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Distribution and breeding of the White Stork (*Ciconia ciconia*) in North Macedonia in 2015 and 2016

Распространување и гнездење на белиот штрк (*Ciconia ciconia*) во Северна Македонија во 2015 и 2016 година

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Abstract

The national White Stork census was conducted as part of the International Stork Census in an attempt to close the gap of 57 years since the last national census and establish a new basis for further conservation action. Total of 837 breeding pairs (HPa) were recorded during 2015/2016. Most of the pairs (534) bred in 45 colonies with 5 of more pairs. Five colonies with more than 20 pairs were found, along with 17 colonies of 11-20 pairs and 19 breeding colonies of 5-10 pairs. The total surface-based population density was 3.26 pairs/100 km^2. The average biological density was 27.59 HPa/100 km^2, but it varies widely at a regional level, with Tikveš region having the highest density of 106.7 pairs/100km^2 and Maleš region having the lowest of 4 pairs/100 km^2. Most of the nests (62.4%) were placed on overhead transmission pylons, followed by buildings (36.8%). Only 0.6% of the nests were placed in trees, and nesting on hay bales and stacks was completely absent. The number of pairs with fledged juveniles (HPm) was minimum of 717 for 2015 and 2016 combined. The breeding success (JZa) in 2015 was 2.78 ± 1.18 and the fledgling rate (JZm) was 2.97 ± 0.96. There were possibly significant differences in the breeding parameters among some of the regions.

Key words: breeding colonies, breeding population, ecological density, White stork census

Апстракт

Националниот попис на белиот штрк беше спроведен како дел од Меѓународниот попис на белиот штрк, во обид да се пополни празнината од 57 години од последниот национален попис и да се постави основа за идни мерки за зачувување. Во текот на 2015/2016 година

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вкупно беа регистрирани 837 гнездечки двојки (HPa). Најголемиот број од двојките гнездеа во 45 колонии од по 5 и повеќе двојки. Беа најдени пет колонии со по повеќе од 20 двојки, покрај 17 колони со 11-20 двојки и 19 колонии со по 5-10 двојки. Вкупната густина по површина изнесуваше 3,26 двојки/100 km^2. Просечната биолошка густина беше 27,59 HPa/100 km^2, при што Тиквешкиот регион имаше најголема густина од 106,7 двојки/100 а регионот Малеш најниска, од 4 двојки/100 km^2. Најголемиот број од гнездата (62,4%) се изградени на столбови за пренос на електрична енергија, следени од гнезда сместени на објекти (36,8%). Само 0,6% од гнездата беа сместени на дрвја, а гнездењето на стогови слама и бали целосно отсуствува. Бројот на двојки со пролетани млади (HPm) беше најмалку 717 комбинирано за 2015 и 2016 година. Успехот на гнездење (JZa) во 2015 година беше 2,78 ± 1,8, а на стапката на пролетување (JZm) беше 2,97 ± 0,96. Возможно е да постојат значајни разлики во гнездечките параметри меѓу некои региони.

Клучни зборови: гнездечки колонии, гнездечка популација, еколошка густина, попис на белиот штрк

Introduction

The White Stork *Ciconia ciconia* is among the species whose populations have largely recovered globally. Following a large decrease before 1984, the global population in 1995 was estimated to 166000 pairs and to 233000 pairs in 2005 (Thomsen 2013). More recently, only the European population has been estimated at 224000-247000 pairs (BirdLife International 2015).

Before 2015 the White Stork population in present-day North Macedonia had been counted only once, in 1958 (Jovetić 1959, 1960). However, several other counts have been made in separate regions at irregular intervals; one survey of Skopje valley in 1988 (Micevski et al. 1992), a survey in Pelagonija in 2002 (Štumberger & Velevski 2002), an unpublished survey of several regions of North Macedonia from 2010 (Heckenroth & Heins 2010), and one more survey of Pelagonija in 2012 (Velevski et al. 2013). The data collected from these counts are difficult to compare or to use as an overview for the national population trends.

The national census of the White Stork breeding population in 2015 and 2016 was carried out as part of the International White Stork Census. The primary goal of this survey was to estimate the population size of the White Stork in North Macedonia. Additionally, we aimed to compare the biological breeding densities, breeding parameters and nest-site selection among different regions of the country, and to compare this recent information with best available data from the past.

