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Seasonal trends of waterbirds at Vourkari inlet, western Attiki, Greece

Vasilios LIORDOS*

Hellenic Forest Service, 12 Minoas str., GR-19100 Megara, Attiki, Greece

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The waterbird assemblage of a small shallow coastal wetland, the Vourkari inlet, western Attiki, Greece, was studied in 2008. Weekly counts revealed distinctive seasonal patterns of occurrence and abundance. A total of 54 species of waterbirds were recorded, 22 of which were regular visitors and 32 scarce vagrants and were classified as residents, winter and early spring migrants, autumn migrants, and spring migrants. The highest total numbers of individuals were observed in winter and early spring migration. The monthly number of species varied from 6 in June to 29 in October and was not correlated with the monthly total population size ($r_s = 0.420$, $n = 12$, ns). The yellow-legged gull (*Larus michahellis*), little egret (*Egretta garzetta*), grey heron (*Ardea cinerea*), common redshank (*Tringa totanus*) and dunlin (*Calidris alpina*) were regularly observed in most of the months, whilst the black-headed gull (*Larus ridibundus*), Mediterranean gull (*Larus melanocephalus*), yellow-legged gull, sandwich tern (*Sterna sandvicensis*), great cormorant (*Phalacrocorax carbo*), common redshank and little egret were the most abundant. The inlet holds nationally important wintering populations of the common shelduck (*Tadorna tadorna*), little egret, common redshank and sandwich tern. At least 13 of the regularly occurring species have an unfavourable conservation status on the national and/or international level. The Vourkari inlet hosts a diverse waterbird assemblage and its value lies more in its use as a feeding, roosting and staging site for wintering and migrating waterbirds. The inlet is currently threatened by overexploitation and conservation efforts should focus therefore on its protection and improvement through the designation of a wildlife refuge and with appropriate habitat management interventions.

Key words: waterbirds, seasonal occurrence and abundance, small coastal wetlands, Greece.

INTRODUCTION

The waterbirds are a large and diverse group of birds which are ecologically dependent on aquatic habitats. This term originally referred to waterfowl and large wading birds (such as herons and storks), but its meaning has expanded to include all the waterfowl, seabird and wading bird species (Gill, 1994; Podulka *et al*., 2004). Wetlands are critical habitats for the fulfillment of the foraging, resting and breeding requirements of many waterbird species. Despite their importance for waterbirds, millions of hectares of wetland habitats (e.g. coasts, estuaries, marshes, shallow lakes) have been drained worldwide and used for human activities (Shine & Klemm, 1999). The continuing deterioration of wetlands and the consequent decline of many waterbird species populations have rendered their protection and restoration a major conservation priority (Gill, 1994; Birdlife International, 2004).

Coastal wetlands are used by waterbirds during most of their life-cycle. They are of particular importance during migration, as the long coastal routes are preferable from an energetic perspective to the shorter inland ones for most of the waterbird species (Alerstam, 2001; Alerstam *et al*., 2003), because coastal regions provide the required network of high-quality staging sites. Current research on international level has demonstrated the significance of small, permanent or temporary, wetlands especially as wintering and migration stopover sites for waterbirds (Ntiamoa-Baidu *et al*., 2000; McCulloch *et al*., 2003; Jack-

* Corresponding author: tel.: +30 22960 83651, fax: +30 22960 83652, e-mail: liordos@yahoo.com

son *et al*., 2006; Baar *et al*., 2008; Skagen *et al*., 2008). There is a growing need for quantitative information on dispersed bird populations and for methods and techniques to monitor these populations that will enable the formulation and application of appropriate conservation strategies. However, dispersed, small-sized populations in small wetlands often do not gain the attention of scientists and managers the way large avian congregations in well-known important sites do. The population trends of some waterbird assemblages or single species occurring at large Greek wetlands have been studied in some cases (Goutner, 1983; Meininger, 1990; Goutner & Papakostas, 1992; Goutner & Kazantzidis, 1993; De Nobel, 1995; Goutner *et al*., 2005). Many waterbird species involved are protected under international agreements (such as the Ramsar Convention, the EU Wild Birds Directive, and the EU Habitats Directive).

Dispersed small, coastal or inland, wetlands are common in Greece. However, there are major gaps in our knowledge on the ecology of the waterbird assemblages of small coastal wetlands, including lack of data on numbers and population fluctuations. Therefore, the aim of this paper is to study the importance of Vourkari inlet, a small coastal wetland in Greece, as a waterbird habitat through the application of a population monitoring method during the course of a calendar year and analysis of the seasonal patterns of occurrence and abundance.

MATERIALS AND METHODS

The study was carried out at Vourkari inlet (37° 58′ 47″ N, 23° 23′ 17″ E), Saronikos Gulf, western Attiki, Greece, a small, relatively shallow, coastal wetland covering 3.0 km^2 with its associated habitats (Fig. 1). It is situated about 30 km to the east of the capital city of Athens, with Salamina island delineating its easterly-oriented mouth. The wetland water is less than 6 m deep and six habitat types, mainly used by

