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USE OF THE DRANA LAGOON (EVROS DELTA, GREECE) BY THREATENED COLONIALLY NESTING WATERBIRDS AND ITS POSSIBLE RESTORATION

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Abstract

Six species of waterbirds nested colonially on small islands in the Drana saltwater lagoon in the Evros Delta from 1980 to 1986 and in the freshwater lake created in 1989, namely avocet Recurvirostra avosetta, *collared pratincole* Glareola pratincola, *common tern* Sterna hirundo, *little tern* Sterna albifrons, *gull-billed tern* Sterna nilotica *and Mediterranean gull* Larus melanocephalus. *The favoured islands provided greater isolation, were larger, and had greater cover of plant species preferred by the birds. The most important habitat factor affecting the choice of bird populations in general was isolation of islands. The gradual concentration of most species in the Drana lagoon was due to habitat alteration, predation and disturbance in coastal habitats resulting in scarcity of suitable breeding habitat. The Drana lagoon had a prominent conservation, scientific and economic value and therefore its restoration is recommended by reflooding with sea water, which would better ensure the preservation of the values of the area.* © *1997 Elsevier Science Ltd*

Keywords: Colonial waterbirds, breeding habitat, Drana lagoon, Evros Delta and restoration.

INTRODUCTION

Mediterranean wetlands have been drained and altered to such a degree that their very existence is threatened. The reasons for this have been widely considered during recent decades and, especially for the Mediterranean lagoons and saltmarshes, are summarized in Goutner (1994). In the Mediterranean, the integrated management of lagoons and saltmarshes and consideration for the welfare of waterbirds is scarce. The most important management procedures are probably those that have been applied in the Camargue, in southern France, through a long-term programme of habitat monitoring (Bassett, 1980). In addition to their usefulness for wintering waterfowl (Tamisier, 1979; Verhoeven, 1980; Allouche & Tamisier, 1984; Joensen & Madsen, 1985), Mediterranean lagoon islands and their saltmarsh vegetation constitute important breeding habitat for a variety of waterbirds such as the avocet *Recurvirostra avosetta*, collared pratincole *Glareola pratincola*, common tern *Sterna hirundo*, little tern *Sterna albifrons*, gull-billed tern *Sterna nilotica*, Mediterranean gull *Larus melanocephalus*, slender-billed gull *Larus genei* and the yellow-legged gull *Larus cachinnans michahellis* (Blondel & Isenmann, 1981; Goutner, 1985; Atta, 1986; Fasola *et al.*, 1993). Many of these species are threatened in the European Community and their populations are decreasing in large parts of the western Palearctic (Goutner & Papakostas, 1992; Goutner & Isenmann, 1993; Tucker & Heath, 1994).

In the Evros Delta on the Greek/Turkish border breeding bird habitats have suffered a continuous and alarming shrinkage in the past three decades (Britton & Hafner, 1978; Goutner & Kazantzidis, 1989). In addition to the species studied the area is important for the conservation of threatened bird species such as the slender-billed curlew *Numenius tenuirostris* and the lesser white-fronted goose *Anser erythropus* (Goutner & Handrinos, 1990; Handrinos & Goutner, 1990). The purpose of this paper is: (1) to indicate the importance of the former Drana lagoon in the Evros Delta as a habitat for colonially nesting waterbirds; (2) to describe the use of the Drana lagoon islands; and (3) and to propose restoration measures that could contribute to the conservation of the Evros Delta.

STUDY AREA

The Drana lagoon was created at the northwestern part of the Evros Delta (Fig. 1; see also Goutner & Kazantzidis, 1989) by surrounding a shallow area of *c.* 400 ha by dykes in 1975. It had a maximum depth of *c.* 1·2 m and communicated with the sea through an opening 4 m

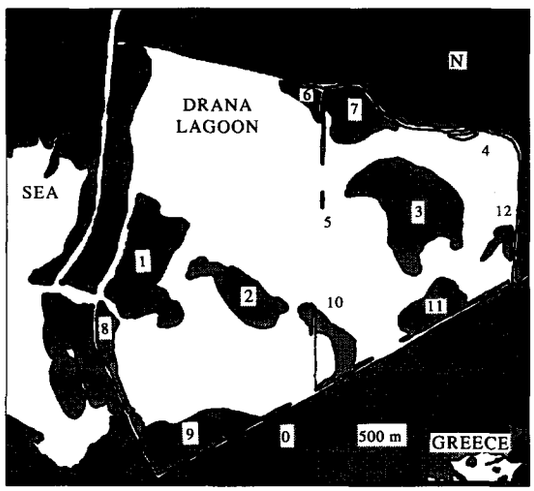

Fig. 1. Map of the Drana lagoon, Evros Delta. Stippled areas represent land. The inset places the study area within the context of Greece.