Methodology

Field survey

Almost the entire territory of North Macedonia, excluding high mountains and some highlands, was covered with the census. The territory was divided into regions which would most closely fit regions used in previous counts (Jovetić 1959; Micevski et al. 1992; Štumberger & Velevski 2002; Heckenroth & Heins 2010) and the proposed regional division of the country for the needs of the biodiversity databases (Melovski et al. 2013). The published data for each region was analysed in a preparatory phase. Census data were collected in standardized forms. In total, 19 people participated in the census. All surveyors were instructed to focus on regions they were familiar with and all of them received training and maps with the assigned territory. Most of the surveyors used cars as a mode of transport. The census was conducted between 24th May and 20th July. One region (Kičevo and Poreče) was left out during the census of 2015 due to lack of manpower, but was covered in 2016.

The surveyors were recording breeding parameters on the field following the standardised parameters for the White Stork (Schulz 1999, Schulz and Thomsen 1999): number of all White Stork breeding pairs (HPa – storks sitting or standing in the nest), number of pairs with fledged juveniles (HPm), number of pairs without fledged juveniles that occupied a nest for at least four weeks during the first half of the breeding season (HPo), number of pairs with unknown breeding success that occupied a nest for at least four weeks during

the first half of the breeding season (HPx), unoccupied nests and nest sites (H) and the number of fledged young (JZG). Location of the nests (nest-site) was noted descriptively and/or with GPS. Information on size of nest, reports for unsafe and nests considered problematic to locals (information collected through interviews) and single or paired birds visiting a nest but with no connection to nest (HB) were collected as additional data. Majority of nests (n=733) were surveyed between 18th June and 20th July, which is the period before the fledgling of the juveniles and in which juvenile storks can be easily counted from ground (Denac 2010). When at least five pairs bred in a village, they were considered to be a colony (Štumberger & Velevski 2002).

The relative inexperience of the surveying team has led to the inconsistency and therefore uselessness of some additional data such as number of storks with no connection to nest (HB) as well as several entries for fledgling juveniles which were not recorded by surveyor but collected as data from local people. This has led to the exemption of this data from the analyses. In the case of HB it become obvious that we can not provide precise calculations, while cases where information were collected from local people were considered as "unknown breeding success" (HPx).

Statistical analyses

We analysed the total and biological densities and nest-site selection, for each region separately and for the entire country, and two breeding parameters: breeding success (JZa – average number of fledged juveniles per breeding pair) and fledgling rate (JZm – average number of fledged juveniles per successful pair). The 104 nests that were surveyed early in the breeding season were excluded from the analyses of the breeding parameters. However, we have added the number of pairs (n=44+4+3) that had juveniles on the dates of visits in the calculation of the minimal HPm. Breeding parameters were calculated for 2015 only. When calculating the breeding parameters (JZa, JZm) we did not include the pairs with unknown breeding success (HPx).

Surface-based population density (StD) was calculated as the number of breeding pairs (HPa) per 100 km^2 using the entire territory of the country (25713 km^2). The biological population density (StDBiol) was calculated as the number of breeding pairs (HPa) per 100 km^2 area of potential feeding habitats (3033.6 km^2) (Denac 2010).

The potential feeding habitats were delineated as flat areas under the elevation of 1000 m a.s.l. (as no storks were found breeding or foraging above that altitude), that had slope of 1% of less. From this area, unsuitable CORINE land cover classes (European Union et al. 2018) were removed: 111 – Continuous urban fabric, 221 - Vineyards, 222 - Fruit tree and berry plantations, 311 - Broad-leaved forest, 312 - Coniferous forest, 313 - Mixed forest, 323 - Sclerophyllous vegetation and 324 - Transitional woodland/shrub). Water surface of the larger lakes was also excluded. Rural areas were not removed as Storks are frequently seen foraging in the villages. The final refinements were done using satellite imagery of ESRI Satellite (ESRI 2020) and Google Earth (Google 2020) removing the remaining areas that are misclassified in the Corine Land Cover data. All analyses were done using ArcGIS 10.7.1. (ESRI 2019).

