pesticides to control (among other organisms) the crustacean *Triops cancriformis*, a seedling pest (Kazantzidis, unpubl. data). Such management of rice fields reduces their importance as feeding habitats for breeding Little Egrets. In the Camargue, *Triops* has been an important prey item (Hafner *et al.* 1986). In northern Italy, an important factor affecting prey was the temporary draining of fields for agricultural management resulting in the death of many tadpoles (Fasola and Ghidini 1983). In the study area, such draining does not take place once fields have been sown. Rice fields in the Axios Delta should be managed for wildlife as well. Agreements are needed among producers, wildlife researchers, and conservation groups to ensure that appropriate cultivation methods and pesticide selection and control will be used to facilitate the development of appropriate prey species in the rice fields. Additionally, a better understanding about prey productivity and cycles in the area is needed for habitat management purposes.

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