wide. Salinity varied seasonally from 37·5‰ to 55‰ (Britton & Hafner, 1978). There were several islands covered by saltmarsh vegetation. Because of its designation as a local no-hunting reserve, the Drana lagoon became a stronghold for waterfowl in winter (Goutner & Jerrentrup, 1987) and the area was protected by the Ramsar Convention, the EC Bird Directive 79/409 and a Ministerial Decree in 1980. The lagoon was used for fish-farming until early May 1987, when it was drained by local people because saltwater was considered to be destroying the surrounding cultivated land through underground seepage (Goutner & Jerrentrup, 1987). The single connection of the lagoon to the sea was blocked and water was drained through an opening made in a dyke on the eastern edge of the lagoon by pumping water into drainage canals.

In 1988 the local inhabitants, in agreement with the Ministry of the Environment, Housing and Public Works, constructed sluices to allow fresh water (mainly from canals) to flow into the area, but the connection to the sea was not restored. This management procedure aimed at the desalination of the area to reduce the salinity risk to surrounding cultivations, and was not directed towards wildlife conservation. In terms of water level the area regained its former appearance by the beginning of June 1989 and colonial bird species reused the islands for breeding. Recently, however, there has been an increasing interest by the local communities, in collaboration with conservation bodies, to restore the lagoon.

METHODS

From 1981 to 1986 I monitored the breeding populations of birds nesting on the Drana lagoon islands (avocets and collared pratincoles from 1980) and in two coastal islands and some associated coastal sand bars, the only remaining breeding grounds of these species in the Evros Delta, situated *c.*3 km from Drana (Goutner, 1990; Fasola *et al.*, 1993). The number of breeding pairs was recorded by nest counts during the breeding season (late April to late July). Common and little terns and avocets bred in two distinct periods. The breeding population of these species was taken to be the number of early breeders, to avoid overestimation, but for evaluating the relative importance of the Drana islands for breeding I took account of all nests found on them throughout the whole breeding period. In 1987 and 1988 when the Drana area was dry, and in 1989 when it was a freshwater lake, I continued monitoring the Evros Delta breeding populations of the study species.

The distance to the nearest mainland, nearest other island and the size of the Drana islands were measured on official maps scaled 1:10,000 and 1:20,000 based on air photographs. Substrate type and % vegetation cover were recorded around nests and closest conspecific distances measured using a 0·5 × 0·5 m grid (see Blokpoel *et al.*, 1978; Goutner, 1990) in most years and breeding sites. Overall vegetative cover of the Drana islands was measured in 1985 by averaging the % cover in a *c.*1 in 150 random sample of 5 × 5 m plots taken in proportion to the extent of each island. Dominant plant species were also recorded in the samples.

To assess the grazing impact of cattle on waterbird populations a grazing intensity index 1–10 was assigned to each island for each year and values were averaged for 1981–1986.

The Mann–Whitney *U*-test was used for comparing habitat data. Scheffe tests were used to distinguish differences between the nearest neighbour distances after analysis of variance or *t*-tests (on log-transformed data when necessary to obtain normality). To determine the most important factors that played a role in the selection of Drana islands by the birds studied, a stepwise multiple regression was applied using island size, nearest mainland distance, nearest other island distance, % vegetation cover and grazing intensity as independent variables and total populations (1981–1986) of each species as well as overall populations as dependent variables. Intercorrelations among variables were not significant. The independent variables were standardised by subtracting the mean and dividing by the standard deviation, but each dependent variable was log $(x+1)$ transformed as standardisation of the dependent variables is not recommended (Fry, 1993).

In mixed seabird colonies some species tend to nest together or avoid others and such relationships can be examined using the coefficient of association (Jernigan *et al.*, 1978; Goutner, 1990; Fasola & Canova, 1992). To assess whether the presence of colonially breeding birds in the same colony areas was due to association among species I estimated coefficients of association

$$V = ad - bc/[(a+b)(c+d)(a+c)(b+d)]^{\frac{1}{2}}$$

where a = species x and y are both present in a colony, b = species x absent, species y present, c = species x present, species y absent, d = both species absent (Krebs, 1972). Their significance for each combination of two species was examined by 2 × 2 exact tests (Bailey, 1979).

