Distribution, population size and population dynamics of the White Stork (*Ciconia ciconia*) in Cluj County (Romania)

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SUMMARY. During the VIIth International White Stork Census the breeding population of the White Stork was censused in Cluj county. In 2014 at 90 localities 123 White Stork nests were identified. The population of the White Stork in Cluj county was estimated at 110-120 breeding pairs (HPa), and the total density amounted to 1.39 pairs/100 km^2. The mean distance between each nest and the nearest White Stork nest was 4320.54 m. The majority (55.28%) of the nests were found at altitudes between 300-500 m. Between 1996-2014 there was a moderate increase in the proportion of nests built in the 301-500 m altitudinal range, from 48.61% in 1996 to 55.28% in 2014. During the last 18 years there was a steep increase in the proportion of nests built on overhead electricity line poles, from 59.72% in 1996 to 91.86% in 2014. The average breeding success (JZa) and productivity (JZm) values for the county were 3.12 and 3.38, values which are higher than the estimated JZa and JZm values needed to keep the population stable. In comparison to the last survey in 1996, the 2014 census shows a moderate 5.35% increase in the number of the breeding pairs (HPa).

Keywords: breeding success, distribution, nest site selection, population trends, white stork

Introduction

In 2014 during the VIIth International White Stork Census data of more than 5600 nests were obtained from more than 2500 romanian localities distributed in 39 counties (Kósa, unpublished data). The total romanian White Stork population can be estimated to 5000-6000 breeding pairs (Kósa, 2013). With the exception of high mountainous regions and forested area, the White Stork is distributed over the entire territory of Romania.

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The first regional White Stork census in Cluj county was conducted in 1956 by Miklós Béldi (Béldi, 1959). The first detailed census covering the whole area was made 40 years later, in 1996 (Kósa *et al.*, 1998). Some data on the numbers and population dynamics of the White Stork in Cluj county were published later by Kósa *et al.* (2002).

In 2014, the White Stork population from Cluj county was censused again. The main goal of this study was to assess the changes occurring after 18 years in the distribution, population size, breeding parameters and population dynamics of the White Stork in this area.

Materials and methods

The study area covers 6650 km^2 and is situated in the central-western part of Romania. The geographical range of Cluj county is from 22º36'E to 24º15'E and from 46º24'N to 47º22'N.

Between June 30th and July 21th 2014, 175 villages were surveyed for White Stork nests. The survey was conducted according to the standardized count methodology accepted in Romania (Kósa, 2014). In order to ensure the compatibility of our results with the data of the VIIth International White Stork Census, the following parameters were determined (Schulz 1999):

HPa – Number of breeding pairs (HPa=HPm+HPo+HPx);

HPm – Number of successfully breeding pairs;

HPo – Number of unsuccessfully breeding pairs;

HPx – Number of breeding pairs with unknown success;

JZG – Total number of fledged young.

The following numbers were calculated from the compiled data:

JZa – Productivity (breeding success) - the mean number of fledged young from all breeding pairs (JZG/HPa);

JZm – Mean fledged brood size – mean number of fledged young from successful nests only (JZG/HPm);

Std – "Stork density" or population density - number of breeding pairs (HPa) per 100 km^2.

Number of fledglings was recorded for each breeding pair by direct observation with binoculars.

Locations and altitude of White Stork nests were recorded with a Garmin Oregon 650t GPS receiver (GPS accuracy: 3–5 m). All nests were photographed.

Data analysis was made with the FileMaker Pro software and maps were produced with the QGIS 2.8.2 software.

Results and discussion

Distribution, abundence and population size

During the VIIth International White Stork Census the breeding population of the White Stork was censused in Cluj county. Compared to the last census (Kósa *et al.*, 1998) the number of surveyed localities increased from 78 to 175 (Fig. 1). In 2014 at 90 localities 123 White Stork nests were identified (Table 1). The mean number of nests/localities was 1.36 and the maximal number of 4 nests/localities were observed in Morlaca and Brăişoru.

Over the period of 1996 to 2014 the proportion of localities with one nest decreased from 86% to 40%, while the proportion of localities with 2 nests increased from 10.9% to 21.11%.