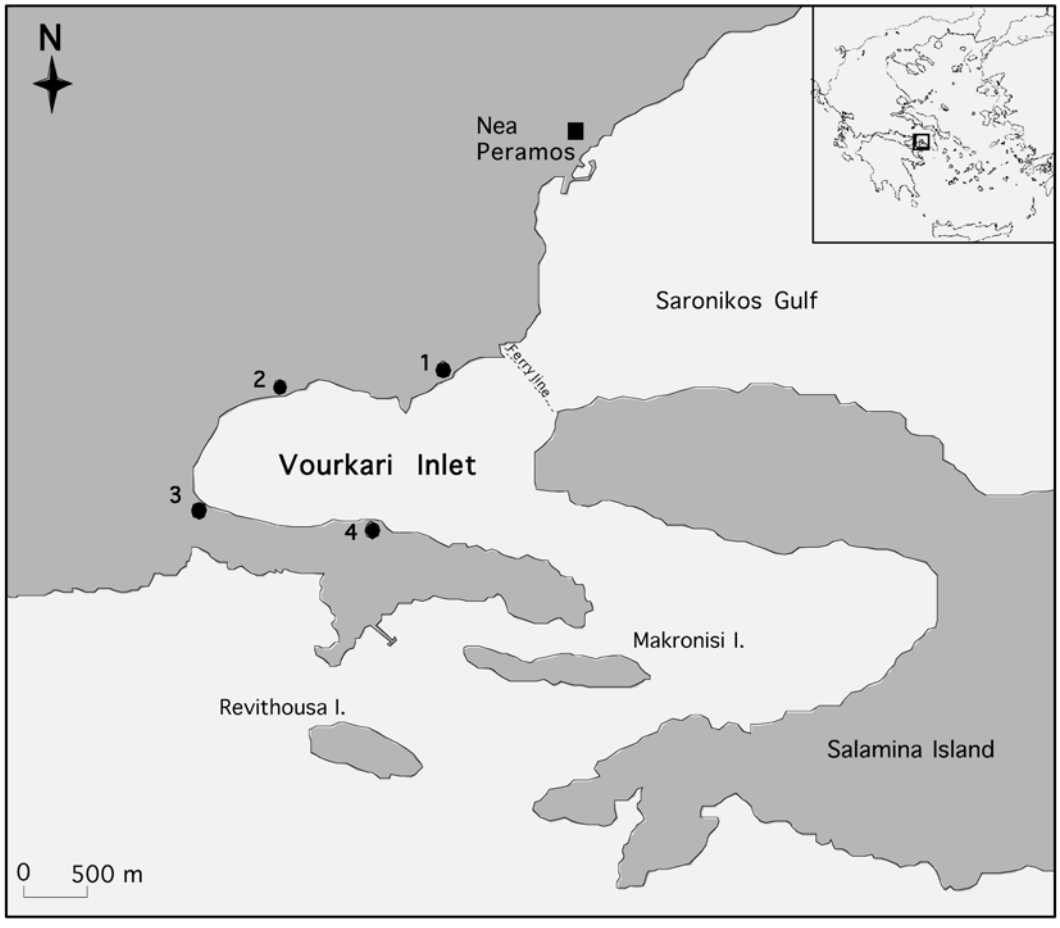

FIG. 1. Map showing the location of Vourkari inlet, Saronikos Gulf, western Attiki, Greece. Numbers refer to survey stations.

waterbirds for foraging and roosting activities, have been identified (Liordos, 2010). The main habitats are shallow water (extending from the tide line to 6 m deep), intertidal mudflats (with muddy or muddy and rocky substrate) and glasswort (*Salicornia fruticosa*) – shrubby seablite (*Suaeda vera*) dominated halophytic grassland (Margaris *et al*., 2004). Other habitats include tidal pools (intertidal areas holding water during low tide), tidal channels (with water channelling through a limited area in the substrate), and ditches (a 200 m long, 1.5 m wide and 0.8 m deep artificially excavated ditch, running across the western limits of the inlet, within the halophytic grassland). Shallow water (2.0 km^2; 66.67%), intertidal mudflats (0.7 km^2; 23.33%) and halophytic vegetation (0.24 km^2; 8%) covered 98% of the inlet, followed by tidal pools (0.05 km^2; 1.67%), tidal channels (0.009 km^2; 0.3%), and ditches (0.001 km^2; 0.03%) (Liordos, 2010). Human activities within and around the inlet include aquaculture, boat fishing, housing, and industry. The latter two threaten the inlet by habitat destruction through building and pollution influx.

The monitoring methodology proposed by Bibby *et al*. (1992), as adapted by Yasué (2006), was followed. The inlet was surveyed from January to December 2008. Waterbird censuses were carried out weekly (i.e., four or five weeks per month, 52 in total) using four observation points (Fig. 1) from which the scanning of the entire inlet was possible. The counts occurred in the morning and lasted for two to three hours (from 08.00 to 11.00 AM; GMT+2:00). Birds were identified and counted using a 25-75×82 fieldscope and 10×50 binoculars. Flock and individual bird movements were taken into account during switching between observation points to avoid double counts.

Seasonal abundance of waterbirds at Vourkari inlet was analysed by taking the mean number of individuals per species per month. However, since average counts do not necessarily indicate how often a species is found at a site, the frequency of occurrence per month was also calculated for each species as $C = p \times 100/P$, where p represents the number of visits in which a species was seen, and P represents the total number of visits for a month (Barbieri & Hvenegaard, 2008). Waterbirds were then placed into four categories, based on their frequency of occurrence per month: regular (species observed in > 50% of the visits in a month); sporadic (observed in 50% of the visits); accidental (observed in 25% of the visits); and absent (not observed).

Common seasonal trends were identified by cluster analysis performed with the statistical software Primer (vers. 5.1.2, PRIMER-E, Roborough, Plymouth, UK) on the standardised monthly counts. The Bray-Curtis (1957) similarity was used as distance measure and complete linkage as linkage rule. The relationship between the monthly number of species and number of individuals was examined using the Spearman rank correlation coefficient (Zar, 1999). Common and scientific nomenclature follows the BirdLife International checklist of the birds of the world (BirdLife International, 2009).

RESULTS

Specific seasonal trends

Overall, 54 species of waterbirds belonging to 13 families were recorded at Vourkari inlet in 2008 (Table 1, Appendix 1). Of the 22 regularly occurring species most were shorebirds (n = 8), followed by larids (n = 4) and ardeids (n = 3). Seasonal patterns of occurrence and abundance of the 22 most regular species are described below in taxonomic order. Figures 2-4 show monthly average counts (± s.e.) and frequency of occurrence of these species. Information on the numbers and occurrence of the 32 vagrant species is given in Appendix 1.

Podicipedidae

Great crested grebes (*Podiceps cristatus*) were regular in February, March and December, sporadic in April and November, accidental in January and October, and absent from May to September (Fig. 2). Average counts ranged from less than one bird in October to a peak of about 26 birds in February, decreasing from February through April and increasing from October through December.

Phalacrocoracidae

Great cormorants (*Phalacrocorax carbo*) were regular in January to March and from August through December, accidental in July, and absent during the rest of the study period (Fig. 2). They showed a steadily upward seasonal trend from August through December and two peaks, one in December (c. 150 birds) and one in February (c. 100 birds).

Ardeidae

Great egrets (*Casmerodius albus*) were regular in March through May and in October through Decem-