RESULTS

Use of the Drana lagoon by colonially breeding waterbirds 1980–1986

Six species of colonially breeding waterbirds nested on the islands of the Drana lagoon during 1980–1986.

Avocet

The Drana lagoon attracted almost all the breeding avocets in the Evros Delta in all study years, but the population declined greatly from a maximum of 133 breeding pairs in 1981 (Fig. 2) to 26 pairs in 1986. Two of the islands (2 and 3, Fig. 1) were favoured during this period and a few other sites were used occasionally (Table 1). Conspecific distances were shorter on island 2 than on 3 (Table 2). Vegetation cover around nests varied from low to moderate (Table 2).

Collared pratincole

Between 1980 and 1986 the proportion of collared pratincoles selecting the lagoon increased from 25% to nearly 90% but their population in the Delta declined markedly (Fig. 2). During most study years island 2, followed by 3, held the highest proportion of the pratincole population in the Delta (Table 1), although some birds used a coastal island every year. Closest conspecific distances and vegetation cover around nests were moderate (Table 2).

Common tern

There was a progressive and prominent preference of the Drana lagoon by the common tern through the

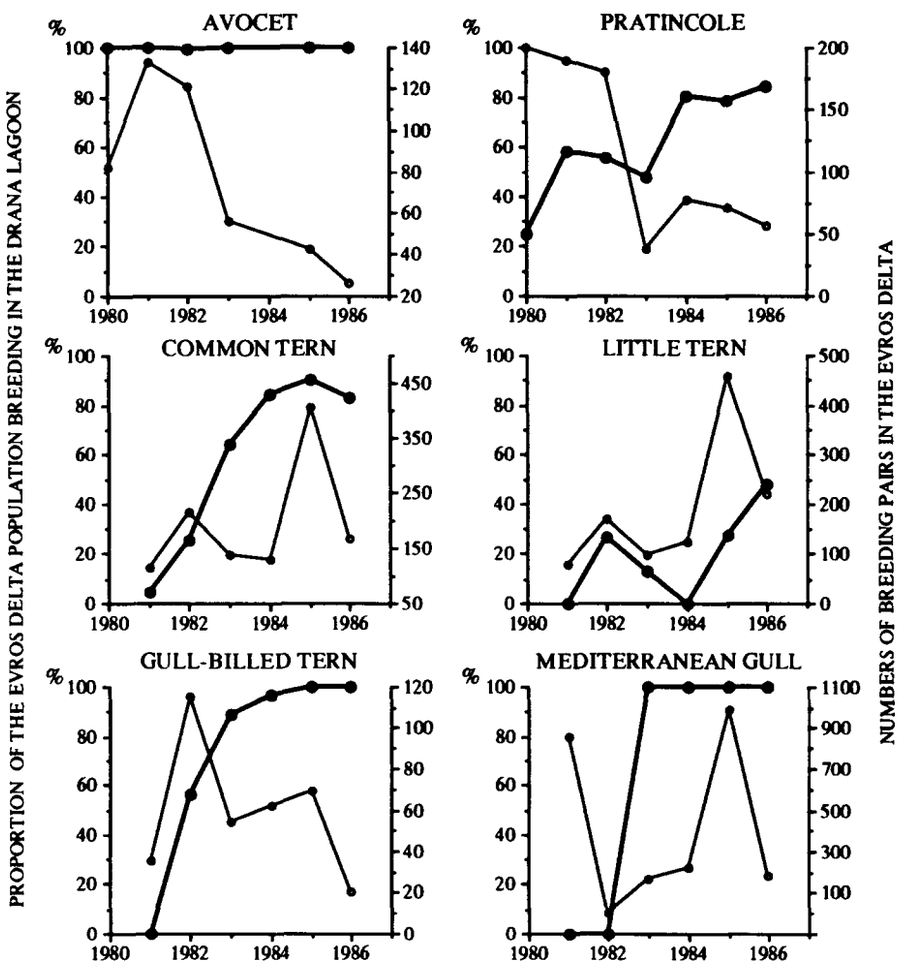

Fig. 2. Proportions of the breeding population (number of pairs) of each species studied (left y axes, thin line, open dots) in relation to their total breeding population in the Evros Delta (right y axes, thick line, closed dots), from 1980 to 1986.

study years, although its population did not vary markedly in size with the exception of a peak in 1985 (Fig. 2). Island 2 was by far its most important breeding area followed by islands 1 and 5 (Table 1). Nearest conspecific distances of nests made on shelly substrates were significantly shorter than those among vegetation and/or on a sand–mud substrate, even on the same island (Table 2). Vegetation cover around nests was moderate or absent on sand–mud substrate, and absent on shell substrates (Table 2).