The mean distance between each nest and the nearest White Stork nest was 4320.54 m. The greatest distance recorded between neighbouring White Stork nests was 25399 m.

In Southeast Europe the presence of the White Stork nests is probably determined by a set of environmental variables with the greatest negative influence being topography and the amount of forest and the greatest positive influence beig presence of human settlements, the availability of open habitats such as grasslands or non-irrigated arable lands in proximity to White Stork nests (Radovic *et al.,* 2015).

The distribution of the White Stork throughout Cluj county is uneven. The highest densities of nests were recorded in the western part of the county in the upper valley of Crişul Repede (24 nests). About half of the total number of nests concentrated in the valleys of five larger watercourses: Someş (19 nests), Nadăş (19 nests), Borşa (11 nests), Luna (7 nests) and Hăşdate (7 nests). The lowest densities of White Stork nests were recorded in the eastern part of the county in an 1237 km^2 area situated between Apahida, Cămăraşu and Viişoara localities. In this area, characterised by more intensive agriculture, from the 29 surveyed localities only 3 had 3 storks nests.

No White Stork nests were identified at the following 85 localities: Agârbiciu, Apahida, Ardeova, Bădeni, Băişoara, Beliş, Berchieşu, Bogata, Boian, Bolduţ, Borşa-Cătun, Boteni, Buru, Buteni, Călăraşi, Cămăraşu, Căprioara, Ceanu Mare, Ciucea, Chesău, Ciumafaia, Coasta, Cojocna, Colonia, Coruşu, Corpadea, Crişeni, Cristorel, Dezmir, Dâmbu Mare, Dingău Mare, Dingău Mic, Domoşu, Dumbrava, Feleacu, Fânaţe, Frata, Gădălin, Ghirişu, Hodai-Boian, Horlacea, Huedin, Iacobeni, Ignita, Jucu Herghelia, Juriu de Câmpie, Lacu, Leghia, Liteni, Măcicaşiu, Mănăstirea, Mănăşturel, Mihaiu Viteazul, Moldoveneşti, Morău, Oşorhel, Păglişa, Petreştii de Mijloc, Plăeşti, Popeşti, Pustuţa, Prelucele, Răchiţele, Rediu, Râşca, Săcel, Săcuieu, Salatiu, Sălişte, Sănduleşti, Sânmartin, Săvădisla,

Scrind-Frăsinet, Soporu de Câmpie, Suceagu, Stoiana, Tiocu de Jos, Tiocu de Sus, Tritenii de Jos, Tritenii de Sus, Văleni, Vaida-Camaraş, Viişoara, Viştea, Zorenii de Vale (Fig. 1).

Population size was assessed based on the number of nests occupied by breeding pairs only (HPa). During the census 93 White Stork breeding pairs (HPa) were identified (Table 1): 86 successfully breeding pairs (HPm), 2 unsuccessfully breeding pairs (HPo) and 5 breeding pairs with unknown success (HPx). As about 20% of the county was not covered by the censuses, the total population is estimated to 110-120 breeding pairs (HPa).