All analyses of the breeding parameters were done using the computer language R, version 3.6.3 (R Core Team 2020).

We first calculated the average breeding success (number of juveniles fledged per breeding pair, JZa) and fledgling rates (number of juveniles fledged per successful pair, JZm) and their medians and standard deviations (SD) for each region separately and for the entire country. As there were apparent differences in the breeding parameters among regions (see Results), we checked whether they are statistically significant. We first checked for normality of the data and performed Levene's test from the *car* package (Fox & Weisberg 2019) for homoscedasticity. As data were heteroscedastic, we performed Kruskal-Wallis test (McDonald 2014; Mangiafico 2015). Because the sample sizes were not equal among the regions, Dunn test of the *FSA* package (Ogle et al. 2020) was used as a *post hoc* test (Zar 2010; Mangiafico 2015).

The dataset and the R code for the analyses are given as Annex I in Electronic supplementary material.

Results

Breeding population size, distribution and densities

During the census we counted a total of 837 breeding pairs (HPa); 819 in 2015 and another 18 in 2016. The number of pairs with fledged juveniles (HPm) for both years was minimum of 717. The number of pairs without

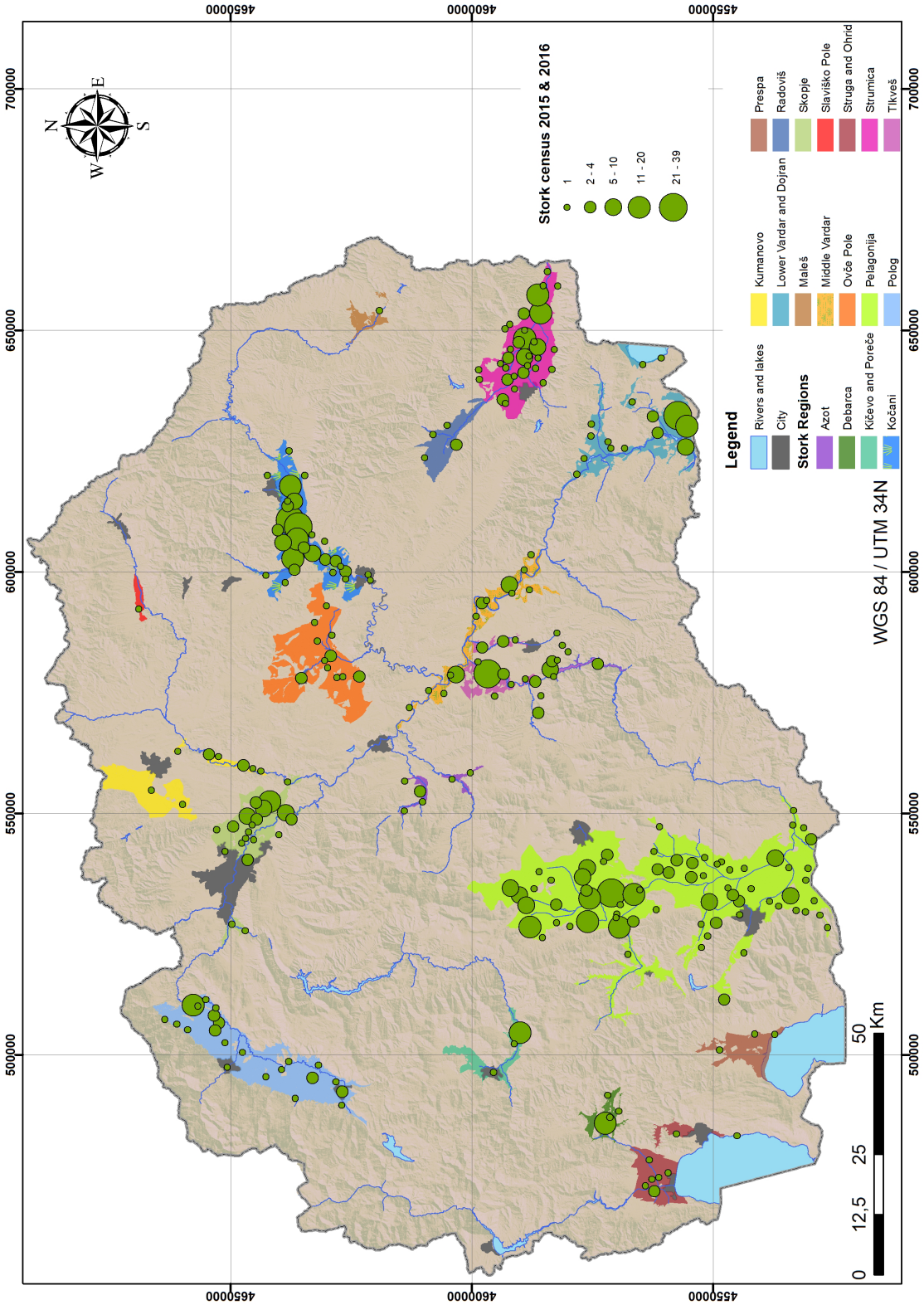

Fig. 1. distribution of White Stork pairs (HPa) in North Macedonia in 2015/2016.

fledged juveniles (HPo) was no less than 44 and the number of pairs with unknown breeding success (HPx) was 128. Pelagonija, Štip and Kočani and Strumica were regions with the largest number of breeding pairs (Tab. 1, Fig. 1).

The total surface-based population density (StD) was 3.26 HPa/100 km^2. The

Table 1. Regional distribution of white stork breeding pairs in North Macedonia. Unless noted (2016), data were collected in 2015. Some regions were visited early in the breeding season, while adults were still incubation. Therefore, some of the number are given as minimums. Unknown situations are given with 'slash' (/)

Region	HPa	HPm	HPo	HPx
Azot	9	8	1	0
