

# The historical and current distribution of Dalmatian Pelican *Pelecanus crispus* and Great White Pelican *Pelecanus onocrotalus* in Greece and adjacent areas: 1830-2019

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**Abstract** – Evidence about the historical breeding distribution of Dalmatian Pelicans *Pelecanus crispus* and Great White Pelicans *Pelecanus onocrotalus* in Greece and an adjacent zone was sought in all historical scientific literature containing references to pelicans, starting from the antiquity. Pelicans were familiar to ancient Greeks, although the two species were not distinguished. Aristotle was the first to observe and describe their migration movements in the Balkans. Subsequently, nothing was mentioned for pelicans until the 16th century observations and writings of Pierre Belon du Mans. In mid-19th century the first scientific data for both species appeared and nesting of the Dalmatian Pelicans was noted for the period 1830- 1900 in seven wetlands at Peloponnese and south mainland Greece and six at northern Greece and adjacent areas along latitude 41°N. It is impossible to evaluate the actual status of pelicans in the region during 1900-1950 as none of the few contemporary ornithological publications mentioned anything about nesting of pelicans in Greece. The breeding range of Dalmatian Pelicans had probably shrunk dramatically, although it is unlikely that all the old colonies were exterminated. Until the end of 1970s, many of the wetlands where Dalmatian pelicans bred were drained or heavily altered and the number of known colonies was reduced from seven to three, with two of them in Greece, at Amvrakikos and Lake Mikri Prespa and one at Karavasta in Albania. Scientific and conservation work initiated in 1983 mainly by the “International Pelican Research and Conservation Project” and conservation organisations, led at the turn of the century to a manyfold increase of the Amvrakikos and the Lake Mikri Prespa Dalmatian pelican colonies, which subsequently gave rise to four new colonies in the period 2003-2015: Lake Kerkini, Messolonghi lagoons, Karla Reservoir and Lake Chimaditis. The overall breeding population rose from 100-120 pairs and two colonies in the late ‘60s to over 2100 pairs and six colonies in the end of the 2010s. Simultaneously, the Great White Pelican breeding population rose from less than 100 pairs and one colony to over 700 pairs and three colonies.

**Key-words:** waterbirds, geographical range, breeding population, colonial birds, Prespa, Amvrakikos.

## INTRODUCTION

Both the Dalmatian Pelican *Pelecanus crispus* and the Great White Pelican *Pelecanus onocrotalus* have currently a fragmented but widespread distribution, spanning a huge area mainly across the Palearctic and the Afro-tropic biogeographic regions. Dalmatian Pelicans breed in several localities, from the Western Balkans eastwards to China (Crivelli & Vizi 1981, Catsadorakis & Portolou 2018, Wetlands International 2019). Great White Pelicans also breed from the Balkans to S.E. Kazakhstan, but they also nest in India and Pakistan and are widely distributed over much of Africa, as a resident species (Crivelli & Schreiber 1984, del Hoyo et al. 1992, del Ponte Machado 2010). In Greece, where both species nest, Dalmatian Pelicans are

resident and short distance migrants, with their numbers slightly increasing in winter, and Great White Pelicans are summer visitors with a much smaller breeding population (Crivelli et al. 1991, Hatzilacou 1992, Handrinos & Akriotis 1997). Long term scientific studies and conservation efforts during the last 40-50 years have been instrumental in helping the two species to reach and maintain good and viable populations in Greece. In fact, the breeding populations of both species in Greece have shown a dramatic increase in numbers and an impressive geographical expansion, with quite a few new colonies already established.

In an effort to document the former breeding distribution and status of both species in Greece, this paper summarises all the available historical scientific and non-scientific literature about breeding evidence of Dalmatian and

Great White Pelicans. Existing sources of information, although both limited and of varying quality and accuracy, cover a period of ca. 140 years (1830-1968), which, modifying Handrinos & Akriotis (1997) for the purposes of this analysis, can be divided into three parts: 1830-1900, 1900-1950 and 1950-1968. In this context, this study may provide a reasonably reliable documentation of the history of the two species in Greece and thus contribute in filling the existing gaps of our knowledge about them. The modern (1968-2019) distribution of pelican colonies in Greece is also discussed, and currently differs greatly from the one described by Crivelli (1987) and Hatzilacou (1993), which consisted of only the two older breeding sites (Prespa & Amvrakikos). This study provides the most up-to-date information on the geographical breeding distribution of both species, and refers to all sites which fall within Greek territory, as well as sites within a c. 100 km wide strip around the border of Greece, in an attempt to include colonies which are, or were, close enough to potentially interact with those located in Greece.