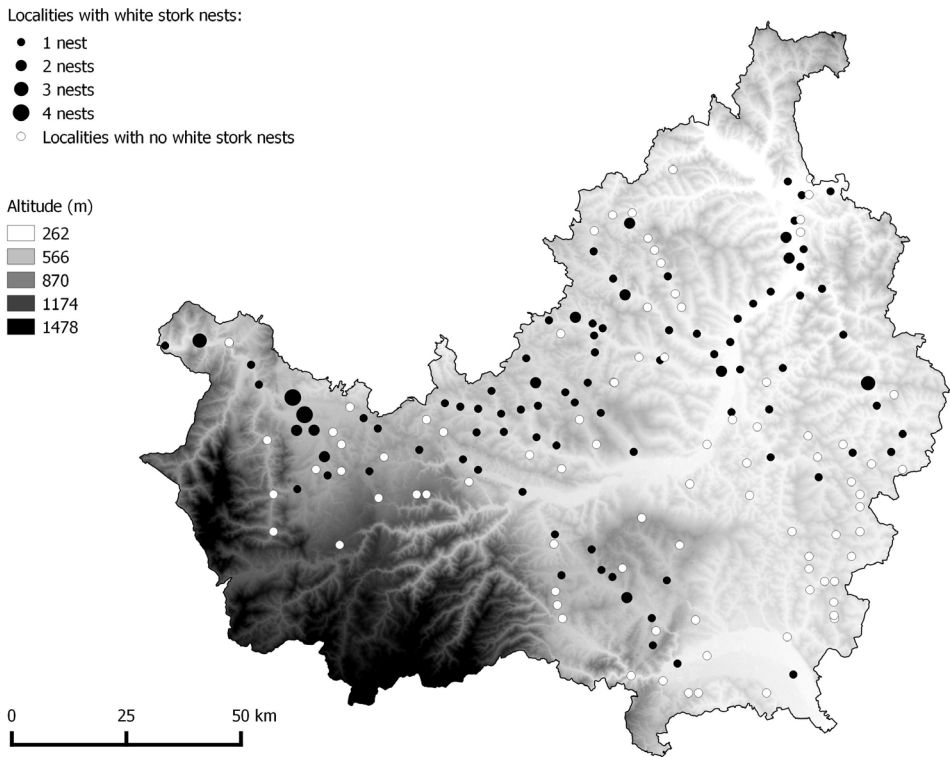The mean population density (StD) for Cluj county was 1,39 breeding pairs (HPa)/100 km^2.

Figure 1. Distribution of localities with White Stork nests in Cluj county in 2014

Table 1.

List of White Storks nests in Cluj county in 2014 (breeding parameters:
uH – unoccupied nest, HE – nest with one bird, HPm1-5 – stork pair with
1-5 fledglings; nest support: E0 – electric pylon without artificial support,
E1 – electric pylon with artificial support, C – chimney, R – roof, B – barney, T – tree).

Localities	Latitude	Longitude	Altitude (m)	Breeding data	Nest support
Aghireşu	46.87192	23.23611	452	HPm2	E1
Aghireşu Fabrici	46.86732	23.26634	447	HPm2	E0
Alunişu	46.83562	22.94535	605	HPo	E0
Alunişu	46.83410	22.94386	605	HPm4	E0
Aşchileu Mare	46.98675	23.49200	367	HPm4	E1
Aşchileu Mare	46.98096	23.48039	365	HPm4	E0
Aşchileu Mic	46.98261	23.44014	379	HPm4	E1
Băbuţiu	46.93987	23.53026	377	HPm4	E0
Băgara	46.86444	23.30134	433	HPo	B
Băiţa	47.02085	23.87492	279	HPm3	E0
Bologa	46.89680	22.87153	498	HPm4	E0
Bonţida	46.91694	23.81497	269	HPm5	E1
Bonţida	46.90370	23.81256	273	uH	E0
Borşa	46.92938	23.65812	308	uH	E0
Brăişoru	46.85653	22.96099	552	HPm3	E0
Brăişoru	46.85641	22.96196	554	HPm2	E0
Brăişoru	46.85756	22.95527	550	HPm4	B
Brăişoru	46.85755	22.95532	550	HPm4	B
Bucea	46.94878	22.68750	377	HPx	E0
Buneşti	47.06537	23.91097	255	HPm3	E0
Buneşti	47.04284	23.90046	269	HPm4	E0
Căianu Vamă	46.79964	23.87478	323	HPm3	E0
Călata	46.80028	22.99993	614	HPm4	E0
Călata	46.80673	22.99837	611	HPm4	E1
Călăţele	46.77525	23.00621	658	HPm2	E0
Căpuşu Mare	46.78276	23.30118	467	HPm3	C
Căpuşu Mic	46.79684	23.27156	473	HPm5	E0
Chinteni	46.85905	23.54174	467	HE	E0
Chinteni	46.85901	23.53850	463	HPm3	E1
Ciurila	46.64851	23.54308	589	HPm3	E0
Cluj-Napoca	46.80690	23.60627	354	HPm3	E0
Comşeşti	46.63454	23.67126	533	uH	E0
Corneşti	46.88839	23.32749	455	HE	E0
Corneşti	47.04121	23.67317	373	uH	E0
Corneşti	46.52275	23.69208	351	HPm4	E0
Crăeşti	46.61139	23.59279	502	HPm3	E0
Crăeşti	46.61872	23.58034	497	HPm2	E0
Cuzdrioara	47.16747	23.90849	278	HPm4	E0
Dăbâca	46.96941	23.67568	321	HPm4	E1
Dârja	47.01665	23.58933	357	HPm4	E0
Dârja	47.01838	23.58890	360	HPm3	E1

