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White Stork *Ciconia ciconia* survey in Pelagonia indicates a decrease in its breeding population and colony disintegration

Popis bele štorklje *Ciconia ciconia* v Pelagoniji kaže na nazadovanje gnezdeče populacije in razpad kolonij

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In May 2002, a survey of the White Stork *Ciconia ciconia* was carried out in Pelagonia in the south of the Republic of Macedonia. In an area covering 1,104 km^2, 223 breeding pairs (HPa), 7 unoccupied nests (H) and 5 breeding attempts (HB1 or HB2) were established. The largest colony (≥ 5 HPa) numbered 20 pairs. In Pelagonian villages, White Storks breed as follows: 56.1% on buildings, 29.6% on pylons of the overhead transmission lines, 12.1% in trees, and 2.2% on stacks and bales of hay. The ecological density (StDBiol) reached 20.2 pairs / 100 km^2. In comparison to the last survey by Jovetić (1959) in 1958, the 2002 survey shows a 52.4% HPa decrease, and a decrease in the number of colonies from 27 to 15, as well as of colony size from 16.7 to 9.7 pairs per colony. The proportion of colonial breeders in the Pelagonian population has decreased from 92.9% to 65.0%, while the proportion of solitary breeders (1HPa / village) has risen from 2.1% in 1958 to 18.8% in 2002. White Stork colonies have drastically declined from the land claimed areas in southern Pelagonia. In northern and central Pelagonia, where extensive grazing and mowing is still practised, the numbers of breeding pairs (HPa) and colonies were found to be the same in both surveys: the decline in colony size from 14.5 to 9.7 pairs per colony has been compensated by the increased number of solitary breeders. The population decrease and the disintegration of White Stork colonies in Pelagonia indicate a general negative trend in Macedonia. An extensive reconstruction of overhead transmission lines in Pelagonia that is utterly at variance with nature conservation will only hasten the process of colony disintegration and decline of the population.

Key words: colony, colonial breeding, White Stork, *Ciconia ciconia*, survey, population numbers, nest site selection, breeding density, Macedonia

Ključne besede: kolonija, kolonijsko gnezdenje, bela štorklja, *Ciconia ciconia*, popis, populacija, izbira gnezdišča, gnezditvena gostota, Makedonija

1. Introduction

During the last International White Stork Census (IWC) in 1994/95, the species was not surveyed in the Republic of Macedonia (Schulz 1999a). The last survey there of the White Stork *Ciconia ciconia* breeding population dates from 1958 (Jovetić 1959). The results of a further survey in the Skopje basin in 1988 has shown a marked decline in the size of the population since 1958 (Micevski *et al.* 1992). The number of pairs occupying nests (HPa) has decreased by no less than 86.4%. Furthermore, colonies numbering more than 10 pairs have simply disappeared. It is not clear, however, whether this population decrease and colony disintegration has taken place in other parts of Macedonia too. The IWC has shown that population trends in White Stork are positive in many parts of its range for the

first time in several decades, with the exception of the large area of the states in the southern part of the Balkan Peninsula and Turkey (Schulz 1999b). The present paper presents the results of the survey of the White Stork's breeding population carried out in Pelagonia in 2002. We compare our results with the 1958 survey, and discuss the types of Stork's nests used in 2002 and the reconstruction of overhead transmission lines, which appears to be in conflict with nature conservation.

2. Study area and methods

Pelagonia is a tectonic depression (41°30′ – 40°53′ N, 21°15′ – 21°37′ E) running in a N-S direction, along which flows the Crna reka river, one of the longest Macedonian water courses. The plains of the depression's floor at the average of 600 m a.s.l. cover some 900 km^2. The Pelagonia Depression is 66 km long and, on average, 16 km wide. It is surrounded by mountains 1400 to 2600 m high. In the south, Pelagonia is virtually open towards Greece and is a rural landscape. Most of its northern and central parts are characterized by large, extensively farmed pastures and grasslands, while its southern part, from the village of Mogila to the Greek border, has been drained and is now covered by monocultures such as maize and tobacco. Forests cover less than 1% of the area. (Kolčakovski *pers. comm.*, own data)