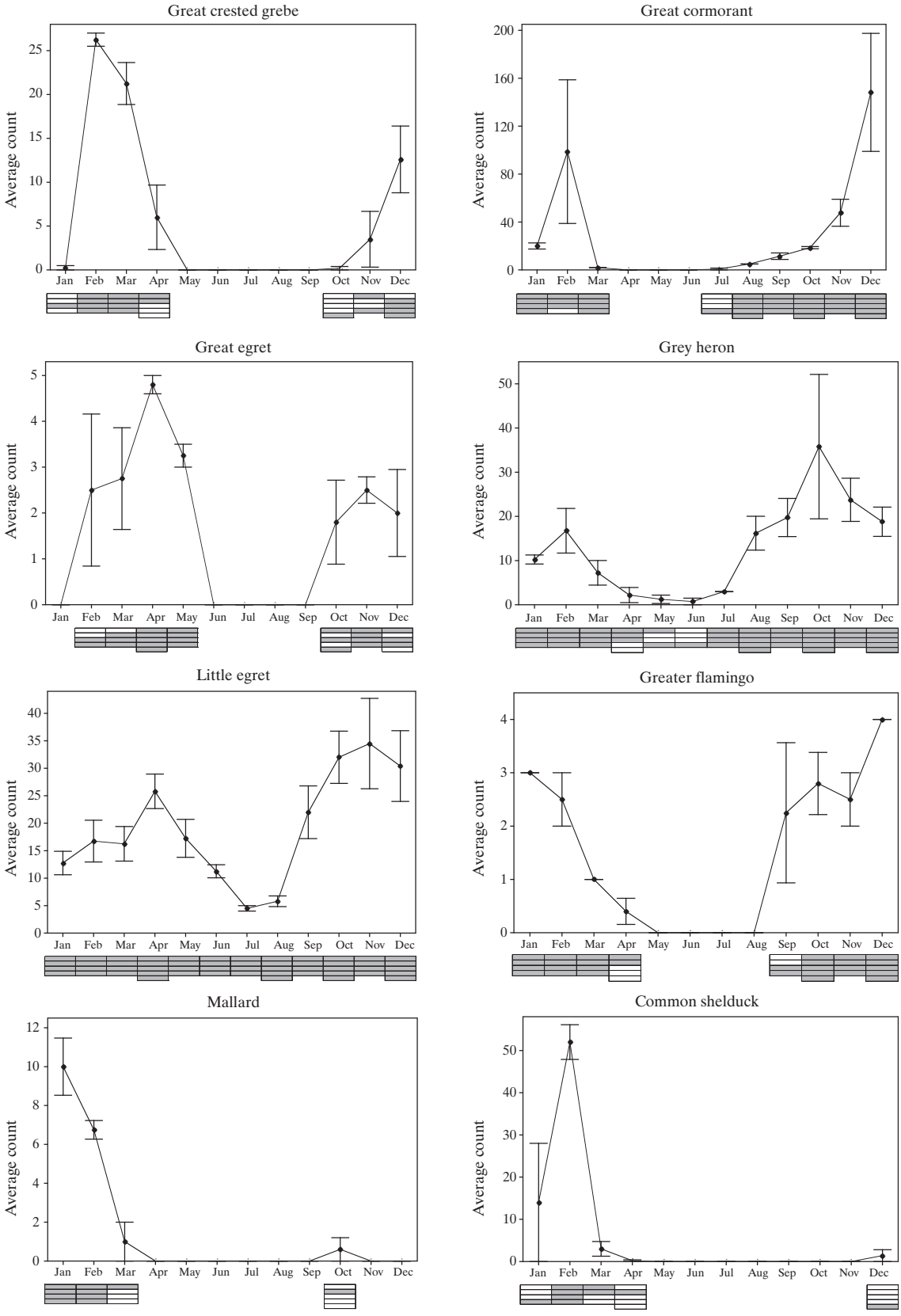

FIG. 2. Average monthly count (± s.e.) and frequency of occurrence (grey-shaded cells indicate weekly presence) of eight waterbird species of the families Podicipedidae, Phalacrocoracidae, Ardeidae, Phoenicopteridae and Anatidae observed at Vourkari inlet in 2008.

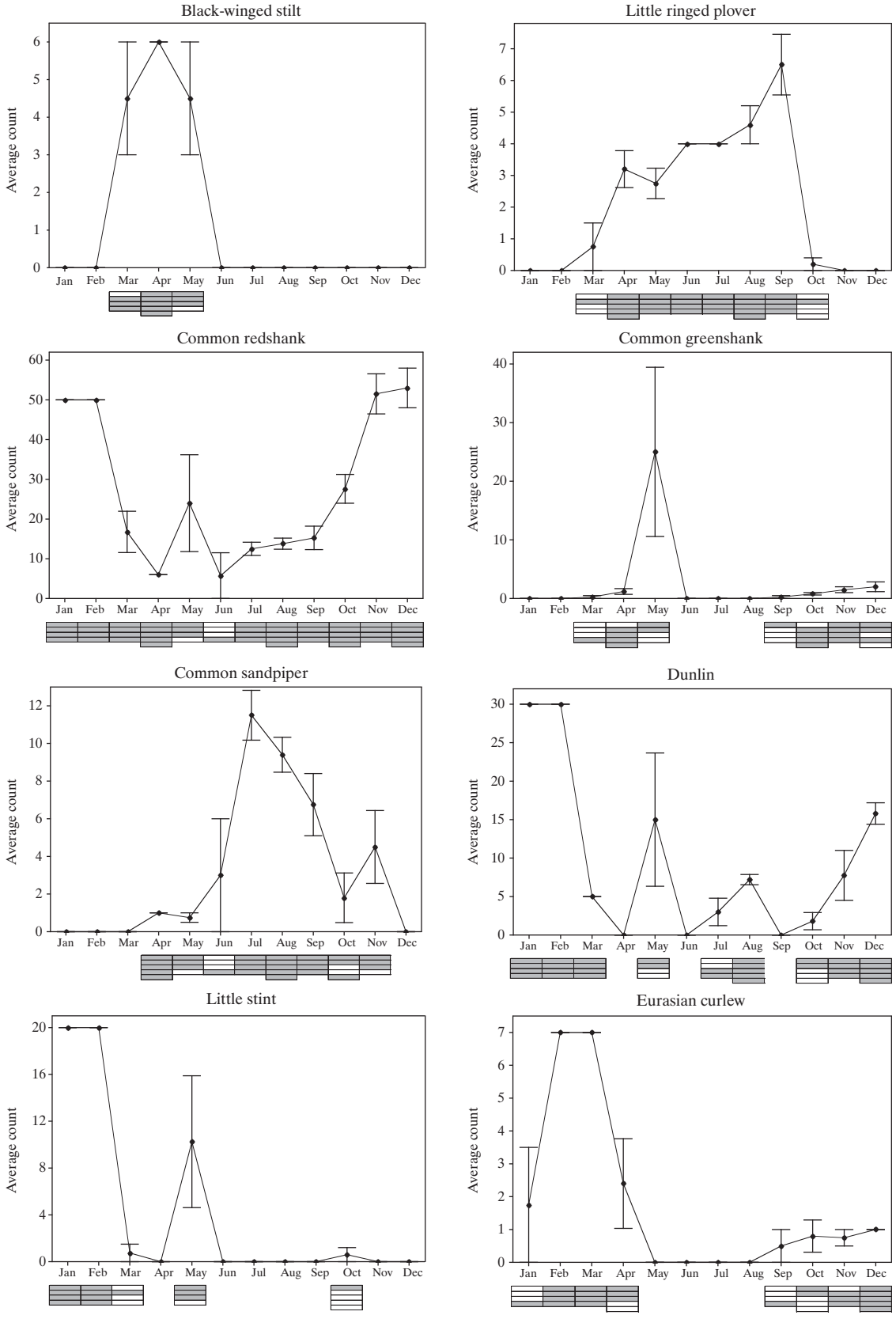

FIG. 3. Average monthly count (± s.e.) and frequency of occurrence (grey-shaded cells indicate weekly presence) of eight waterbird species of the families Recurvirostridae, Charadriidae and Scolopacidae observed at Vourkari inlet in 2008.

ber, sporadic in February, and absent during the rest of the study period (Fig. 2). Average counts were low (one to three birds), with a peak of about five birds in April. Grey herons (*Ardea cinerea*) were recorded throughout the year, with seasonal trends (Fig. 2). They were sporadic in May, accidental in June and regular throughout the rest of the year. They declined steadily from February to June (lowest average count less than one bird), then increased steadily through October (highest average count > 35 birds) and decreased again through December. Little egrets (*Egretta garzetta*) were present throughout the year, again with seasonal trends (Fig. 2). They increased steadily from January to April, then decreased steadily through July (lowest average count less than five birds), and then increased again steadily through November (highest average count c. 35 birds).