Little tern

The population of little terns on the Drana islands was a minor part of the Evros Delta population (Fig. 2). The most-preferred island was 3, followed by 2 and 1 and occasionally 4 (Table 1). Nearest conspecific distances varied significantly between islands and within the same year even on the same island (Table 2); they were significantly shorter on shell substrates. Vegetation cover around nests was low or absent.

Gull-billed tern

After 1981 the breeding gull-billed tern population increasingly preferred the Drana lagoon but the Evros Delta population reached a peak in 1982 and gradually declined again (Fig. 2). Only island 2 was used (Table 1) and in 1985 and 1986 this was its only breeding site in the Evros Delta. Moderate nest spacing and moderate to high vegetation cover were used and were similar between years (Table 2).

Mediterranean gull

Mediterranean gulls bred for the first time in the Evros Delta in 1981 (Goutner, 1986*a*). Their population fluctuated through the years and from 1983 to 1986 exclusively preferred the Drana lagoon (Fig. 2). Only island 2

Table 1. Numbers of breeding pairs of birds using the islands in the Drana lagoon and coast from 1981 to 1986

Species	Island number (Fig. 1)												Coast	Totals	% on Drana island
	1	2	3	4	5	6	7	8	9	10	11	12			
Avocet	2	184	172	15	1	0	0	0	0	0	0	0	1	375	99·7
Collared pratincole	18	292	89	0	0	0	0	0	0	0	0	0	370	769	92·7
Common tern	92	768	5	0	76	0	0	0	0	0	0	0	409	1350	69·7
Little tern	12	91	227	9	0	0	0	0	0	0	0	0	811	1150	29·5
Gull-billed tern	0	262	0	0	0	0	0	0	0	0	0	0	93	355	73·8
Mediterranean gull	0	1568	0	0	0	0	0	0	0	0	0	0	906	2474	63·4
Totals	124	3165	493	24	77	0	0	0	0	0	0	0	2590	6473	60·0
% of Drana totals	3·2	81·5	12·7	0·6	1·2	0	0	0	0	0	0	0			
Total number of bird-seasons[a]	5	29	16	2	2										
Cattle grazing score	4·5	0·0	8·7	0·0	0·0	0·7	4·2	3·1	2·3	0·0	3·1	9·1			

[a]Produced by adding the number of breeding seasons each island was used by each species on each island.

Table 2. Nesting parameters of colonially breeding waterbirds on the islands in the Drana lagoon. Substrate: SM, sand–mud; SH, shells; SA, sandy

	Year	Island number	Substrate	Average % nest cover	Mean nearest neighbour (cm) ± SD (*n*)
Avocet	1980	3	SM	50	605 ± 358 (50)[b]
	1981	2	SM	< 30	535 ± 250 (17)
	1982	2	SM	< 30	408 ± 166 (54)[a]
	1985	3	SM	11	615 ± 351 (28)[a]
Collared pratincole	1980	Coast[c]	SA	17	375 ± 104 (21)[a]
	1982	2	SM	30	200 ± 172 (30)
Common tern	1985	1	SH	0	137 ± 82 (40)[a]
	1985	2	SH	0	68 ± 28 (50)[a]
	1985	5	SM	0	146 ± 151 (34)
	1986	2	SM	43	153 ± 112 (27)[b]
Little tern	1985	3	SM	6	273 ± 157 (69)
	1986	2	SH	0	119 ± 30 (13)[a]
	1986	3	SH	0	111 ± 33 (28)[a]
	1986	3	SH	7	76 ± 38 (17)[a]
Gull-billed tern	1985	2	SM	59	140 ± 64 (66)[b]
	1986	2	SM	57	122 ± 54 (15)
Mediterranean gull	1985	2	SM	70	58 ± 33 (356)[a]
	1985	Coast[c]	SA	21	143 ± 163 (34)

[a]Significant differences between adjacent values.
[b]Insignificant differences between adjacent values.
[c]Data are given from the coastal habitat to indicate difference.