Between May 10th and 17th 2002, all Pelagonian villages and hamlets were surveyed for White Stork nests. The study area covered 1,104 km^2. The surface area was obtained from a map on the scale of 1 : 50,000 on the basis of 2 x 2 km squares on the Gauss-Krüger grid. Prilep and Bitola, the two major towns of Palegonia, were surveyed only along their main roads. We began the survey at dawn and finished at dusk. The survey methods and abbreviations used are those recommended by the International White Stork Census (Schulz & Thomsen 1999). On the basis of the survey date, Storks sitting or standing on nests were considered as pairs occupying a nest (HPa). We also noted any white excrements on the nests' rims, and whether the nests had been repaired or not. Thus we reduced the possibility of visitors (HB1 and HB2) adding to the numbers of pairs that had occupied nests (HPa). Unoccupied nests (H) were noted as well. At the same time we recorded the type of nest site, whether they rested on platforms, whether they were in contact with electric wires or if original wooden pylons had been replaced with concrete posts. For nests on transmission lines we also examined the types of insulators and interviewed some of the locals. If at least five pairs bred in a village within a distance of less than 200 m (Guziak & Jakubiec 1999, Peterson *et al.* 1999), the Storks were arbitrarily considered a colony. Different proportions of Storks nesting colonially in the area during surveys in 1958 and 2002 were tested using the Mann-Whitney U-test. Differences with $p < 0.05$ are considered statistically significant.

3. Results

3.1. Population size, distribution and density

In the towns of Prilep and Bitola, no Storks were recorded. In the 124 Pelagonian villages surveyed, Stork pairs (HPa) occupied nests in 71. A total of 223 pairs (HPa), 7 unoccupied nests (H) and 5 new breeding attempts with up to half-completed nests in most cases (HB1 or HB2), were recorded. In Pelagonia White Storks bred in villages, the only exceptions were two nests on concrete posts outside the villages of Krivogaštani and N. Zmirnevo, and a nest on a dried up tree some 200 metres away from the village of Belo Pole. The distribution of breeding pairs in the study area is presented in Figure 1. The ecological density (StDBiol) in Pelagonia was 20.2 pairs / 100 km^2.

In comparison to our survey in 1958 a total of 493 nests, 468 occupied (HPa) and 25 unoccupied (H), were counted in Pelagonia (Jovetić 1959). Among them were 4 solitary pairs in the montane area around Kruševo, which was not surveyed in 2002. StDBiol was 42.0 pairs / 100 km^2. Compared to the 1958 survey, the 2002 survey indicates a decrease of HPa by 52.4% and a decline in StDBiol by 48.1%.

3.2. Colonies

In 1958, 27 White Stork colonies were recorded in Pelagonia. 21 of these were larger than 10 pairs and contained no less than 85% (398 HPa) of the total breeding population in the area (Jovetić 1960). During the 2002 survey only 6 colonies exceeded 10 pairs, i.e. 36.3% (81 HPa) of the population (Table 1). Thus, since 1958 the proportion of colonial breeders (≥ 5 HPa) has fallen from 92.9% to 65.0%. On the other hand there has been a great increase in the number of solitary breeders (= 1 HPa / village), from 2.1% (10 HPa) in 1958 to no less than 18.8% (42 HPa) in 2002 (Figure 2). White Stork colonies were found primarily in the northern part of Pelagonia. In the central part no colonies were recorded but only isolated pairs. In the southern part of the area two