Debarca	15	13	2	0
Kičevo and Poreče (2016)	18	18	0	1
Kumanovo	10	10	0	0
Lower Vardar and Dojran	66	55	2	9
Maleš	1	1	0	0
Middle Vardar	28	17	0	11
Ovče Pole	14	12	2	0
Pelagonija	241	225	16	0
Polog	42	40	2	0
Prespa	3	3	0	3
Radoviš	6	min 4	/	6
Skopje	50	50	0	0
Slaviško Pole	1	/	/	1
Štip and Kočani	157	138	17	2
Struga and Ohrid	8	6	2	0
Strumica	95	min 44	/	95
Tikveš	73	73	0	0
TOTAL:	**837**	**min 717**	**min 44**	**128**

Abbreviations after Schulz (1999): **HPa** – Pair that occupied a nest for at least 4 weeks during the first half of the breeding season, "breeding pair" (HPm + HPo + HPx); **HPm** – Pair with fledged young; **HPo** – Pair without fledged young, that occupied a nest for at least 4 weeks during the first half of the breeding season; **HPx** – Pair with unknown breeding success, that occupied a nest for at least 4 weeks during the first half of the breeding season

Table 2. Regional biological densities of White Stork breeding pairs in North Macedonia

Region	Surface of potential foraging habitat (km^2)	HPa	StDBiol (HPa/100 km^2)
Azot	22.1	9	40.72
Debarca	33.0	15	45.45
Kičevo and Poreče	51.8	18	34.75
Kumanovo	123.3	10	8.11
Lower Vardar and Dojran	160.0	66	41.25
Maleš	25.0	1	4.00
Middle Vardar	106.1	28	26.39
Ovče Pole	245.7	14	5.70
Pelagonija	1060.8	241	22.72
Polog	298.8	42	14.06
Prespa	70.5	3	4.26
Radoviš	69.7	6	8.61
Skopje	145.9	50	34.27
Slaviško Pole	13.0	1	7.69
Stip and Kočani	208.9	157	75.16
Struga and Ohrid	100.3	8	7.98
Strumica	230.3	95	41.25
Tikveš	68.4	73	106.73
Total/Average	**3033.6**	**837**	**27.59**

total biological population density was 27.59 HPa/100 km^2, but varied widely among regions (Tab. 2), being highest in Tikveš region and lowest in Maleš region.

The breeding pairs were distributed in 45 colonies Five of the colonies numbered more than 20 breeding pairs, 17 consisted of 11-19 breeding pairs, and 19 consisted of between 5 and 10 pairs. The largest colony was recorded in the village Rosoman (Tikveš region), with 39 breeding pairs. In total there were 534 nests (63.8%) in colonies, which means that the storks were mainly colonial breeders.