Table 3. Characteristics of islands in the Drana lagoon

Island number (Fig. 1)	Distance to nearest		Surface area (ha)	Vegetation cover (%)	Dominant vegetation[a]
	Mainland (m)	Other island (m)			
1	374	44	18·4	70	HP, AF
2	418	66	8·0	65	HP, HS, AF
3	288	88	20·2	60	HS, HP, AF
4	10	220	0·4	5	HS
5	539	132	0·2	0	—
6	77	10	1·9	10	SE
7	6	10	8·1	35	HS, PF
8	3	7	3·4	50	HS, SE
9	7	7	12·3	55	AF, PF, SE
10	20	66	4·3	55	GR, HP, TS
11	20	88	6·1	57	GR, AF, HP
12	5	121	1·7	45	GR, HS

[a]HP, *Halimione portulacoides*; AF, *Arthrocnemum fruticosum*; HS, *Halocnemum strobilaceum*; SE, *Salicornia europaea*; PF, *Puccinellia festuciformis*; TS, *Tamarix smyrnensis*; GR, grasses.

attracted this species for breeding (Table 1). Nearest conspecific nest distances were shorter and vegetation cover higher than on the coastal island where it also nested (Table 2).

In total, 3883 nests were made by the six species on the Drana lagoon islands from 1981 to 1986. Of these the highest numbers belonged to the Mediterranean gull followed by the common tern, avocet and collared pratincole in similar numbers and by the little and gull-billed tern.

Island structure in relation to their use by colonially breeding waterbirds

Of the six islands preferred by the bird species studied, island 2 was by far the most important. From 1981 to 1986 it attracted about 80% of the breeding populations and was used in total for 29 (out of 31 available) bird-seasons (Table 1). Island 3 followed in importance attracting 13% of the populations in 16 bird-seasons. Island 1 attracted about 3% of the populations in five bird-seasons while two sites were only used occasionally. Island 6 was used by nine pairs of avocets in 1980, but islands 7–12 (Fig. 1) were not used by the birds during the study.

There were differences in the particular features of the Drana lagoon islands (Table 3). The distance to the mainland of the three most used islands (1–3) was obviously greater than that of the other islands (excluding site 5, which consisted of a sand-mud bar occasionally appearing above water). However, the average surface area of these islands did not differ significantly from the non-used ($U = 19$, NS, Mann–Whitney U-test) and percentage cover did not differ between these two categories ($U = 18$, ns). Their surface area was significantly greater than of the other islands ($U = 22$, $p = 0.025$) and they also had significantly greater percentage cover ($U = 24$, $p = 0.01$). Additionally, despite similarities in vegetation among the Drana lagoon islands, the dominant species of these three islands did not include *Puccinellia festuciformis*, *Salicornia europaea*, *Tamarix smyrnensis* and grasses.

Of the Drana islands, 2, 4 and 5 (Fig. 1) were never grazed (the last two because they were almost vegetation-free). Cattle were grazed on all the others because most were dominated by more palatable plants (Table 3), but islands 7–12 were never colonised by the birds in this study (Table 1), and on island 1 the cattle never grazed over the breeding grounds. The effects of grazing on breeding avocets were documented on island 3 in 1980 and 1981, when 26·0% and 17·1% of eggs and 26·2% and 8·7% of chicks respectively were destroyed by trampling and resulted in the desertion of the site in 1980 (Goutner, 1985).

The stepwise multiple regression revealed that the only factor contributing significantly to the relationship between the five fixed variables and all species' populations taken together (1981–1986) was the distance of islands to the nearest mainland ($R^2 = 0{\cdot}696$, $F = 22{\cdot}935$, $p = 0.0007$). This factor was also the only one providing a significant relationship with the common tern populations ($R^2 = 0{\cdot}850$, $F = 56{\cdot}865$, $p = 0{\cdot}00002$) whereas no significant relationships were found for the remaining species.

The coefficients of association between the species varied from −0·26, between the little tern and avocet, to +0·61 between the Mediterranean gull and gull-billed tern, but coefficients were insignificant in all cases.