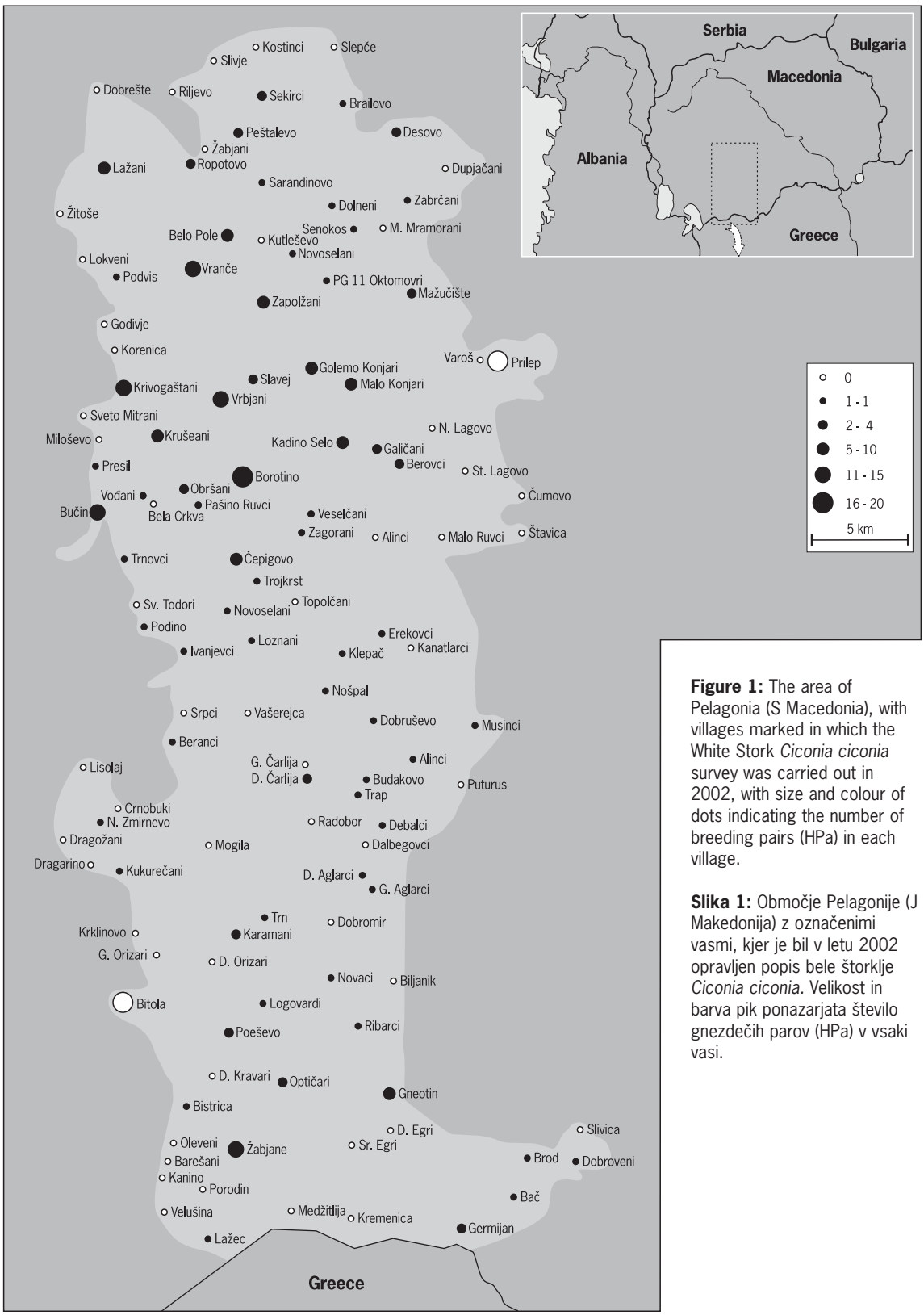

Figure 1: The area of Pelagonia (S Macedonia), with villages marked in which the White Stork *Ciconia ciconia* survey was carried out in 2002, with size and colour of dots indicating the number of breeding pairs (HPa) in each village.

Slika 1: Območje Pelagonije (J Makedonija) z označenimi vasmi, kjer je bil v letu 2002 opravljen popis bele štorklje *Ciconia ciconia*. Velikost in barva pik ponazarjata število gnezdečih parov (HPa) v vsaki vasi.