#### **Prehistory, myth and early scientific data**

There is paleontological evidence that Dalmatian Pelicans were present and breeding from at least the Mid-Holocene (Neolithic Age) in quite a few sites in Western Europe – the Danish Archipelago, the Netherlands, north Germany and the British Isles – where there is evidence for nesting until at least the Pre-Roman era (for details see Crivelli & Vizi 1981 and several references therein, Nikulina & Schmölcke 2015). Pelicans have been also present in Greece since antiquity but the available literature does not provide any documented evidence of breeding. They were well known to the ancient Greeks, although, in that period, they would not have been likely to be identified as belonging to two different species. It seems that, like many other birds in ancient Greece, pelicans were considered to be edible and so were trapped and killed for food, but at the same time they were shrouded with myths and omens, fables and folklore. In one of his strangest fables, Aesop wrote that the parental affection of pelicans to their offspring is so strong that the mother perforates them with her bill and kills them. Then, they are restored to life when sprinkled from the blood of their father's self-inflicted wounds (Thompson 1895, Pollard 1977). Far from these myths, Aristotle is the first scientist in history who observed that "...*Pelicans migrate, flying from the River Strymon (in Central Macedonia) to the River Hister (the Danube) where they breed. They leave in flocks...*", an important scientific observation from such an early period. Interestingly he also reported that "...*pelicans living in rivers swallow big, smooth shells. After cooking them in the pouch in front of the stomach they*

*vomit them up, so that when they are open they may pick out the flesh and eat it...*" (Thompson 1895, Pollard 1977). Later on, in 77 A.D., the Roman writer and historian Pliny the Elder completed his multi-volume "*Naturalis Historia*", in which he noted that, in around 50 A.D., pelicans nested in the northern parts of Gallia (Bostock & Riley 1855, Nikulina & Schmölcke 2015), what is now Belgium, and the Netherlands, and also nested at the deltas of the Schelde, Rhine and Elbe rivers, but from the Roman period onwards any scientific documentation on pelicans in Europe is lacking. Myths prevailed again and Aesop's fable seems having survived well into Christianity, in both the Orthodox and Catholic Churches, first through "*Physiologus*", a Greek ecclesiastical natural history treatise (Stressmann 1975), written in Alexandria in the 2<sup>nd</sup> c. A.D., and later on (between 570-636 A.D.) through "*Etymologia*", a similar treatise written in Seville. Both of these two didactic books praise pelicans as a symbol of piety, redemption and the Passion of Christ.

During the 1,500-year period from Aristotle to the early 19<sup>th</sup> century, the only scientific documentation of pelicans in Greece, comes from Pierre Belon du Mans, a French diplomat and naturalist, who published a book on birds in 1555 (Belon du Mans 1555). In this treatise, he is clearly relying on both Aristotle and Pliny, a fact which confirms the lack of any other sources on the species for many centuries. Belon du Mans, who travelled in Crete, Northern Greece, Egypt, Asia Minor etc. in 1547-1549, writes that he observed pelicans on the island of Rhodes, in Thessaloniki, the Mediterranean and Marmara seas and at the Nile and Strymon rivers, the species being common in the latter river (Belon du Mans 1555), thus confirming Aristotle's own observations about the same river made many centuries previously. During the next three centuries, Piton de Tournefort and Sonnini de Manoncourt, two more French naturalists, also travelled in Greece (in 1700-1702 and 1778 respectively), but there is no mention of pelicans in their works (Tournefort 1717, Sonnini 1801).

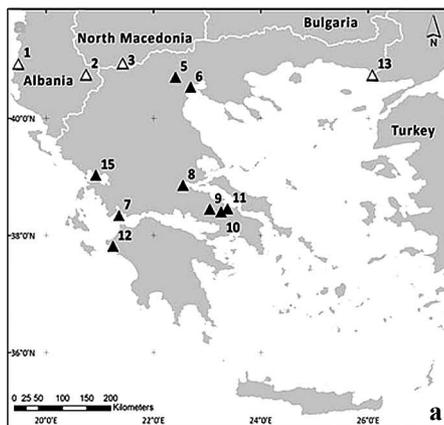
#### **First period: 1830-1900**

After the revolution against the Ottomans in 1821, Greece became an independent state in 1830 and scientific explorations of its flora and fauna began almost immediately. The first of these was a French project for the study of the natural history of the Peloponnese. The results of the "*Expédition Scientifique de Morée*" (1829-1830) were published in Paris in 1833, and in the Zoology section (Vol. III, 1<sup>st</sup> part) the first ever scientific treatment of the birds of Greece was included: it is a catalogue of the 58 bird species recorded in the study area, including the Great White Pelican (Geoffroy St. - Hilaire 1833). This was the first time