Phoenicopteridae

Greater flamingos (*Phoenicopterus roseus*) occurred in small numbers but were regular in January to March and in October to December, sporadic in April and September, absent in May to August, and showed seasonal trends (Fig. 2). They were declining from January to April and increasing from September to December. Average counts were three birds or less, with a peak of four birds in December.

Anatidae

Mallards (*Anas platyrhynchos*) were regular in January and February, accidental in March and October, and absent during the rest of the study period (Fig. 2). Average counts were low (less than two birds), being higher only in January and February (six to 10 birds) with a decreasing trend. Common shelducks (*Tadorna tadorna*) were regular only in February, when their highest average count occurred (52 birds), while they were sporadic in March, accidental in January, April and December (with average counts less than 15 birds), and absent in the other months (Fig. 2).

Recurvirostridae

Black-winged stilts (*Himantopus himantopus*) were only observed in March, April, and May as a regular species with low average counts of about four to six individuals (Fig. 3).

Charadriidae

Little ringed plovers (*Charadrius dubius*) were regular in April to September and accidental in March and October, with average counts ranging from lower than one bird in March and October to higher than six birds in September (Fig. 3). They showed a steadily increasing trend from March to September. Little ringed plovers were the only species recorded breeding in the inlet. A 4-egg nest was found in mid-April but was missing later. However, two young were observed in mid-July, a possible result of re-nesting or first breeding attempt by another pair.

Scolopacidae

Common redshanks (*Tringa totanus*) were regular throughout the year, except in June when they were accidental (Fig. 3). They showed two clear seasonal trends. After a peak of 50 birds in January and February they declined sharply to about five birds in April, and then increased again to an average of just over 50 birds in November and December. Common greenshanks (*Tringa nebularia*) were regular in April and in October to December, sporadic in May, accidental in March and September, and absent during the rest of the year (Fig. 3). They had average counts of two or less individuals, with a peak of 25 birds in May. Common sandpipers (*Actitis hypoleucos*) were present in low numbers but with variable seasonal trends (Fig. 3). They were regular in April and May, and in July to November, accidental in June, and absent in January to March and in December. Average counts were less than 10 birds, except for a peak in July (c. 12 birds). Dunlins (*Calidris alpina*) were absent in April and September but present as a regular or sporadic species during the rest of the study period (Fig. 3). They displayed variable seasonal trends, but increased steadily from October through December, reaching an average of over 15 birds. Little stints (*Calidris minuta*) were regular in January, February and May, accidental in March and October, and absent throughout the rest of the year (Fig. 3). They were present in low numbers, with a peak of 20 birds in January and February. Eurasian curlews (*Numenius arquata*) were also observed in low numbers, with a peak of seven birds in February and March (Fig. 3). They were regular in February to April and in November and December, sporadic in October, and accidental in January and September.

Laridae

This was the bird family with the most numerous representatives at the inlet (Figs 4 and 5, Table 1). Black-headed gulls (*Larus ridibundus*) were the most abun-

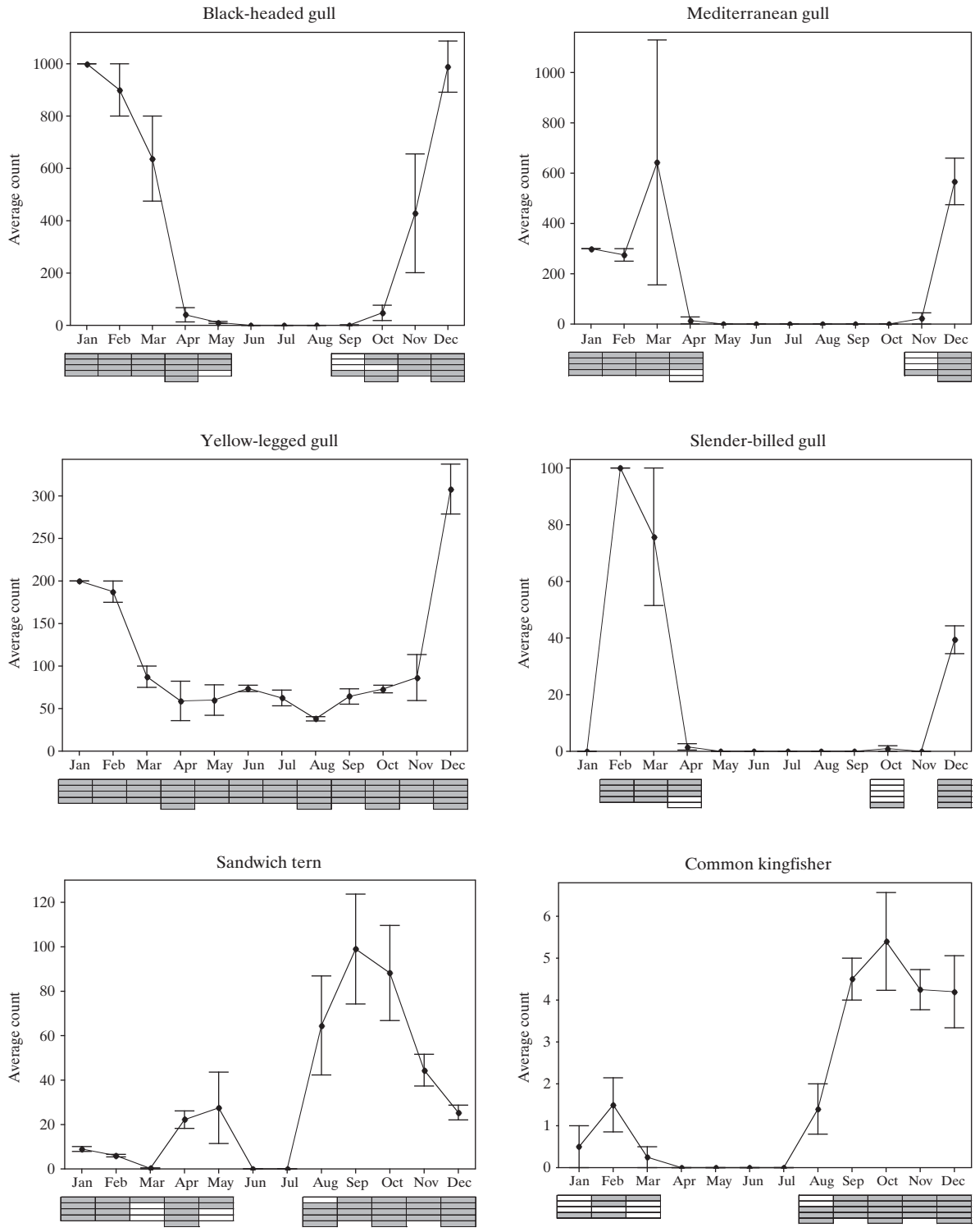

FIG. 4. Average monthly count (± s.e.) and frequency of occurrence (grey-shaded cells indicate weekly presence) of six waterbird species of the families Laridae, Sternidae and Alcedinidae observed at Vourkari inlet in 2008.