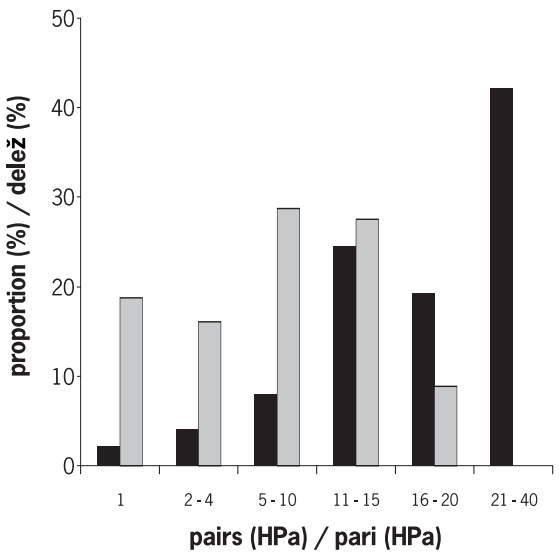

Figure 2: Proportion of colonial and solitary breeders (HPa) in the White Stork *Ciconia ciconia* population in Pelagonia during the surveys carried out in 1958 (black, Jovetić 1959) and 2002 (grey, this work)

Slika 2: Delež kolonijskih in solitarnih gnezdilk (HPa) v populaciji belih štorkelj *Ciconia ciconia* v Pelagoniji med popisoma leta 1958 (črno, Jovetić 1959) in 2002 (sivo, to delo)

colonies were established, while about a half of the villages had no Storks at all (Figure 1). Of the 15 colonies surveyed in Pelagonia, the largest numbered 20 pairs. A comparison between colony sizes observed in 1958 and 2002 shows that the average number of stork pairs per colony in Pelagonia has fallen from 16.7 to 9.7 ($U = 82$, $p < 0.001$, see Table 1), and from 14.5 to 9.7 ($U = 41$, $p < 0.05$) in its northern and central parts.

In the south of Pelagonia, between Mogila and the Greek border, 285 HPa or 61.4% of the population were registered in 1958 (Jovetić 1959). After the first survey this area was drained and, in 2002, only 43 HPa, or 19.3% of the whole Pelagonian breeding population, were recorded here. In 1958 the area contained 14, in 2002 just a single colony of storks exceeding 10 pairs. In contrast, in northern and central parts of Pelagonia, numbers of breeding pairs remained virtually the same in the two surveys – 179 HPa in 1958 and 180 HPa in 2002. The reduction of Stork colony sizes in this area was compensated by a rise in the number of solitary breeders. The number of colonies remained the same in the two surveys (13 in 1958 and 13 in 2002).

3.3. Nest sites

125 (56.1%) pairs were registered on buildings, 66 (29.6%) pairs on pylons, 27 (12.1%) pairs on trees, and 5 (2.2%) pairs of White Storks on stacks and bales of hay (Table 2). Of the 7 unoccupied nests (H), three were built on pylons, two on transformer stations, one on a tree, and one on a stable. Of the 5 breeding attempts with half-completed nests, 4 rested on pylons and one on a chimney. Near the village of Belo Pole and in the village of Gneotin, White Storks bred in mixed colonies with Grey Herons *Ardea cinerea*. White Stork nest sites differed between as well as within colonies. 8 colonies were built on buildings and pylons, 4 on buildings, 4 on pylons and trees, one on buildings and trees, one on pylons, buildings and hay stacks, and one on buildings and hay stacks/bales.

3.4. Overhead lines

Of the 66 pairs of White Storks (HPa) nesting along power lines, 32% bred on concrete pylons. None of the nests built on pylons rested on a platform. All were in contact with electric conductors. In 32% of the villages the wooden pylons had recently (one to two years ago) been replaced by concrete pylons equipped with short upturned insulators. Wooden pylons were actually replaced during our survey, by

Table 1: Statistics of colonies of the White Stork *Ciconia ciconia* in Pelagonia

Tabela 1: Značilnosti kolonij belih štorkelj *Ciconia ciconia* v Pelagoniji

	Survey / Popis 1958	Survey / Popis 2002
no. of colonies / št. kolonij (≥ 5 HPa)	27	15
no. of colonies / št. kolonij (≥ 10 HPa)	21	6
aver. no. of pairs in colony / povpr. št. parov v koloniji	16.7	9.7
max. no. of pairs in colony / največje št. parov v koloniji	39	20

Table 2: Type of White Stork's *Ciconia ciconia* (HPa) nest base in Pelagonia in 2002

Tabela 2: Tip podlage gnezd bele štorklje *Ciconia ciconia* (HPa) v Pelagoniji leta 2002