Effect of draining and creation of freshwater lake, 1987–1994

In 1987 and 1988, all the study species left the drained site and used the coastal islands (Table 4). However, in 1989 the highest breeding populations of all these species except little terns were once more found on islands 2 and 3 of the freshwater lake, while the remaining birds bred on the coastal islands. For the first time during the study, Mediterranean gulls and gull-billed terns used island 3, the former in the highest numbers ever recorded breeding in the Evros Delta. From 1990 to 1994, insufficient freshwater entered the area to maintain the lake and thus no islands were formed during the

Table 4. Numbers of pairs of colonially nesting birds from 1987 to 1989 in the available Evros Delta breeding grounds

Species	Coastal island			Drana islands (1989)		% of delta population
	1987	1988	1989	2	3	
Avocet	5	3	0	0	12	100
Collared pratincole	21	27	3	0	60	95
Common tern	153	195	68	200	71	80
Little tern	161	194	204	0	68	25
Gull-billed tern	58	5	0	10	19	100
Mediterranean gull	17	85	0	1040	170	100

breeding season. As a result, none of the study species bred there (personal observations).

DISCUSSION

Nest site selection in gulls and terns is frequently a compromise between avoidance of predators and disturbance, flooding and vegetation increase (Burger & Lesser, 1978; Kotliar & Burger, 1986; Storey, 1986). The absence of breeding birds on the former Drana islands in 1987 and 1988, and their recolonisation in 1989 suggests that the presence of water was very important for effecting isolation from terrestrial predators and encouraging birds to breed on the islands. It is therefore not surprising that the distance of the Drana islands from the mainland was found to be the most important habitat selection factor for breeding populations.

The greatest vegetation cover was on higher ground on the three preferred islands. This was favoured by Mediterranean gulls and gull-billed terns (Goutner, 1987), whose colonies were therefore not flooded. Low % cover, mostly favoured by common terns, little terns and avocets, was available mainly on the edges where the danger of flooding was greatest. The larger size of the preferred islands may have provided breeding birds with a greater variety of environmental features and available space for their specific requirements. This requirement for a range of habitat variables is also known from other Mediterranean countries (Casini, 1986; Fasola, 1986; Fasola *et al.*, 1993; Calvo, 1994; Calvo & Furness, 1995).

Grazing was intense on some of these islands and in such conditions breeding success is a function of cattle density and days of exposure (Beintema & Müskens, 1987). The fact that grazing intensity had no significant relationship with nesting bird populations may mean that birds returned to islands despite the risk of trampling probably due to a loss of suitable breeding grounds elsewhere. This loss was reflected in increased aggregation of the study species on the islands but the lack of association between them suggests that this was due to common habitat preferences. Collared pratincole and Mediterranean gull both had significantly shorter conspecific distances on the Drana islands than on the coastal island, and avocets had shorter conspecific distances on island 2 in 1982 than in 1981, a fact related to interspecific interactions with invading larids on this island (Goutner, 1985).

The overall decline of bird populations in the Evros Delta over the years may be due to the gradual worsening of breeding conditions generally. Even in the late 1970s, Britton & Hafner (1978) reported that Drana and the coastal habitat were the only remaining ones important for the study species in the Delta, but, except for avocets, the other species preferred the coastal islands. The increased interest of pratincoles, gulls and terns in the Drana islands in the 1980s seems to be due to a number of reasons. For example, although Mediterranean gulls bred in 1981 on a coastal island, they then shifted to the Drana lagoon owing to the encroachment of reeds *Phragmites australis* over their breeding grounds (Goutner, 1986*a*). Predation increased on little terns in the coastal habitat over the years, but was considerably less on the Drana islands (Goutner, 1990). Additionally, disturbance on the coastal islands increased due to activities such as fishing, digging for bait and bivalves, and visits by tourists. Avocets, Mediterranean gulls and gull-billed terns were not dependent on the Drana lagoon for foraging (Goutner, 1985, 1986*b*, 1991). In general, therefore, the Drana islands probably became relatively more attractive due to increasing habitat alteration, predation and disturbance in the coastal habitat. In 1989, because no appropriate management plan was enforced to improve conditions elsewhere in the Delta, the birds returned to the islands in the freshwater lake.