dant of all species occurring at the inlet, showing strong seasonal trends (Figs 4 and 5). They were regular in January through May and in October through December, accidental in September, and absent during the summer months. The average count was highest in January (1000 birds), decreased greatly and steadily through May (< 15 birds), and then increased again steadily and greatly from September (less than

one bird) to about 1000 birds in December. Mediterranean gulls (*Larus melanocephalus*) were regular in January to April and in December, and accidental in November (Fig. 4). Average counts ranged between 15 and 300 birds with two peaks in March and December (about 650 and 570 birds, respectively). Yellow-legged gulls (*Larus michahellis*) were regular throughout the year, being more abundant during the winter months (Fig. 4). They had an average count of about 50-100 individuals from March to November, with two peaks of about 200 birds in January and February, and a peak of about 300 birds in December. Slender-billed gulls (*Larus genei*) were regular in February to April and in December, and accidental in October, with average counts of less than 40, except for two peaks in February (100 birds) and March (c. 80 birds; Fig. 4).

Sternidae

Sandwich terns (*Sterna sandvicensis*) were present during most of the year, except in June and July, showing seasonal trends (Fig. 4). They were a regular species for most of the occurring months, being accidental in March and sporadic in May. The average counts were 25 or fewer birds from January to May, with an irregular but increasing trend through September when a peak average count of c. 100 birds occurred, decreasing steadily thereafter to c. 25 birds on average in December.

Alcedinidae

Common kingfishers (*Alcedo atthis*) were regular in February and between August and December and accidental in January and March, while they were absent from April to July (Fig. 4). Average counts were low from January to August (less than two birds), being highest (four to six birds) from September to December, with an increasing trend from August to October, then decreasing through December.

Numerical and seasonal trends

Larids, namely the black-headed gull, Mediterranean gull and yellow-legged gull dominated in total numbers, followed by the sandwich tern, great cormorant, common redshank and little egret (Fig. 5). In particular, black-headed gulls were dominant during four months, from November to February accounting for 44% to 59% of the total population present (Table 1). Yellow-legged gulls also dominated for four months, from April to July (with percentages ranging from 21% to 75%), being of equal importance to curlew sandpipers (*Calidris ferruginea*) in May. Sandwich terns were dominant in numbers for three months, from August to October (25% to 39%). Finally, Me-

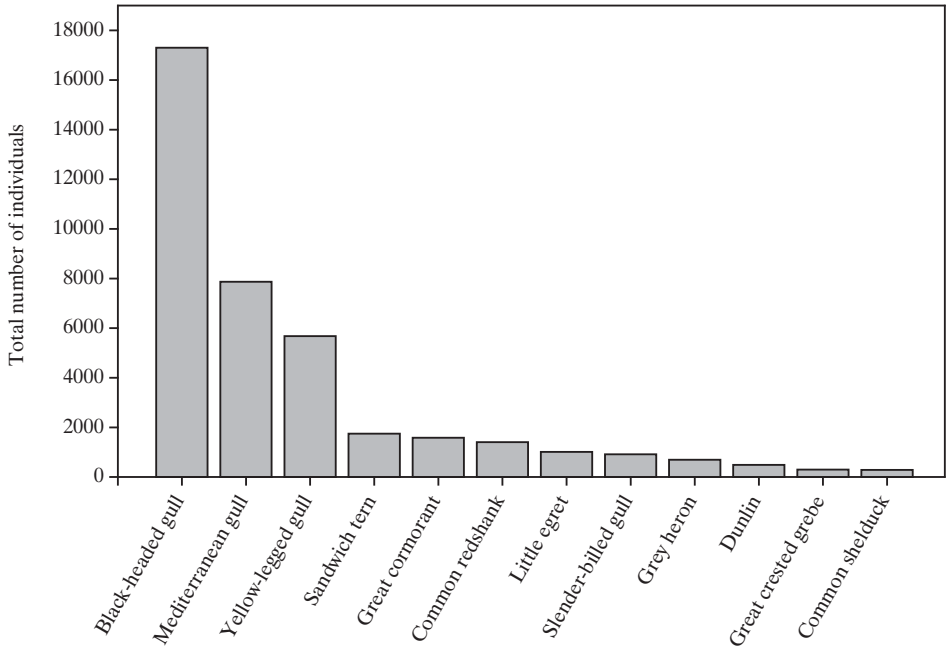

FIG. 5. Total count of the most abundant waterbird species recorded at Vourkari inlet in 2008.

TABLE 1. Monthly relative percentages of the 22 most regular waterbird species populations that occurred at Vourkari inlet from January to December 2008. Species' codes used in cluster analysis, conservation status and monthly total numbers of species and individuals recorded are also given. Species' superscripts denote conservation categories. See Appendix 1 for description

Species[a,b,c,d]	Species code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Great crested grebe[c4]	Pcrist	0.01	1.45	1.38	2.87	–	–	–	–	–	0.06	0.46	0.57
Great cormorant[c4]	Pcarbo	1.19	5.47	0.13	–	–	–	0.73	2.99	4.43	5.37	6.22	6.65
Great egret[b3,c4,d1]	Calbus	–	0.14	0.18	2.29	1.12	–	–	–	–	0.52	0.33	0.09
Grey heron[c4]	Aciner	0.60	0.93	0.47	1.05	0.43	0.76	2.95	9.68	7.61	10.33	3.09	0.84
Little egret[c4,d1]	Egarzt	0.76	0.93	1.06	12.32	5.95	11.42	4.42	3.46	8.48	9.24	4.49	1.36
Greater flamingo[c2,d1]	Prosus	0.18	0.14	0.06	0.19	–	–	–	–	0.87	0.81	0.33	0.18
Mallard[c4,d2,d4]	Aplaty	0.60	0.37	0.06	–	–	–	–	–	–	0.17	–	–
Common shelduck[b3,c4]	Ttador	0.80	2.88	0.19	0.10	–	–	–	–	–	–	–	0.06
Black-winged stilt[c4,d1]	Hhiman	–	–	0.29	2.87	1.55	–	–	–	–	–	–	–
Little ringed plover[c4]	Cdubus	–	–	0.05	1.53	0.95	4.06	3.93	2.75	2.50	0.06	–	–
Common redshank[c1,d3]	Ttotan	2.96	2.77	1.09	2.87	8.28	5.84	12.29	8.24	5.88	7.97	6.70	2.38
Common greenshank[c4,d3]	Tnebul	–	–	0.02	0.57	8.62	–	–	–	0.10	0.23	0.20	0.09
Common sandpiper[c2]	Ahypol	–	–	–	0.48	0.26	3.05	11.30	5.62	2.60	0.52	0.59	–
Dunlin[c2]	Calpin	1.78	1.66	0.32	–	5.17	–	2.95	4.30	–	0.52	1.01	0.71
Little stint[c4]	Cminut	1.19	1.11	0.05	–	3.53	–	–	–	–	0.17	–	–
Eurasian curlew[a4,c1,d3]	Narqta	0.10	0.39	0.45	1.15	–	–	–	–	0.19	0.23	0.10	0.04
Black-headed gull[c3,d3]	Lridib	59.25	49.87	41.44	19.39	3.88	–	–	–	0.48	13.80	55.74	44.37
Mediterranean gull[b2,c3,d1]	Lmelan	17.78	15.24	41.76	7.07	–	–	–	–	–	–	2.93	25.44
Yellow-legged gull[c3,d3]	Lmichs	11.85	10.39	5.69	28.18	20.69	74.87	61.43	22.70	24.76	21.07	11.26	13.82
Slender-billed gull[b3,c2,d1]	Lgenei	–	5.54	4.92	0.76	–	–	–	–	–	0.29	–	1.77
Sandwich tern[b3,c1,d1]	Ssandv	0.53	0.33	0.02	10.60	9.48	–	–	38.59	38.15	25.46	5.79	1.14
Common kingfisher[b5,c2,d1]	Aatths	0.03	0.08	0.02	–	–	–	–	0.84	1.73	1.56	0.55	0.19
Other species*		0.39	0.31	0.35	5.71	30.09	–	–	0.83	2.22	1.62	0.21	0.30
Number of individuals		6785	7219	6154	1047	1160	394	407	837	1038	1732	3073	11144
Number of species		19	18	26	27	27	6	8	15	19	29	19	21