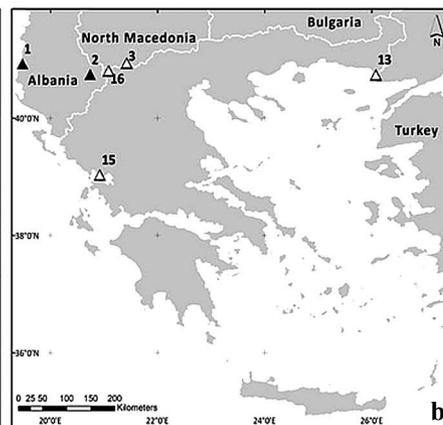
that a pelican species in Greece was fully identified and mentioned by its scientific name. In the same period, it was also written that Dalmatian Pelicans were very common in Greece, and that it was, most probably, this species that the ancient Greeks knew well (Temminck 1840). A few years later, two important books on the ornithology of Greece were published, both by Germans who had already spent many years living, mainly, in Athens: “*Beiträge zur ornithologie Griechenlands*” by Heinrich Graf von der Mühle (Mühle 1844), and “*Die Vögel Griechenlands*” by Ritter Anton Lindermayer (Lindermayer 1860), a work almost identical with an earlier publication by the same author which appeared in 1843. Both authors provide important information on pelicans. For the Dalmatian Pelican, der Mühle writes “... *It is very plentiful in Greece the whole year through, and on many lakes and swamps, such as Liq-eri (today Yliki), Kopais, and Paralimni, are broad colonies of them. They are also very plentiful on the lakes of Missolonghi and Thermopylae (today Spercheios Delta).*”

“ (Fig. 1a, Tab.1), whereas the Great White Pelican “... *is very rare in Greece. I believe that it comes there to breed, but is only seen singly now and then in winter. Among all my specimens of pelicans I have only one of this species, which was killed in April in the lake of Missolonghi. It was a female, and about to lay, as a mature egg was taken out of its body ...*” (cited in Bree 1875-76). Lindermayer writes that Dalmatian Pelicans are resident in Northern Greece and he confirms that they nest in the areas given by von der Mühle, but adds that the species also breeds in the wetlands of the N.W. Peloponnese, from Gastouni north to Cape Glarentza (today Kyllini), N.W. Peloponnese (Fig.1a). He also agrees that, in Greece, Great White Pelicans are much rarer than Dalmatian Pelicans and only single birds are occasionally seen on the large lakes. According to his opinion, the former species most probably did not nest in Greece (Lindermayer 1860). In the same period, outside mainland Greece, Great White Pelicans are listed as winter visitors in the Cyclades (Erhard 1858).

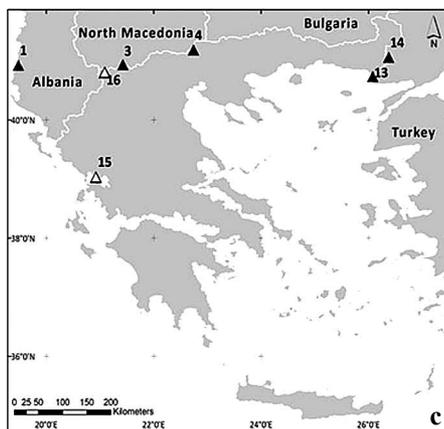
1830-1900



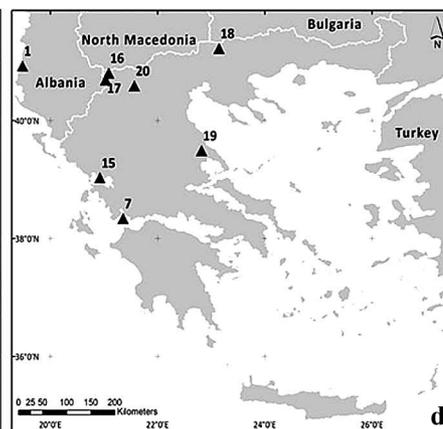
1900-1950



1950-1968



1968-2019



**Figure 1.** Geographical distribution of Dalmatian Pelican colonies in Greece and adjacent parts of neighbouring countries in four successive time periods according to published information: Filled triangles: Documented breeding; open triangles: possible / presumed / suspected breeding. Numbers correspond to sites mentioned in Table 1.

**Table 1.** List of wetland sites in Greece and adjacent areas where Dalmatian pelican breeding has been documented historically and time periods to which such evidence refers (DP = Dalmatian Pelican, GWP = Great White Pelican).

Name of site	Lat - Lon (WGS84)	Sratus	Documented Pelican breeding	Species breeding
1 Karavasta Lagoon (AL)	40.92 - 19.51		1905-to date	DP
2 Maliq Lake & marshes (AL)	40.76 - 20.76	Drained 1946	1926-1945	DP
3 Crna Reka marshes (MK)	40.94 - 21.43	Drained 1959	-1957	DP / GWP
4 Lake Dojran (GR/MK)	41.21 - 22.72		-1954	DP
5 Giannitsa marshes	40.71 - 22.40	Drained 1932	1869	DP
6 Axios Delta	40.55 - 22.69		1869	DP
7 Messolonghi & Aitolikon lagoons	38.36 - 21.36		1853-1887 / 2011-to date	DP / (GWP)
8 Spercheios Delta	38.85 - 22.52		-ca 1840	DP
9 Lake Kopais	38.45 - 23.01	Drained 1882-1931	-ca 1840	DP
10 Lake Yliki	38.41 - 23.25	Heavily modified	-ca 1840	DP
11 Lake Paralimni	38.46 - 23.34	Heavily modified	-ca 1840	DP
12 Pinios estuary	37.83 - 21.24	Heavily modified	ca 1850	DP
13 Evros/Meriç Delta	40.76 - 26.08	Heavily modified	-1962	DP
14 Ergene River (TR)	41.06 - 26.39	1950-1960	-1968	DP
15 Amvrakikos lagoons	39.03 - 20.92	Reclaimed 1969	1857-to date	DP
16 Lake Mikri Prespa (North part) (GR)	40.81 - 21.09		ca 1930s-to date	DP / GWP
17 Lake Mikri Prespa (Borderline) (GR/AL)	40.69 - 21.04		ca 1930s-1990	DP / GWP
18 Kerkini Reservoir	41.24 - 23.14		2002-to date	DP / GWP
19 Karla Reservoir	39.50 - 22.81	Created 1983	2011-to date	DP / GWP
20 Lake Chimaditis	40.59 - 21.57	Created 2009	2016-to date	DP