The colonies were found in 10 out of the 18 regions. Largest number of colonies was found in Pelagonija region (15 colonies), followed by Štip and Kočani region (eight colonies). Stumica and Tikveš region supported five colonies each, Skopje region supported four, Lower Vardar and Dojran region supported three colonies, two were found in Middle Vardar region, and three regions (Debarca, Kičevo and Poreče, Polog) supported only one colony each.

Nest site selection

We registered 522 (62.38%) nests on pylons and 310 (37.04%) nests on man-made buildings. Only 5 nests (0.6%) were on trees, while hay-bales and stacks were completely abandoned as nest-sites (Tab. 3).

Breeding parameters

Regional differences in breeding parameters

The minimal number of fledged juveniles (JZG) in North Macedonia was 1926 in 2015 (Strumica, Radoviš, Prespa and Kicevo-Poreče regions were not counted in 2015) and 38 in Kicevo-Poreče region in 2016. The average productivity of all breeding pairs (JZa) in 2015 was 2.78 ± 1.18 while the average productivity of successful breeding pairs (JZm) was 2.97 ± 0.96. The breeding parameters in 2015 vary regionally (Tab. 4). They were highest in Skopje region (JZa=JZm=3.22),

Table 3. Nest-site selection in different region of North Macedonia

Region	building		pylon		tree		Total	
	N	%	N	%	N	%	N	%
Azot	3	0.36	6	0.72	0	0	9	1.08
Debarca	11	1.31	4	0.48	0	0	15	1.79
Kičevo and Poreče	6	0.72	12	1.43	0	0	18	2.15
Kumanovo	1	0.12	9	1.08	0	0	10	1.2
Lower Vardar and Dojran	6	0.72	60	7.17	0	0	66	7.89
Maleš	1	0.12	0	0	0	0	1	0.12
Middle Vardar	7	0.84	21	2.51	0	0	28	3.35
Ovče Pole	6	0.72	8	0.96	0	0	14	1.68
Pelagonija	80	9.56	159	19	2	0.24	241	28.8
Polog	0	0	42	5.02	0	0	42	5.02
Prespa	0	0	3	0.36	0	0	3	0.36
Radoviš	1	0.12	5	0.6	0	0	6	0.72
Skopje	5	0.6	44	5.26	1	0.12	50	5.98
Slaviško Pole	0	0	1	0.12	0	0	1	0.12
Štip and Kočani	100	11.95	56	6.69	1	0.12	157	18.76
Struga and Ohrid	3	0.36	5	0.6	0	0	8	0.96
Strumica	36	4.3	58	6.93	1	0.12	95	11.35
Tikveš	44	5.26	29	3.46	0	0	73	8.72
Total	**310**	**37.06**	**522**	**62.39**	**5**	**0.6**	**837**	**100.00**

Table 4. Regional breeding parameters of White Stork populations in North Macedonia. Unless noted (2016), data were collected in 2015.

Region	JZG	JZa	median (JZa)	SD (JZa)	JZm	median (JZm)	SD (JZm)
Azot	28	3.11	4	1.36	3.50	4	0.76
Debarca	42	2.80	3	1.26	3.23	3	0.60
Kičevo and Poreče (2016)	38	/	/	/	/	/	/
Kumanovo	31	3.10	3	0.57	3.10	3	0.57
Lower Vardar and Dojran	152	2.67	3	1.17	2.76	3	1.07
Maleš	2	2.00	2	NA	2.00	2	NA
Middle Vardar	51	3.00	3	0.71	3.00	3	0.71
Ovče Pole	43	3.07	3	1.54	3.58	3.5	0.90
Pelagonija	638	2.65	3	1.22	2.84	3	1.03
Polog	121	2.88	3	1.04	3.03	3	0.83
Skopje	161	3.22	3	0.91	3.22	3	0.91
Štip and Kočani	410	2.65	3	1.36	2.97	3	1.05
Struga and Ohrid	21	2.63	3	1.69	3.50	3.5	0.55
Tikveš	226	3.10	3	0.63	3.10	3	0.63
Totals/national averages	**1964**	**2.78**	**3**	**1.18**	**2.97**	**3**	**0.96**