[a] Birds of Conservation Concern, global conservation status (IUCN, 2008)

[b] Birds of Conservation Concern, Greek conservation status (Handrinos & Kastritis, 2009)

[a,b] Red List categories (IUCN, 2001): [a1,b1]CR; [a2,b2]EN; [a3,b3]VU; [a4,b4]NT; [a5,b5]DD

[c] European conservation status listing (BirdLife International, 2004): [c1]SPEC2; [c2]SPEC3; [c3]Non-SPEC[E]; [c4]Non-SPEC

[d] 79/409/EEC Birds Directive: [d1]Annex I; [d2]Annex II-1; [d3]Annex II-2; [d4]Annex III-1; [d5]Annex III-2

* Other species category includes 32 vagrant species. See Appendix 1 for information on numbers and occurrence

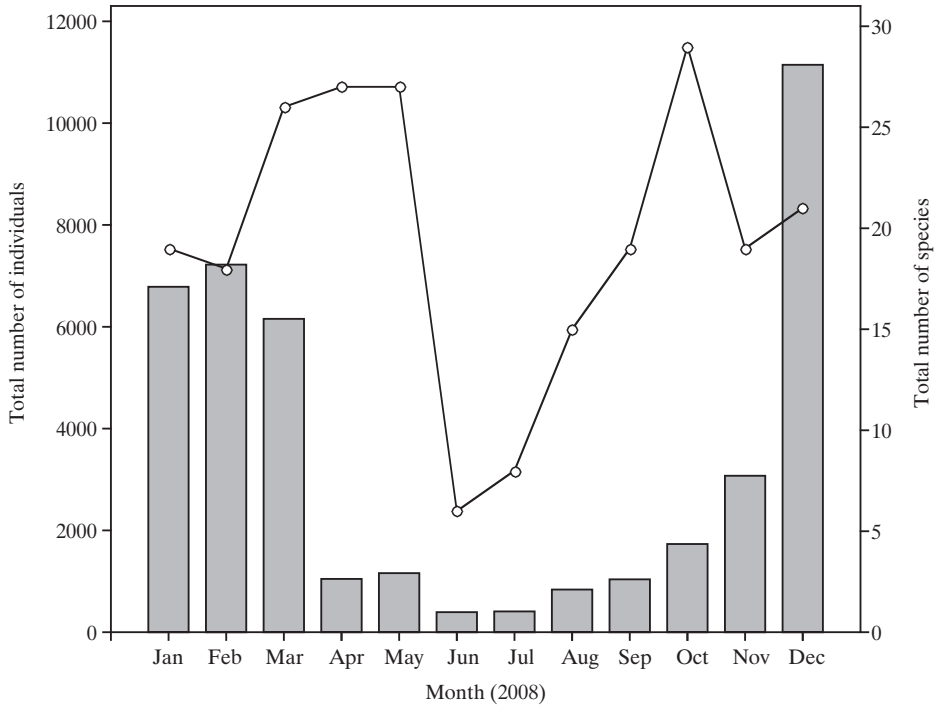

FIG. 6. Total monthly count of individuals (bars) and number of species (line) at Vourkari inlet in 2008.

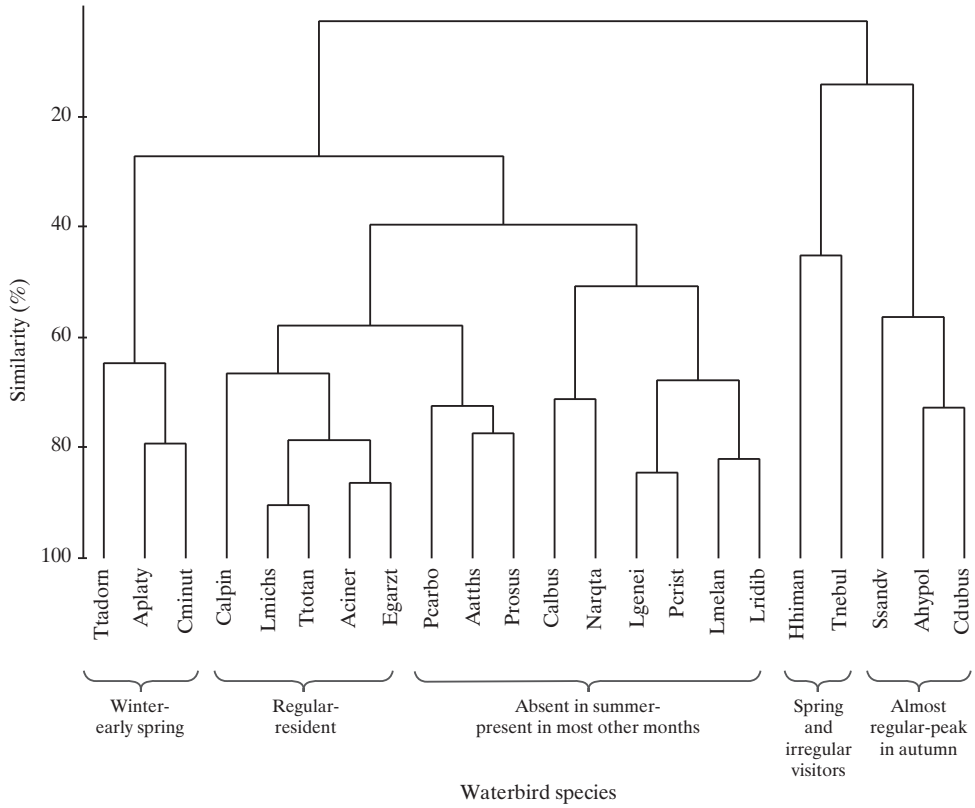

FIG. 7. Cluster analysis of the population of 22 waterbird species regularly recorded at Vourkari inlet from January to December 2008. Species' symbols are explained in Table 1.

diterranean gulls dominated in March (42%).