Some important distribution data on both species are also given by a number of papers published between 1840 and 1870, with ornithological information from various areas of Greece, including Epirus, at that time still part of the Ottoman Empire. T. L. Powys (later Lord Lilford) found Dalmatian Pelicans to be common residents along the coasts of Epirus, with nesting documented in the Gulf of Amvrakikos, namely at Suttanieh, a locality which cannot be identified today, but almost certainly situated within the extensive lagoons, reedbeds and marshes formed by the deltas of the Louros and Arachthos rivers in the northern part of the gulf. For Great White Pelicans he notes that “*in November, they migrate southwards over Corfu Island in enormous numbers, but only a few remain in Epirus during the winter*” (Powys 1860). Another British scientist, W. H. Simpson, summarising his ornithological exploration of Messolonghi Lagoon and S.W. Aetoloakarnania, expressed his regret that whereas a few years ago Dalmatian Pelicans were seen “*by the hundreds*” around the Acheloos Delta and the rest of the Messolonghi-Aitolikon lagoon complex, at that time only single birds were flying around (Simpson 1860). Although nesting in the area was first documented in 1853, by a certain Nieder who lived

in Messolonghi (Nieder 1853), in 1858 Simpson found 35 nests on an island between the lagoons of Aitolikon and Prokoponistos, but only seven nests in 1859, due to persecution and egg stealing by the fishermen (Simpson 1860). Dr Theobald Krüper was another great figure of Greek ornithology, working for many years as the curator of the Zoological Museum of the University of Athens. Krüper himself had written only a little general information on the two pelican species, but according to his notes cited by Reiser (1905), on 3.3.1861 he found 35 Dalmatian Pelican nests on an islet in Aitolikon Lagoon from which he had been repeatedly collecting eggs for at least three years. In 1864 Krüper also knew of a second Dalmatian Pelican colony within this vast wetland complex, this time in the Acheloos Delta (Reiser 1905). Otmar Reiser, who travelled extensively in Greece collecting birds and eggs, confirms the Acheloos Delta colony, but during his exploration of the area (January-April 1897) he could neither visit it or in fact find any Dalmatian Pelicans nesting anywhere else in this vast wetland complex and, as told by locals, pelicans had ceased to nest in that area almost 10 years previously. He also visited Lake Karla, Thessaly on 16.3.1894, but although he saw at least 10 Dalmatian Pelicans, he writes

that they did not nest at this lake (Reiser 1905). Finally, a list of the birds of Turkey, including Macedonia, at that period still under the Ottoman rule, which was published in 1870 (Elwes & Buckley 1870), provides some important data on pelicans nesting in that region. Both authors listed Dalmatian Pelican as a breeding species in Macedonia, with nesting colonies at the Axios Delta and the nearby Lake Giannitsa (Elwes & Buckley 1870). A few years earlier, during the winter of 1845-1846, Captain H. M. Drummond found Great White Pelicans to be very common in Macedonia (Drummond 1846).

Information on pelicans from adjacent countries in the S.W. Balkans, also under Ottoman rule, was extremely rare during this period. During his travels in Albania, Edward Lear, not an ornithologist but an accomplished British traveller and landscape painter, visited Avlona (today Vlorë), from where he wrote: "... As we skirted these salt lagunes I observed an infinite number of what appeared to be large white stones, arranged in rows with great regularity, though yet with something odd in their form not easily to be described. The more I looked at them, the more I felt they were not what they seemed to be ... so I resolved to examine these mysterious white stones forthwith, and off we went, when—lo! on my approach, one and all put forth legs, long necks, and great wings, and "stood confessed" so many great pelicans, which, with croakings expressive of great disgust at all such ill-timed interruptions, rose up into the air in a body of five or six hundred and soared slowly away to the cliffs north of the gulf...". On the same day (29.10.1848), he produced a beautiful landscape in watercolor with those Great White Pelicans he saw on the shores of – almost certainly – Narta Lagoon with Avlona in the background, published later as a lithograph in his book (Lear 1851). Incidentally, Lear painted many birds for several contemporary bird books, including two fine lithographic plates of both pelican species in J. Gould's monumental five-volume work "*The Birds of Europe*" (Vol V. plates 405 and 406).