Abbreviations after Schulz (1999): **JZG** − Total no. of fledged young; **JZa** − Average no. of fledged young per all breeding pairs (JZG / HPa); **JZm** − Average no. of fledged young per breeding pairs with fledged young (JZG / HPm); median numbers of fledglings per nests and standard deviation (SD) are also presented.

closely followed by Azot region (JZa = 3.11, JZm = 3.50) and Kumanovo and Tikveš regions (JZa=JZm=3.10). Ovče Pole region had highest fledgling rate (JZm = 3.58). Struga and Ohrid region had somewhat lower breeding success (2.63), but high fledgling rate (3.50), with Lower Vardar and Dojran region and Pelagonija region having somewhat lower fledgling rates.

Differences in breeding parameters depending on the nest-site type

There were no apparent differences in the average values of the breeding success and fledgling rates among the different nest-sites (Tab. 5).

Effects of regions on the breeding success and fledgling rates

Not considering the observations from 2016, the Kruskal-Wallis test and the *post hoc* Dunn test showed possible effect of the region on the breeding success (H = 21.105, df = 12, *p*-value = 0.049) and the fledgling rate (H = 23.798, df = 12, *p*-value = 0.022). The results of the *post hoc* Dunn test are given in Tab. 6.

Table 5. Breeding parameters of White Stork in North Macedonia according to the nest-site.

Nest-site	JZG (2015 & 2016)	for all breeding pairs (2015)			for successful pairs (2015)		
		JZa	median No of fledglings	SD of No of fledglings	JZm	median No of fledglings	SD of No of fledglings
building	741	2.77	3	1.20	2.98	3	0.96
pylon	1210	2.79	3	1.17	2.97	3	0.96
tree	13	3.25	3.5	0.96	3.25	3.5	0.96

Table 6. Pairwise comparison of the breeding success and fledgling rates among regions, using Dunn *post hoc* test. Holm method is used to calculate *p*-adj. Only pairs of regions where *p*-unadjusted <0.05 are shown.

Parameter	Region comparison	Z	*p*-unadj.	*p*-adj.
Breeding success	Lower Vardar and Dojran - Skopje	-2.410	0.016	1
	Pelagonija - Skopje	-3.022	0.003	0.196
	Skopje - Štip and Kočani	2.501	0.012	0.940
	Lower Vardar and Dojran - Tikveš	-2.049	0.040	1
	Pelagonija - Tikveš	-2.731	0.006	0.485
	Štip and Kočani - Tikveš	-2.128	0.033	1
Fledgling rate	Azot - Lower Vardar and Dojran	2.185	0.029	1
	Azot - Pelagonija	2.144	0.032	1
	Lower Vardar and Dojran - Ovče Pole	-2.535	0.011	0.865
	Ovče Pole - Pelagonija	2.539	0.011	0.867
	Lower Vardar and Dojran - Skopje	-2.264	0.024	1
	Pelagonija - Skopje	-2.475	0.013	1
	Pelagonija - Tikveš	-2.034	0.042	1

Discussion

After 57 years the national White Stork census was repeated on the territory of North Macedonia. With this long period in mind, the possibilities for more detailed analyses of the national population trend are limited. The direct comparison of both periods (1958 and 2015-2016) indicates a decline from 1490 to 837 breeding pairs, i.e. an overall decline of 44%. The lack of data for the 57 years in-between prevents us from suggesting any reasons for this decline. Several regional comparisons are possible, indicating significant overall decreases, but with fluctuating recent trends (Tab. 7).

The decline of the population in Skopje region was attributed to the drainage of the wetland Katlanovsko Blato in the early seventies (Micevski et al. 1992). There is no conclusive evidence for the decline of the once strongest population of White Storks in Pelagonija, but intensification of agriculture and extensive reconstructions of overhead transmission lines may have played significant roles (Štumberger & Velevski 2002).