The highest total numbers (6-11 thousands) were counted in winter and early spring (Fig. 6). The total number of species recorded on each month ranged from 6 to 29, it was highest in October (29), April (27), May (27), and March (26) (Fig. 6), and it was not significantly correlated with the monthly total number of birds ($r_s = 0.420$, $n = 12$, ns). This was due to the high number of scarce vagrants that passed through the wetland during the spring (mainly) and autumn migration.

Cluster analysis (Fig. 7) identified five main groups of waterbird species. The first group on the far left side of the dendrogram includes species which are regular and more abundant during the winter and early spring migration (common shelduck, mallard and little stint). The second group consists of the resident species that occur as regular, in low or high numbers, during all or most of the months (dunlin, common redshank, yellow-legged gull, little egret and grey heron). The third group includes species which are absent mainly during the summer months (great cormorant, common kingfisher, greater flamingo, great egret, Eurasian curlew, slender-billed gull, great crested grebe, Mediterranean gull and black-headed gull). The fourth group incorporates spring migrants (black-winged stilt) and irregular visitors with peak numbers during spring migration (common greenshank). Finally, the fifth group on the far right side of the dendrogram includes also regular visitors, found in the inlet during most of the year, but in low numbers and with peak numbers during the autumn migration (sandwich tern, common sandpiper and little ringed plover).

Several, both common and vagrant, waterbird species that occurred at Vourkari inlet have an unfavourable conservation status at the global, European and Greek level (Table 1, Appendix 1). Of the 22 most regular species, one was of global, 12 of European and five of Greek conservation concern. Of the 32 vagrant species, one, 18 and seven were of global, European and Greek conservation concern, respectively. In total, 30 species were of conservation concern on one or more of the global, European and national levels (Table 1, Appendix 1).

DISCUSSION

Jackson *et al*. (2006) found that the national population size estimates of several dispersed waterbird species in Great Britain were improved by more than 50% when counts away from large waterbodies were also included. Jackson *et al*. (2004) reviewed the network of Special Protection Areas and Ramsar sites in Great Britain and highlighted the need for inclusion of dispersed species populations (such as larids, great cormorants, great crested grebes, mallards, grey herons, Eurasian curlews) to ensure that the network continues successfully to protect nationally and internationally important waterbird populations. McCulloch *et al*. (2003) found that small wetlands provide valuable feeding sites and migration staging posts for lesser flamingos (*Phoeniconaias minor*) and greater flamingos during the non-breeding season and emphasised the need for the conservation of the network of small wetlands around southern Africa. A large part of Mediterranean wetlands are extremely small in size, remnants of extensive pristine habitats, as a result of historical human intervention (Semlitsch & Bodie, 1998; Blondel & Aronson, 1999). As habitat loss and fragmentation proceed, wetlands tend to become even smaller and more isolated and many waterbirds need to use multiple sites to fulfill their need for resources (Gibbs, 1993, 2000; Haig *et al*., 1998). Therefore, the understanding of composition and abundance patterns of waterbirds in small, scattered wetlands embedded in humanised landscapes is of great conservation concern in the Mediterranean (Battisti *et al*., 2008). This study describes the seasonal patterns of occurrence and abundance of waterbirds at Vourkari inlet, a small Mediterranean coastal wetland. Given the scarcity of such information in Greece, findings can be used for the conservation and correct management of the studied and other similar wetlands.

The small size and high accessibility of Vourkari inlet made possible the identification of species and the estimation of their numbers with high accuracy. Most waterbird species that occurred at the inlet in 2008 showed distinctive seasonal patterns of occurrence, being present throughout the year, during winter and/or spring and autumn migration. The Vourkari inlet was mostly used, in terms of both specific and numerical abundance, during the wintering period and early spring migration.

Larids were the most abundant bird group at Vourkari inlet, although black-headed, Mediterranean and slender-billed gulls were absent in summer and yellow-legged gulls moved to the nearby Pahi islands from late winter/early spring to nest in a colony of hundreds of nests (personal observation). However, it was not possible to assess their importance on the national level due to lack of country-wide census-

es. All the other species' populations are estimated annually during the mid-winter counts. The importance of Vourkari inlet as a wintering area for waterbirds (excluding larids) was evaluated by comparing the maximum numbers counted at the inlet between 13 to 31 January, that is the period the mid-winter counts are carried out in Greece, with these from the mid-winter waterbird census in Greece in 2005 (the latest year for which data were available; Hellenic Ornithological Society, unpublished data). This comparison revealed that the Vourkari inlet exceeds the 1% criterion as a wetland of national importance for four species: the common shelduck (1.0%), little egret (1.0%), common redshank (2.2%) and sandwich tern (2.2%).

Open water, intertidal mudflats and halophytic grassland are the main foraging habitats for waterbirds at Vourkari inlet (Liordos, 2010). Open water was used by most birds, with mudflats preferred by common redshanks, dunlins and little stints, while halophytes were important for little egrets. However, ever-expanding anthropogenic activities, such as airport, industrial and residential building have claimed most of the wetland. The protection of the remaining habitats is therefore critical and could be implemented within the framework of conservation of a network of small wetlands in the wider area of Attiki.

Goutner & Papakostas (1992) carried out weekly counts during a 12-month period, from October 1988 to October 1989, at Alyki Kitrous wetland, Macedonia, Greece and recorded 63 waterbird species in total. The Vourkari inlet is comparable to the 4-time larger Alyki Kitrous wetland in terms of species richness, but holds considerably lower numbers of most species. The waterbirds wintering at the inlet were structured in five foraging guilds with generally low niche overlap between species of different guilds, suggesting a relatively high degree of specialisation within the waterbird assemblage (Liordos, 2010). It might be that the small size of the wetland does not allow for large numbers of individuals, but allows for a diversity of species with different ecological requirements able to exploit different microhabitats and so to ease interspecific competition (Wiens, 1989).

Patterns of occurrence of waterbirds at Vourkari inlet could be compared with published counts from other waterbodies in Greece: Messolonghi wetlands, Alyki Kitrous, Axios Delta (Goutner & Papakostas, 1992; De Nobel, 1995; Goutner e*t al*., 2005). Cormorants, grebes and ducks mainly occurred during winter at both Messolonghi and Alyki Kitrous wetlands. Great egrets were observed in winter and spring at Messolonghi, while little egrets and grey herons were present throughout the year, being more abundant during the spring and autumn migration. In contrast, egrets and herons mostly occurred in summer and early autumn at Alyki Kitrous, mainly due to post-breeding dispersion (Goutner & Papakostas, 1992). Larids were resident at Messolonghi but most numerous in winter and spring, with the exception of Mediterranean gulls that were mainly spring migrants. Larids were also resident at Alyki Kitrous, although differing in seasonal trends, as they were most abundant in late spring, summer and early autumn. This was mainly due to the breeding of Mediterranean and slender-billed gulls in the wetland. Waders were present in most months at Messolonghi, Axios and Alyki Kitrous, being mainly spring and autumn migrants and winter visitors with some exceptions. Little ringed plovers and black-winged stilts were also important in summer at Messolonghi, black-winged stilts at Axios and common redshanks and black-winged stilts at Alyki Kitrous due to their breeding in these wetlands. The waterbirds of Vourkari displayed similar seasonal trends with these coastal wetlands, at least during the winter and migration periods. This was probably due to the location of these wetlands within the Mediterranean wintering grounds and along the eastern Mediterranean migration flyway (Goutner e*t al*., 2005). Most of the differences in bird phenology were mainly observed in summer and in late spring, and early autumn, probably a result of breeding and post-breeding dispersion of several waterbird species at Messolonghi, Axios and Alyki Kitrous wetlands.