In the rest of Western Europe pelicans were gradually becoming extinct. Within the second half of the 19<sup>th</sup> century, the last Dalmatian and Great White Pelicans disappeared from Lake Balaton and Tisza River in Hungary (in 1868) (Keve & Udvardy 1951, in Crivelli & Vizi 1981), and the wetlands of former Yugoslavia in Titel, Hutovo Blato, the marshes of Vojvodina and the deltas of the Neretva and Dracevo rivers (Crivelli & Vizi 1981).

### Second period: 1900-1950

Within the first two decades of the 20<sup>th</sup> century, Greece attained its present boundaries, except for the Dodecanese. Some of the most interesting ornithological publications of

that period, came from British officers of the Allied Forces in Macedonia (1916-18), summarising their ornithological observations, mainly from the Axios Valley and the wetlands along the River Strymon. Apart from a few random, insignificant records, however, none of these publications provide new information or data about the breeding of pelicans in Northern Greece. Captain A. Sladen, for example, recorded small flocks of Great White Pelicans appearing in Lake Artzan, during April and May 1917 (Sladen 1918), whereas P. J. C. McGregor, the British Consul at Sarajevo, writes that Dalmatian Pelicans were common in the marshes of Crna Reka near Bitola (McGregor 1906). Even W. E. Glegg in his "*List of the Birds of Macedonia*" adds nothing new, only his observation of a flock of Great White Pelicans flying over Veroia, on 11.3.1919 (Glegg 1924). Interestingly, even in larger publications, pelican records from Greece or the adjacent countries are either extremely few or completely lacking: Dr. J. Gengler in his "*Balkanvögel*" (a treatise which, however, excludes Greece) lists 261 species, but surprisingly omits both pelicans, despite the fact they had been already recorded in the region by others (Gengler 1920), whereas Prof. E. Stresemann, in his own book on the birds of Macedonia, briefly notes that a few isolated pairs of Dalmatian Pelicans nested in Bulgaria, Northern Greece and Lake Skadar (Stresemann 1920). In 1930 Hugo Adolph Bernatzik, an Austrian anthropologist and photographer, visited Lake Maliq, Albania, and published a small book and photographic album on the Dalmatian Pelicans nesting there. Bernatzik, who knew Albania well, claimed that pelicans were abundant in that country and their breeding sites were not difficult to find, naming Karavasta Lagoon and Lake Terbuf, for example (Bernatzik 1930). Other authors, however, could not confirm the existence of a nesting colony in either Maliq, or in the Mikri and Megali Prespa lakes (Ticehurst & Whistler 1932, Thorpe et al. 1936), despite the fact that local people asserted Thorpe et al. (1936) for pelican breeding in Lake Mikri Prespa. In 1938, A. Ilić discovered Great White Pelicans nesting in Crna Reka for the first time, together with Dalmatian Pelicans, whose breeding colony in this wetland on 7.7.1940 numbered 20-30 pairs (Fig. 1b). In the last pre-war years, and until 1950, ornithology in Greece was dominated by the works of Dr. Wolfgang Makatsch, particularly his classic book "*Die Vogelwelt Macedoniens*" (Makatsch 1950). In this book he incorporated information from others, such as the valuable unpublished manuscript of A. Ilić, but this treatise is mostly based on his own extensive data, since he had amassed a broad knowledge of the avifauna of the region through numerous field trips. Although he recorded both pelican species several times in suitable wetlands during the breeding

season, Makatsch, a keen egg-collector himself, failed to find any nesting colony, either in Greece or elsewhere in the region. Datte & Profft (1939), based on the numbers of both pelican species they encountered in Lake Karla in 1939, suggested (without providing any evidence) that pelicans “must” have been breeding in Lake Karla.

### Third period: 1950-1969

In his check list of the birds of Greece published in 1957 A. Lambert classified both pelican species as “fairly common”, with Great White Pelicans as “winter visitors” and Dalmatian Pelicans as “partial migrants, breeding in Northern and possibly in Central Greece” (Lambert 1957). In April-May of 1958 and 1959 a Swedish ornithological expedition in Greece failed to record any actual nesting, although they saw several birds of both species in Amvrakikos and Lake Koronia (Flach 1960). In one of his post-war visits to Greece in 1961, Makatsch saw large flocks of Great White Pelicans in April and June in the deltas of the Axios and Aliakmon rivers and at Lake Karla, again, however, with no proof of breeding (Makatsch 1963), while more or less similar results came from various ornithological excursions, mainly undertaken in Northern Greece, in 1961-1968 (Zelenka 1963, Knötzsch 1965, Bodenstern & Kroymann 1967, Eber 1967, Groh 1968, Kraus et al. 1969). In 1963, a short, but very interesting, paper on the seasonal movements of pelicans in Greece appeared (Zelenka 1963), while B. Sage, who visited the Yugoslavian part of Lake Megali Prespa in May 1964, comments that the exact status of both pelican species in this wetland is “problematic” (Sage 1966).