Towards the restoration of the Drana lagoon

As water demands of the agricultural land in the Evros Delta are high and the river discharge is decreasing, it seems improbable that flooding of Drana by fresh water can be used as a management tool on a regular basis. Even if the required amounts of fresh water were available, long-term management of the former lagoon area as a freshwater lake would probably modify the vegetation composition of the islands and cause an increase of undesirable reedbeds, as in other parts of the Delta which have been managed using fresh water. Additionally, the suspended material in the incoming water would quickly silt up the Drana area, resulting in decreased depth which would reduce the isolation of the islands. The poor quality of the river water polluted by nitrates and phosphates from fertilizers and local activities (Angelidis & Athanasiadis, 1995) would probably lead to biological degradation. As long-term data are not available for the Drana area under this type of management, it is unknown if it would be beneficial for the study species and thus it cannot be recommended as a solution for restoring the wildlife interest. On the other hand, restoration of the lagoon to its former

condition by flooding with sea water would restore its conservation and scientific values, as well as providing a productive fish-farming area for local fishermen.

As the presence of the studied species in the Drana lagoon is greatly dependent on what happens elsewhere in the Evros Delta and particularly on its human uses, it is evident that an integrated management plan is needed. Such a plan, besides acting towards the restoration of the Drana lagoon, should further investigate the factors which affect the presence of colonially breeding waterbirds in the coastal habitat and in the rest of the Delta; the regulation of grazing on the Drana islands should also be examined, and its use as a management tool for restoration of bird habitats in the rest of the Delta.

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REFERENCES

Allouche, L. and Tamisier, A. (1984) Feeding convergence of gadwall, coot and the other herbivorous waterfowl species wintering in the Camargue: a preliminary approach. *Wildfowl* **35**, 135–142.

Angelidis, M. O. and Athanasiadis, A. I. (1995) Pollution mechanisms in a Ramsar wetland: delta of the River Evros, Greece. *Aquat. Sci.* **57**, 161–171.

Atta, G. A. M. (1986) Status of the breeding population of little tern (*S. albifrons*) in the Bardawil nature Reserve (Egypt). MSc thesis, Aberdeen University.

Bailey, N. T. J. (1979) *Statistical Methods in Biology*. Hodder & Stoughton, London.

Bassett, P. A. (1980) Some effects of grazing on vegetation dynamics in the Camargue, France. *Vegetatio* **43**, 173–184.

Beintema, A. J. and Müskens, G. J. D. M. (1987) Nesting success of birds breeding in Dutch agricultural grasslands. *J. Appl. Ecol.* **24**, 743–758.

Blondel, J. and Isenmann, P. (1981) *Guide des oiseaux de Camargue*. Delachaux & Niestlé, Neuchâtel, Paris.

Blokpoel, H., Catling, P. M. and Haymes, G. T. (1978) Relationship between nest sites of common terns and vegetation on the Eastern Headland, Toronto Outer Harbor. *Can. J. Zool.* **56**, 2057–2061.

Britton, R. H. and Hafner, H. (1978) Proposals for nature conservation in the Evros Delta. Station Biologique de la Tour du Valat, Arles, and Ministry of Coordination, Athens (Greece). (unpublished official report).

Burger, J. and Lesser, F. (1978) Selection of colony sites and nest sites by common terns (*Sterna hirundo*) in Ocean County, New Jersey. *Ibis* **120**, 433–449.

Calvo, B. (1994) Effects of agricultural land-use on the breeding of collared pratincole (*Glareola pratincola*) in Southwest Spain. *Biol. Conserv.* **70**, 77–83.

Calvo, B. and Furness, R. W. (1995) Colony and nest-site selection by collared pratincoles (*Glareola pratincola*) in south-west Spain. *Colonial Waterbirds* **18**, 1–10.

Casini, L. (1986) Nidificazione di cavaliere d' Italia (*Himantopus himantopus*) ed avocetta (*Recurvirostra avosetta*), nella salina de Cervia (Ravenna). *Riv. ital. Ornitol.* **56**, 181–196.

Fasola, M. (ed.) (1986) Distributione e population dei Laridi e Sternidi nidificanti in Italia. *Suppl. Richerche Biol. Selvaggina* **11**, 1–179.

Fasola, M. and Canova, L. (1992) Nest habitat selection by eight syntopic species of Mediterranean gulls and terns. *Colonial Waterbirds* **15**, 169–178.

Fasola, M., Goutner V. and Walmsley, J. (1993) Comparative breeding biology of the gulls and terns in the four main deltas of North Mediterranean. In *Status and Conservation of Seabirds—Ecogeography and Mediterranean Action Plan.* ed. J. S. Aguilar, X. Monbailliu and A. Paterson, pp. 99–111. Medmaravis, Madrid.

Fry, J. C. (ed.) (1993) *Biological Data Analysis. A Practical Approach*. Oxford University Press, Oxford.