Results have shown that the Vourkari inlet hosts a diverse waterbird assemblage throughout the year, being most important during the winter and spring migration. Also it may constitute a wetland of national importance for some waterbird species. Furthermore, some of the observed species have an unfavourable conservation status on the national and/or international level. The inlet is positioned within the most heavily populated district of Greece and is continually threatened by further development. This fact combined with findings suggests that, if the Vourkari inlet is to be bequeathed to future generations of waterbirds and humans alike, immediate action should be taken. Conservation efforts should aim at the designation of Vourkari inlet as a wildlife refuge and its maintenance and improvement for the benefit of waterbirds through appropriate habitat management interventions.

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APPENDIX 1. Numbers, occurrence and conservation status of 32 vagrant waterbird species observed at Vourkari inlet from January to December 2008. Conservation categories are described in superscripts which are listed below the appendix itself

Common name	Scientific name	Numbers (range)	Occurrence (months)	Conservation status[a,b,c,d]
	Podicipedidae			
Black-necked grebe	*Podiceps nigricollis*	5-7	Jan, Feb	c4
Little grebe	*Tachybaptus ruficollis*	1	Oct	c4
	Ardeidae			
Purple heron	*Ardea purpurea*	4	May	b2,c2,d1
Squacco heron	*Ardeola ralloides*	1-3	Apr, May	b3,c2,d1
Black-crowned night heron	*Nycticorax nycticorax*	3	May	b4,c2,d1
Little bittern	*Ixobrychus minutus*	1	Apr, May	c2,d1
	Threskiornithidae			
Glossy ibis	*Plegadis falcinellus*	1	Mar	b1,c2,d1
	Anatidae			
Northern pintail	*Anas acuta*	2	Sep-Nov	c2,d2,d5
Northern shoveler	*Anas clypeata*	8	Jan	c2,d2,d5
Common teal	*Anas crecca*	1-9	Sep, Oct, Dec	c4,d2,d5
Eurasian wigeon	*Anas penelope*	3	Dec	c3,d2,d5
Garganey	*Anas querquedula*	1-13	Apr, Sep, Oct	b3,c2,d2
Mute swan	*Cygnus olor*	2-3	Jan, Oct	c3,d3
	Rallidae			
Common moorhen	*Gallinula chloropus*	1-2	Apr, May, Oct	c4,d3
	Recurvirostridae			
Pied avocet	*Recurvirostra avosetta*	3	Mar, Apr	b3,c4,d1
	Charadriidae			
Kentish plover	*Charadrius alexandrinus*	1	Apr	c2,d1
Common ringed plover	*Charadrius hiaticula*	2	Oct	c3
Grey plover	*Pluvialis squatarola*	1-9	Mar, May, Oct, Dec	c4,d3
	Scolopacidae			
Spotted redshank	*Tringa erythropus*	1-3	Aug, Sep	c2,d3
Wood sandpiper	*Tringa glareola*	1-20	Apr, May, Nov, Dec	c2,d1
Green sandpiper	*Tringa ochropus*	1-5	Apr, May, Aug, Nov, Dec	c4
Marsh sandpiper	*Tringa stagnatilis*	1	May, Aug	c4
Sanderling	*Calidris alba*	2-3	Mar, Apr	c4
Curlew sandpiper	*Calidris ferruginea*	1-120	May, Aug	c5
Ruddy turnstone	*Arenaria interpres*	1	May	c4
Bar-tailed godwit	*Limosa lapponica*	1	Oct	c4,d1,d3
Black-tailed godwit	*Limosa limosa*	1	Sep, Oct	a4,c1,d3
Common snipe	*Gallinago gallinago*	1	Mar	c2,d2,d5
Ruff	*Philomachus pugnax*	2-18	Apr, May, Sep	c1,d1,d3
	Sternidae			
Common tern	*Sterna hirundo*	3-5	Mar-May	c4,d1
Little tern	*Sterna albifrons*	1	Aug	b4,c2,d1
White-winged tern	*Chlidonias leucopterus*	1	May	c4

[a] Birds of Conservation Concern, global conservation status (IUCN, 2008)
[b] Birds of Conservation Concern, Greek conservation status (Handrinos & Kastritis, 2009)
[a,b] Red List categories (IUCN, 2001):
[a1,b1] CR, Critically Endangered are species that are considered to be facing an extremely high risk of extinction in the wild
[a2,b2] EN, Endangered are species that are considered to be facing a very high risk of extinction in the wild
[a3,b3] VU, Vulnerable are species that are considered to be facing a high risk of extinction in the wild
[a4,b4] NT, Near Threatened are species that have been evaluated against the criteria but do not qualify for Critically Endangered, Endangered or Vulnerable now, but they are close to qualifying for or are likely to qualify for a threatened category in the near future
[a5,b5] DD, Data Deficient are species for which there is inadequate information to make a direct, or indirect, assessment of their risk of extinction based on their distribution and/or population status
[c] European conservation status listing (Species of European Conservation Concern; BirdLife International, 2004):
[c1] SPEC 2 are species whose global populations are concentrated in Europe but have an unfavourable conservation status within Europe
[c2] SPEC 3 are species whose global populations are not concentrated in Europe but have an unfavourable conservation status within Europe
[c3] Non-SPEC^{E} are species whose global populations are concentrated in Europe but have a favourable conservation status within Europe
[c4] Non-SPEC are species whose global populations are not concentrated in Europe but have a favourable conservation status within Europe
[c5] Not Evaluated are species whose conservation status has not been evaluated
[d] 79/409/EEC Birds Directive, available at http://ec.europa.eu/environment/nature/legislation/birdsdirective/index_en.htm
[d1] Annex I are species in danger of extinction, species vulnerable to specific changes in habitat, species considered rare because of small populations or restricted local distribution, and other species requiring particular attention for reasons of the specific nature of habitat
Annex II are species that, owing to their population level, distribution and reproductive rate, may be hunted:
[d2] Annex II-1 – throughout the European Community, or
[d3] Annex II-2 – in specific Member States
Annex III are species that can be taken and traded:
[d4] Annex III-1 – throughout the European Community, or
[d5] Annex III-2 – in specific Member States