Dalmatian Pelicans did nest, however, in the Crna Reka marshes, probably until 1957 (Hughes & Summerfield 1959, in Velevski & Vasic 2017) (Fig. 1c, Tab. 1), when drainage of these marshes commenced (1957-1959). They also seem to have nested at Lake Dojran until 1954 (Matvejev & Vasic 1973, in Velevski & Vasic 2017). Also Velevski & Vasic (2017) mention that the last recorded breeding of Great White Pelicans in the former marshes of the Crna Reka river in the Pelagonia plain was noted in 1940 (Makatsch 1950). Interestingly, in the same period, significant information comes from another important Greek wetland on the other side of Northern Greece: in their paper on the birds of the Evros Delta, W. Bauer and G. Müller, based on information from locals, mentioned that 40-50 pairs of Dalmatian Pelicans nested there, but in 1962 the colony was destroyed by fishermen (Zelenka 1963, Bauer & Müller 1969). Terrasse et al. (1969) mentioned that another colony existed outside the Delta, somewhere north of the town of Ypsala on the River Ergene, a tributary of the Evros/Meriç, with 100-200 breeding pairs of Dalma-

tian Pelicans, and Bauer & Müller (1969) wrote that, according to Turkish fishermen, the species bred there until 1968-1969, when this colony disappeared due to drainage for agriculture. It is still not known if these two colonies, which seemed to have co-existed for some years, had any kind of connection, as they lay 47 kms away from each other.

Before the end of the 1960s the major breeding grounds of pelicans in Northern Greece were finally discovered. Indeed, during their visits to Lake Mikri Prespa in 1968, three French ornithologists (A. Hiest and later M. Brosselin and A. Molinier) recorded a small mixed colony with 13 Dalmatian Pelican and two Great White Pelican nestlings (Brosselin & Molinier 1968), while on a second visit in 1969, 50 nests of Dalmatian Pelicans and 40-45 nests of Great White Pelicans were counted (Terrasse et al. 1969). Both species were nesting together in two discrete sites, ca. 13.5 kms apart: one at an inaccessible inner pond amidst the marshes between the two Prespa lakes (“Viro”) and a smaller one in the “no-man’s land” on the Greek-Albanian border at the extreme south of Lake Mikri Prespa (“Fragma”). This was a breakthrough discovery, as for the first time after many decades it was confirmed that Great White Pelicans did in fact nest in Greece, and that Dalmatian Pelicans, despite persecution and habitat loss, had managed to maintain a small nesting population in this remote Greek lake. In 1969, the total population of Dalmatian Pelicans breeding in Europe was 400 pairs, with Lake Mikri Prespa holding only 50-70 pairs (17.5%) (Terrasse et al. 1970), making it a small and therefore vulnerable population, in need of further study and specific conservation measures.

### The current breeding status of pelicans in Greece (1970-2018)

A first synthesis of all that was known on the history of pelicans breeding in Greece was published in 1980 (Crivelli 1980). The first quantitative data about numbers of breeding pairs of the Dalmatian Pelican in the modern era came from the year 1967, with data on the Amvrakikos colony (18-20 pairs) (Bauer et al. 1969b). The next year, 1968, the colony at Lake Mikri Prespa was discovered and 70-120 pairs were roughly estimated there (Brosselin & Molinier 1968). For 1969 there was only information on the exact number of pairs for Amvrakikos (c. 20 pairs), and for 1970 only for the number of pairs at Lake Mikri Prespa (60-100 pairs), but not for Amvrakikos. For the following 12 years there was also no simultaneous information about the breeding population sizes in these two sole colonies, so we cannot estimate the overall breeding population in Greece. However, from 1983 onwards, through the monitoring carried out by the International Pelican Research and Con-

ervation Project (IPRCP), led by A.J. Crivelli from the Tour du Valat Biological Station in France, there were full monitoring data annually. These were occasionally supplemented with data provided by the Hellenic Ornithological Society, while in 2010 the Society for the Protection of Prespa took on co-ordination work and, after 2015, was joined by the management bodies for the protected wetlands hosting pelicans.

After 1962, the year of the destruction of the Evros Delta Dalmatian Pelican colony, there were only two colonies of this species still active in Greece, at Prespa and Amvrakikos. They could be considered three, if the two (sub) colonies at Prespa were treated as separate colonies, however, the second (sub) colony at the Greek-Albanian border was abandoned during a drought year in 1990. In May 1990, 13 nests were made, and eggs laid, on an artificial island in Kerkini Reservoir, but these were later destroyed (Pyrovetsi 1997). In 2002, it was the second time since the '90s that some pairs of Dalmatian Pelicans (50 in this case) built their nests at the Kerkini Reservoir, the most productive wetland in Northern Greece, but the nests were flooded by rising water levels caused by hydrological management decisions. The following summer raised platforms were built by the IPRCP and in 2003 Dalmatian Pelicans nested but could not rear any young to fledging, something which finally took place in 2004. In 2011, a few pairs nested at Kleisova Lagoon at Messolonghi (again after ca. 1887) while only one pair bred, unsuccessfully, at the newly constructed Karla Reservoir in Central Greece (A. Dimalexis, *pers. comm.*) In the ensuing years the numbers of breeding pairs increased in both of these colonies. It is not sure exactly when Dalmatian Pelicans started breeding at Lake Chimaditis. The colony was discovered in 2017, but there were indications that they had started nesting there two, or even three, years previously. Thus, currently, there are six breeding colonies of Dalmatian Pelicans in Greece, numbering over 2,000-2,100 pairs in the last five years. The overall breeding population of this species in Greece has shown an annual increase rate of 7.1% within 48 years and continues increasing.