Nests built on / Namestitev gnezd	No. / Število	Proportion / Delež (%)
house-roof / hiša-streha	104	46.6
house-chimney / hiša-dimnik	6	2.7
house-ruin / hiša-razvalina	4	1.8
stable / hlev	2	0.9
belfry-roof / cerkveni zvonik-streha	4	1.8
transf. station-roof / trafo postaja-streha	4	1.8
roofing / ostrešje	1	0.5
buildings / zgradbe	**125**	**56.1**
wooden A-pylon / leseni A-drog	41	18.4
wooden I-pylon / leseni I-drog	9	4.0
concrete I-pylon / betonski I-drog	14	6.3
concrete T-pylon / betonski T-drog	2	0.9
pylons / drogovi	**66**	**29.6**
trees / drevesa	**27**	**12.1**
bales and stacks of hay / bale in kopice sena	**5**	**2.2**
Total / Skupaj	223	100.0

concrete pylons and metal crossbeams in four villages. As a rule, concrete medium voltage pylons (as well as some low voltage pylons) have conductors running at several levels. In the entire Pelagonia only three overhead transmission lines with downturned insulators were registered.

4. Discussion

On the basis of geographically different population trends, the global White Stork population has been divided into subpopulations (Schulz 1999b). The Pelagonian population belongs to the south-eastern peripheral subpopulation, and exhibits negative population trends. In 1958 Jovetić (1959) registered 1,424 breeding pairs of White Storks (HPa) in Macedonia, a third of them in Pelagonia. The results of our 2002 survey show that what was the strongest Macedonian population, has declined dramatically since then. Similar declines were noted in the Macedonian Skopje basin (Micevski *et al.* 1992), neighbouring Greece (Hölzinger & Künkele 1986, Heckenroth 1999) and Albania (Peja & Bego 1999). It is evident that in the countries of the southern Balkans we are actually faced with one of the strongest negative population trends in the whole range of the species. This appears to be contrary to global trends (e.g. Schulz 1999b) and has not yet been researched. A possible reason for this population decline is the combination of wetland drainage and low precipitation in these areas.

It has been known for a long time that White Storks may breed in colonies (Dammerow 1924, Vaczian 1934, Reiser 1939, Ern 1975). With the exception of populations with very low proportions of scattered colonies (e.g. Dziewiaty 1994, Eichelman 1999), White Stork populations with high proportions of colonial breeders have been poorly studied. The first investigations were conducted in Croatia where, in a 1,540 km^2 area in the Sava floodplain, 86.9% were colonial breeders (Schneider-Jacoby 1988), and in Poland, where 50% were colonial breeders in the Ketrzyn district covering 1,225 km^2 (Peterson *et al.* 1999). As a rule White Stork colonies are formed in the vicinity of larger wetlands (Schneider-Jacoby 1993, Eichelman 1999). The disintegration and disappearance of colonies clearly coincides with drainage of the latter (El Agbani & Dakki 1999, Skov 1999). On the basis of our 2002 survey this is true for Pelagonia as well. In Macedonia, a population decline with colony disintegration has been noted in the Skopje basin. In 1958, 219 breeding pairs (HPa), of which 94.5% were colonial

breeders, were registered here (Jovetić 1959 & 1960). In this 1,814 km² large area 30 breeding pairs were recorded in a single colony in 1988. The main reason for the desertion of colonies and the decline of the species population in the Skopje basin can, presumably, be attributed mainly to draining Katalanovsko blato (Micevski *et al.* 1992).

Little is known about the reasons for the formation and/or disintegration of White Stork colonies, particularly for areas where entire populations breed colonially. Macedonia is among those countries with high proportions of colonially nesting White Storks. In 1958, 85% of the population bred there in colonies (Jovetić 1960). The results of our 2002 survey in Pelagonia show that the reduction in colony size has taken place, not only in places where feeding habitats have been destroyed, but also in places where feeding habitats have been little affected by intensive agriculture and development. In areas where surviving habitats have been affected little, the decrease in colony size has evidently been compensated by increasing numbers of solitary breeders.