Goutner, V. (1985) Breeding ecology of the avocet (*Recurvirostra avosetta* L.) in the Evros Delta (Greece). *Bonn. zool. Beitr.* **36**, 37–50.

Goutner, V. (1986*a*) The ecology of the first breeding of the Mediterranean gull (*Larus melanocephalus* Temminck 1820) in the Evros Delta, Greece. *Ecol. Birds* **8**, 189–197.

Goutner, V. (1986*b*) Distribution, status and conservation of the Mediterranean gull (*Larus melanocephalus*) in Greece. In *Mediterranean Marine Avifauna—Population Studies and Conservation*, ed. X. Monbailliu. *NATO ASI Series*, Vol. 12, pp. 431–447. Springer Verlag, Berlin, Heidelberg.

Goutner, V. (1987) Vegetation preferences by colonies of Mediterranean gulls (*Larus melanocephalus*) and gull-billed terns (*Gelochelidon nilotica*) in the Evros Delta. *Seevögel*, **8**, 29–31.

Goutner, V. (1990) Habitat selection of little terns in the Evros Delta, Greece. *Colonial Waterbirds* **13**, 108–114.

Goutner, V. (1991) Food and feeding ecology of gull-billed terns (*Gelochelidon nilotica*) in Greece. *Rev. Ecol. (Terre Vie)* **46**, 373–384.

Goutner, V. (1994) Importanza e gestione di lagune e stagni salmastri. In *La gestione degli ambienti costieri e insulari del Mediterraneo*, ed. X. Monbailliu and A. Torre, pp. 169–198. Medmaravis, Alghero.

Goutner, V. and Handrinos, G. (1990) The occurrence of slender-billed curlews *Numenius tenuirostris* in Greece. *Biol. Conserv.* **53**, 47–60.

Goutner, V. and Isenmann, P. (1993) Breeding status of the Mediterranean gull *Larus Melanocephalus* in the Mediterranean Basin. In *Status and Conservation of Seabirds—Ecogeography and Mediterranean Action Plan.* ed. J. S. Aguilar, X. Monbailliu and A. Paterson, pp. 59–63. Medmaravis, Madrid.

Goutner, V. and Jerrentrup, H. (1987) The destruction of the Drana lagoon in the Evros Delta Ramsar wetland, and its consequences for waterfowl. *W. S. G. Bull.* **50**, 18–19.

Goutner, V. and Kazantzidis, S. (1989) Evaluation of the relative importance of the zoning of the Evros Delta wetland (Greece) for bird groups of special conservation interest. *Acta Oecologica–Oecol. Applic.* **10**, 365–378.

Goutner, V. and Papakostas, G. (1992) Evaluation of the ornithological importance of the Alyki Kitrous wetland, Macedonia, Greece: a priority for conservation. *Biol. Conserv.* **62**, 131–138.

Handrinos, G. I. and Goutner, V. (1990) On the occurrence of the lesser white-fronted goose *Anser erythropus* in Greece. *J. Ornithol.* **131**, 160–165.

Jernigan, L., Soots, R., Parnell, J. and Quay, T. (1978) Nesting habits and breeding populations of the least tern in North Carolina. UNC Sea Grant Publs, UNC-SG-78-07.

Joensen, A. H. and Madsen, J. (1985) Waterfowl and raptors wintering in wetlands of western Greece. *Nat. Jutl.* **21**, 169–200.

Kotliar, N. B. and Burger, J. (1986) Colony site selection and abandonment by least terns *Sterna antillarum* in New Jersey, USA. *Biol. Conserv.* **37**, 1–21.

Krebs, C. J. (1972) *Ecology: The Experimental Analysis of Distribution and Abundance*. Harper & Row, New York.

Storey, A. E. (1986) Adaptations for marsh nesting in common and Foster's terns. *Can. J. Zool.* **65**, 1417–1420.

Tamisier, A. (1979) The functional units of wintering ducks: a spatial integration of their comfort and feeding requirements. *Verh. ornithol. Ges. Bayern* **23**, 229–238.

Tucker, G. M. and Heath, M. F. (1994) Birds in Europe: their conservation status. *Birdlife Conservation Series*, No. 3. Birdlife International, Cambridge.

Verhoeven, J. T. A. (1980) The ecology of *Ruppia* dominated communities in western Europe, III. Aspects of production, consumption and decomposition. *Aquat. Bot.* **8**, 209–253.