On the other hand, until 2015 the only wetland where Great White Pelicans were breeding in Greece was Lake Mikri Prespa. In the period 1983-1985, Hatzilacou studied their breeding biology as part of a doctoral dissertation (Hatzilacou 1992), as well as some aspects of their feeding ecology in several wetlands of Western and Central Macedonia (Hatzilacou 1996). In 2015, nine pairs built nests and incubated eggs at Lake Karla – today a reservoir – but they ultimately abandoned them during the breeding season. In 2016, Great White Pelicans bred again at Karla, and for the first time at Kerkini, and they have kept breeding there,

with a few gaps, until to date (2020). Thus, in the last seven years, there have been three breeding colonies of this species in Greece with 500-780 breeding pairs, of which 85-100% nest at Lake Mikri Prespa. The annual increase rate of the breeding population of Great White Pelicans in Greece can be calculated less accurately than that for the Dalmatian Pelican, but it is around 4-4.5% in a period of 45-47 years and continues increasing.

## DISCUSSION

### Geographical distribution of pelican colonies

The presence, but not the breeding, of pelicans – most probably of both Palearctic species – in Greece since antiquity, is confirmed. Pelicans were well known to the ancient Greeks, and the writings of Aristotle are evidence of this, although they could not distinguish between the two species. From the 16<sup>th</sup> until the early 19<sup>th</sup> century, there is a large gap of information about pelicans occurring in Greece. The first scientific data about pelicans appear after 1830, when the country became an independent state. From the beginning of first available data until 1968, in little more than one century, 12 out of 15 Dalmatian Pelican colonies (80%) disappeared. In ten out of the twelve cases this was clearly due to drainage, heavy reclamation works, persecution, or a combination of those factors.

The five wetlands in Central Greece where Dalmatian Pelicans nested in the mid-19<sup>th</sup> century have since been drastically changed. Lake Kopais was entirely drained for agriculture in the early 20<sup>th</sup> century, whereas lakes Yliki and Paralimni were transformed into reservoirs, hence totally unsuitable for nesting of pelicans or any other colonially nesting waterbird. The exact geographical location of these two lakes has apparently confused first Bauer et al. (1969a) and later Handrinos & Akriotis (1997), who erroneously mentioned “Attica” as a breeding place for Dalmatian Pelicans. In fact, both lakes, although very close to Attica (the province around Athens), belong to the adjacent Boiotia province. In the late 19<sup>th</sup> century, pelicans were also present in Epirus and Macedonia, two regions which, at that period, were still not part of Greece, but under Ottoman rule. In Epirus, the species was nesting in the Amvrakikos Gulf. More to the N.E., in Macedonia, nesting was reported from two sites: Giannitsa, a large, shallow, freshwater lake with extensive marshes, and the nearby Axios Delta, where pelicans are still present but do not nest anymore. In the first 50 years of the 20<sup>th</sup> century, the breeding range of Dalmatian Pelicans shrunk dramatically. None of the – indeed few – ornithological publications of that time, mentions anything about nesting colonies of the

species existing anywhere in Greece. It is, thus, impossible to evaluate the actual status of the species in Greece during this period. Available data are not only extremely limited, but no ornithologists ever visited the historical breeding sites of southern Greece (N.W. Peloponnese, Messolonghi, etc.) to re-confirm their existence, so actually it would be excessive to conclude that all these colonies were totally exterminated.

During this period, and particularly after 1925, extensive areas of natural wetlands with large zones of suitable nesting and feeding habitats for pelicans, were completely drained for agricultural use and to fight against malaria, a disease that decimated rural populations in Greece. This included some major lakes, such as Kopais in Central Greece, Giannitsa and Achinos in Central Macedonia, and others. It has been calculated that, throughout the 20th century and until the end of the 1970s, Greece had lost 61 % of its wetland areas (Handrinos 1992), so there is no doubt that such large-scale habitat loss forced Dalmatian Pelicans to abandon their historic breeding sites, a problem also exaggerated by the relentless persecution of both species by fishermen. Despite these problems, however, we may assume that a few small colonies were still active during these years, but these either remained undetected or the wetlands were never visited by ornithologists. The available data showed that the major changes in wetlands and pelican habitats, which caused the extermination of eight out of nine colonies in Central and Northern Greece, took place between the last quarter of the 19<sup>th</sup> c. and the first half of the 20<sup>th</sup> century. In contrast, in neighbouring Turkey, a country with a completely different social and cultural history to Greece, Onmuş *et al.* (2011) showed that the drainage of wetlands took place mainly between the 1960s and the late 1980s, i.e. at least half a century later, and caused, along with a few other factors, the dramatic reduction of both Dalmatian Pelican colonies (from 25 to 5) and breeding numbers by over 60% (Onmuş *et al.* 2011). Regarding whether pelican nesting ever occurred at Lake Karla, both the statements of all the authors that visited this wetland in the past (e.g. Reiser 1905) and a close examination of the 1945 aerial photos, rather convincingly suggest that most likely pelicans never bred there during the abovementioned period. The floodplain character of this wetland, with an extremely large water level fluctuation, the huge changes in water surface and the intensive fishing activities of local people further support this conclusion. Drainage and land reclamation took place during the 20th century not only in Greece but in other Balkan countries as well, dealing the final blow to the distribution of pelicans. Both World War II and the Civil War that followed (1946-49) devastated Greece, so it was well in the late 1950s-