Considering the stability of breeding colonies in North Macedonia we can have a closer analysis of the Pelagonian population where initial records detected that 85% of the population was breeding in 27 colonies larger than 10 nests (Jovetić 1959). Later findings show only 6 colonies larger than 10 nests (holding 36.3% of the local population) (Štumberger & Velevski 2002), but in 2012 the number of colonies with more than 10 pairs has grown to 10, with 55.6% of the total number of breeding pairs (Štumberger and Velevski, unpubl.). Our census recorded 8 colonies larger than 10 nests which held 49.59% of the Pelagonian population. It seems that after the initial drop, the colonies in Pelagonija continue to fluctuate and remain to be situated mostly in the northern part of the region where agriculture is more traditional, which has already been noted in 2002 (Štumberger & Velevski 2002). In highly urbanized areas such as Skopje, Polog, Kumanovo and Struga-Ohrid region, all breeding colonies are located in the least urbanized outskirts of the regions, or are completely absent.

Nest site selection has changed dramatically in the last 57 years or since the first national census conducted in 1958 (Jovetić 1959). The census of 2015-16 found that the nesting sites were predominantly overhead transmission pylons (with and without artificial nesting platforms) with 62.37%, whereas in 1958 there had been no nests on such structures. The second most favoured location was on buildings with 36.80%, which was the first choice of White Storks in 1958 when 55.23% chose that nest-site. Nesting on trees was nearly abandoned in 2015-2016 with only 0.6%, while nesting on hay bales and stacks was completely abandoned. The first White Stork census found that 37.2% of the nests were placed on trees and 7.52% on hay bales

Table 7. Changes in the numbers of White Stork breeding pairs in the different regions of North Macedonia

Region\Year	**1958** (Jovetić 1960)	**1988** (Micevski et al. 1992)	**2002** (Štumberger & Velevski 2002)	**2010** (Heckenroth & Heins 2010)	**2012** (Velevski et al. 2013)	**2015-2016** (This study)
Azot	17					9
Kičevo and Poreče	11					18
Kumanovo	22					10
Lower Vardar and Dojran	73			74		66
Maleš	0					1
Middle Vardar and Tikveš	25					101
Ovče Pole	69					14
Pelagonija	493		220		330	241
Polog	37					42
Prespa	16					3
Skopje	223	30				50
Slaviško Pole	0					1
Štip and Kočani	152					157
Struga and Ohrid and Debarca	53					23
Radoviš and Strumica	274			67		101
Mavrovo	25					0
TOTAL	**1490**					**837**

and stacks. It seems that the last record of single nest on a hay bale is from the regional census conducted in Pelagonija in 2012 (Štumberger and Velevski, unpubl.). However, it is interesting to note that significant shifts in nest site selection have also happened quite recently in the Pelagonija region (Tab. 8), where buildings are being abandoned for electrical pylons: while in 2002 56.1% of the White Stork pairs nested on buildings, in 2015 only 32.4% choose that location. Along with the disappearance of nests on hay bales and the decreased used of trees (from 12.10% to 0.82%), electrical pylons are fast becoming the most important nest-sites for white storks in Pelagonija. Increase in use of electricity pylons has been observed in many European countries (overview in Moreira et al. 2018), but the proposed drivers for such selection (proximity to food sources and surrounding land cover type) might not be valid for the Macedonian population, as most of it breeds in rural settlements and has equal possibility for nest-site selection between pylons and other substrate, e.g. buildings. Having in mind that electricity structures are very unsafe (majority of nests are not placed on platforms and the pylons are not insulated against electrical shortages) the importance of cooperation with the energy sector in White Stork conservation is very high.

Comparison with the breeding parameters from the earlier study in Skopje region encompassing the period 1954-1958 is not straight-forward, as the number of raised juveniles is not presented by Jovetić (1959), but only the average fledgling rate is given (3.15), leading to calculated average breeding success rate of 2.39. This fledgling rate is generally in line with the national average

Table 8. Changes in nest-site selection (percent of HPa) of White Storks in Pelagonija region

Region	**Year**	**Electrical pylon**	**Building**	**Tree**	**Hay bale**
Pelagonija	1958	0.00	58.80	33.13	13.46
	2002	29.60	56.10	12.10	2.20
	2015	66.39	32.38	0.82	0.00

of 2015 (2.97) and especially with the value in Skopje region (3.22), but the historical breeding success rate is lower than the 2015 national average (2.78) and much lower than the more recent value for Skopje region (3.22, equal to the fledgling rate). Given the large population size of White Storks in Skopje region in the period 1954-1958 (average 193 HPa, range 181-215), and the general better situation of the foraging habitat, we might assume that density-dependent brood reduction was more pronounced in the past.