Of the most important benefits proposed for coloniality, including predator detection, group resistance, numerical swamping, limited nest-sites, cooperative foraging, minimal travel to foraging areas, and information centres (Tinbergen *et al.* 1963, Horn 1968, Alexander 1974, Ward & Zahavi 1979, Campbell & Lack 1985, Bairlein 1996), only the last two or three appear to be significant for White Storks. For birds that exploit resources that are variable in space and time, natural selection does not favour individual territories for resource control (Ehrlich *et al.* 1994). Coloniality as a spatio-temporal clumping of nests (Campbell & Lack 1985) is, as far as the Pelagonian White Stork is concerned, a theoretical answer to the diverse and more concentrated food availability in areas little affected by decline in population numbers. On the other hand, solitary (territorial?) breeding in White Storks may be more frequent in drained areas with presumably reduced total quantities and more constant and dispersed availability of food. From the theoretical point of view it is difficult to explain, on the basis of the 2002 survey, why the average size of colonies has been reduced and why population numbers have been compensated with solitary breeders in areas with little affected habitats in northern and central Pelagonia. The greater part of these areas is still traditionally grazed by sheep, horses and cattle (e.g. water buffaloes), while relatively smaller areas are dry to wet, extensively farmed grasslands.

In view of the impact of overhead lines on White Stork in the countries of western and eastern Europe (Fiedler & Wiessner 1980, Fiedler 1999), we estimate that the rapid reconstruction of Pelagonian overhead transmission lines, which is at complete variance with nature conservation, will have an impact on the development of this bird's population. White Storks have already begun to perish in some places due to high mortality caused by certain structural characteristics of concrete pylons and earth faults. Such is the case in Žabjane, where the reconstruction of the electric power network with concrete pylons equipped with upturned insulators is still in progress – with two dead Storks in a couple of days! Irrespective of the fact that there is no hard information on electrocution of White Storks in Macedonia we believe, that the reconstruction of overhead transmission lines, which are dangerous to birds, is at this moment the most important factor in the White Stork's negative population trend in Pelagonia, and in Macedonia in general. The great land claim overexploitations in Macedonia have ended, while the intensification of agricultural production is stagnating and even receding. But on the basis of the 2002 survey we infer, that the reconstruction of overhead transmission lines in Pelagonia, has and very probably is hastening the decline of the White Stork population.

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5. Povzetek

V maju 2002 je bil v Pelagoniji v južni Makedoniji opravljen popis bele štorklje *Ciconia ciconia.* Na območju, velikem 1104 km², je bilo ugotovljenih 223 parov (HPa), 7 nezasedenih gnezd (H) in 5 poskusov gnezditve (HB1 ali HB2). Med popisanimi kolonijami (≥ 5 HPa) je največja štela 20 parov. Bele štorklje v Pelagoniji gnezdijo v vaseh: na stavbah 56,1%, na drogovih 29,6%, na drevesih 12,1% in na kopicah in balah sena 2,2% para. Ekološka gostota (StDBiol) je 20,2 para / 100 km². V primerjavi s popisom v letu 1958 kaže popis v letu 2002 upad HPa za 52,4%, zmanjšanje števila kolonij z 27 na 15 in nazadovanje velikosti kolonij s 16,7 para na 9,7 para / kolonijo. Delež kolonijskih gnezdilk v pelagonski populaciji se

je zmanjšal z 92,9% na 65,0%, delež solitarnih gnezdilk (1HPa / vas) pa povečal z 2,1% v letu 1958 na 18,8% v letu 2002. Kolonije štorkelj so praktično izginile na izsušenih območjih v južni Pelagoniji. V severni in osrednji Pelagoniji z ekstenzivno pašo in košnjo so števila gnezdečih parov in kolonij ob obeh popisih ostala enaka: nazadovanje velikosti kolonij s 14,5 na 9,7 para / kolonijo je kompenziralo naraščanje števila solitarnih gnezdilk. Nazadovanje populacije in razpad kolonij belih štorkelj v Pelagoniji kaže na splošni negativni proces v Makedoniji. Obsežna in naravovarstveno neskladna obnova zračnih vodov v Pelagoniji bo proces razpada kolonij in nazadovanja populacije pospešila.

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