early 1960s that the first foreign ornithologists started to visit the country again and document its avifauna. Between 1958 and 1967 several papers were published summarising the results of various ornithological studies or excursions, mostly in Northern Greece with its many wetlands. Although many sightings of both pelican species were made, sometimes in good numbers, in suitable areas and even during the breeding season, no actual nesting in Greece had been confirmed. The main reason that the mixed pelican colonies at Lake Mikri Prespa remained undiscovered was that this area was declared a military zone after World War II and, therefore, for the following three decades, access for foreigners was very difficult.

Persecution of pelicans by humans not only continued, but for many years after World War II the Greek State treated pelicans as “vermin”, paying a premium for every bird killed and every egg destroyed. According to a few scattered and incomplete data, 169 pelicans were shot all over Greece in 1956-57, but 173 in the Evros Delta alone in 1952-1958 (Poimenidis 1959). Along the same lines, Brosselin & Molinier (1968) mentioned, though with some uncertainty, that Prespa fishermen had told them that, in 1957 alone, they had killed 400 pelicans and numerous eggs to get the premium.

Except for a few cases of nesting of one odd pair, such as at Messolonghi (Bree 1875-76), the first Great White Pelicans were found nesting in Crna Reka only in 1938 (Makatch 1950). The few data for the species showed that from ca.1840 to the end of the 19th century Great White Pelicans did not nest in Greece, but were seen during migration or in the winter in varying numbers. According to almost all the literature from both the 19<sup>th</sup> and the 20<sup>th</sup> centuries Great White seemed to be very much rarer than Dalmatian Pelicans. Especially in the 19<sup>th</sup> century, many authors considered the Great White Pelicans to be a winter visitor in Greece. This is very interesting, but does it suggest that more Great White Pelicans than today were overwintering in Greece? The enormous numbers migrating southwards over Corfu Island mentioned by Powys (1860), and the birds which Lear saw and painted at the Narta lagoon (29 October 1848, Lear 1851), were probably the Great White Pelicans mentioned as breeding in Lake Balaton, Hungary and in the marshes of Slovenia and Vojvodina (Cramp & Simmons 1977), on their southward migration to their African wintering grounds. From the limited information available on Great White Pelicans in Greece and adjacent areas, we can conclude that there were 5-6 colonies scattered between Lake Balaton to the west and the Danube Delta to the east, but only two survived the late 1950s when the Crna Reka marshes were drained, although Terrasse *et al.* (1969) mentioned, perhaps errone-

ously, nesting of Great White Pelicans at Crna Reka with one or two pairs even in 1968.

### Breeding Population size

In the 19<sup>th</sup> century Dalmatians were reported as much more numerous than Great White Pelicans, with at least nine different nesting sites recorded, from the N.W. Peloponnese and Amvrakikos north to Central Macedonia, but there are inadequate data to estimate total breeding population size in Greece for any period before the late 1960s. However, the impressive twenty-fold increase for breeding Dalmatian Pelican numbers from the early 1970s to the late 2010s (from two to six colonies) and the nine-fold increase of Great White Pelican breeding numbers (from one to three colonies) should be attributed to a combination of factors, the most crucial being: the institutional protection of both species and their habitats and the effective conservation measures, particularly in the largest colonies at Mikri Prespa and Amvrakikos, which both acted as source populations east and west of the Pindos Mountain range respectively, playing a pivotal role in the initiation of colonies in new sites. Furthermore, the gradual decrease of the importance of inland fisheries as an economic activity, combined with guarding and public awareness activities at these sites, have contributed to reduced incidences of pelican persecution by fishermen. However, the full range of factors that made this increase possible deserve further analyses.

**Acknowledgements** – Triantafyllos Akriotis, Alain J. Crivelli and Dionyssia Hatzilacou made useful comments in a previous draft. Julia Henderson improved the English text. Foteini Papanous drew the maps. Since 2018 the work of the Society for the Protection of Prespa for pelicans is supported financially by the Prespa Ohrid Nature Trust (PONT).

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Received: 11 March 2020

First response: 19 April 2020

Final acceptance: 4 May 2020

Associate editor: **Michelangelo Morganti**

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