Breeding parameters of the White Stork population in North Macedonia are higher than most other values from the Balkan Peninsula and especially Europe (Tab. 9). From the sources in the table and the references given therein it is clear that breeding parameters vary widely among regions and/or among years/periods. Environmental factors such as habitat types and landscape structure (Kujawa et al. 2000; Nowakowski 2003), weather conditions and arrival dates (Jovani & Tella 2004; Denac 2006; Hilgartner et al. 2014; Eggers et al. 2015) and distance to the main feeding areas (Hilgartner et al. 2014; Djerdali et al. 2016a) are known to affect the breeding parameters, as is the combination of the environmental factors with colony size (Janiszewski et al. 2014; Djerdali et al. 2016b), sometimes resulting with density-dependent brood reduction (Zurell et al. 2015). These factors might be behind the observed differences in the breeding parameters among some regions in North Macedonia in 2015, but clear correlation between breeding densities and breeding parameters is lacking (Tab. 2 and Tab. 4). Further analyses are needed to identify the underlying causes behind the high breeding parameters and the observed possible differences among some regions if the country.

Conclusions

The Macedonian population of White stork declined for about 44% in the period 1958-2015, but this decline has probably been halted by late 1990ties already. The population trend is not uniform in the entire country, with strongest declines in absolute numbers observed in regions of Skopje, Pelagonija, Radoviš and Strumica, strongest increase is observed in Middle Vardar and Tikveš regions, while there are virtually no changes in the regions of Lower Vardar and Dojran and

Table 9. Breeding parameters of White stork populations in selected regions/countries and breeding periods.

Country	Region	Year(s)	JZa	JZm	Reference
Albania	Entire country	2011-2015	3.13	3.36	Bego et al. (2016)
Bulgaria	Entire country	2004-2005	2.50	2.80	Petrov et al. (2013)
Croatia	Entire country	2004-2005	2.39	2.86	Mužinić & Hackenberger (2015)
Greece	Selected regions	1993-1995		3.38	Goutner & Tsachalidis (2007)
	Entire country	2004	2.70	2.99	Kominos & Galanaki (2013)
Serbia	Vojvodina	2000	3.14	3.38	Gergelj et al. (2000)
	Tamiš river valley	2004	2.58	2.60	Tucakov (2006)
Slovenia	Entire country	1999	1.83	2.39	Denac (2001)
	Entire country	1999-2010	2.02	2.57	Denac (2010)
Turkey	Kızılırmak delta	2010		3.82	Erciyas Yavuz et al. (2012)
Romania	North-eastern Romania	2016	2.19	2.25	Fasolă-Mătăsaru et al. (2018)
Lithuania	Entire country	2009-2010		2.70	Vaitkuvienė & Dagys (2015)
Poland	Entire country	2004	2.33	2.61	Guziak & Jakubiec (2006)
	Leszno	1983-2006	1.99	2.60	Tryjanowski et al. (2009)
	Siedlce	2000-2014	2.98	3.00	Kaługa et al. (2016)
Hungary	Entire country	2004	2.67	2.97	Lovászi et al. (2013)
France	Entire country	2004-2005	2.20	2.80 (2.90)	Wey (2013)
	northeastern France	2003-2004	2.40	2.50	Massemin-Challet et al. (2006)
Spain	part of population	2004	1.67	2.06	Molina (2013)
North Macedonia	Skopje valley	1954-1958	2.39	3.15	Jovetić (1959)
	Entire country	2015	2.78	2.97	this study

Štip and Kočani regions. Colonial breeding is dominant, with 534 pairs breeding in 45 colonies of 5 or more pairs. Electricity pylons are preferred choice for nest construction (62.4% of all nests are built on pylons).

The average breeding success was 2.78 juveniles/breeding pair and the average fledgling rate was 2.97 juveniles/successful pair, with possible significant differences in the breeding parameters among some of the regions.

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