Table 1 continued

Localities	Latitude	Longitude	Altitude (m)	Breeding data	Nest support
Deuşu	46.89938	23.51613	493	HPm4	E0
Fizeşu Gherlii	47.02460	23.97556	274	HPm3	E0
Fodora	46.97831	23.52579	351	HPm4	E0
Fundătura	46.95365	23.79559	293	HPm4	E1
Gârbău	46.83354	23.35166	408	HPm5	E1
Geaca	46.86864	24.08285	300	uH	E0
Geaca	46.86380	24.08539	308	HPm4	E0
Gilău	46.75328	23.38832	417	HPm3	C
Hodaie	46.83078	24.13361	307	HPm2	E1
Iclod	46.98472	23.81029	290	HPm4	E0
Izvoru Crişului	46.83813	23.10455	583	HPm3	E0
Jucu de Sus	46.86000	23.79799	328	HPm5	E0
Lita	46.64142	23.46465	563	uH	E0
Livada	47.00487	23.84053	291	HPm4	E1
Lujerdiu	46.96462	23.73017	326	uH	E0
Luna	46.50803	23.91923	279	HPx	E0
Luna de Jos	46.93731	23.76418	293	HPm3	E1
Macău	46.83280	23.29824	454	uH	E0
Mănăstirea	47.11533	23.92180	270	HPm3	E1
Mănăstireni	46.78090	23.08815	718	HPm2	E0
Mărgău	46.75686	22.94674	755	HPm4	E0
Mera	46.81540	23.45489	405	uH	B
Mera	46.82101	23.44932	409	HPm3	E0
Mica	47.14938	23.93580	261	uH	E1
Mihăieşti	46.89939	23.41402	406	HPm5	E1
Mihăieşti	46.90147	23.41587	411	HPm2	E0
Mihăieşti	46.90832	23.41695	412	uH	E1
Mintiu Gherlii	47.05382	23.93292	272	HPm4	E0
Mintiu Gherlii	47.05457	23.93866	275	HE	E1
Mociu	46.80567	24.03563	318	uH	E0
Morlaca	46.87952	22.93789	519	HPm4	E0
Morlaca	46.88164	22.91732	519	HPm3	E0
Morlaca	46.86155	22.92934	540	HPm4	R
Morlaca	46.86056	22.91697	538	HPm3	E0
Nădăşelu	46.82635	23.41571	382	HPm4	O
Negreni	46.95560	22.75526	414	HPx	E0
Negreni	46.95977	22.73954	408	HPx	E0
Negreni	46.96153	22.72987	402	HPx	E0
Nicula	47.01576	23.93250	270	HPm3	E0
Nima	47.09327	23.90494	251	HPm3	E0
Nima	47.07842	23.90952	253	HPm5	E1
Păniceni	46.80958	23.18588	648	HPm1	E0
Panticeu	47.03810	23.56598	377	HPm4	E0
Panticeu	47.04199	23.55652	372	uH	C
Petreşti	47.07730	23.93946	278	uH	E0
Petreşti	47.08054	23.93583	273	uH	E0
Petreştii de Jos	46.58392	23.64178	472	HPm3	E0
Petreştii de Sus	46.54738	23.64383	552	uH	E0

Table 1 continued

Localities	Latitude	Longitude	Altitude (m)	Breeding data	Nest support
Poieni	46.92320	22.85613	480	uH	E0
Pruniş	46.63905	23.56461	569	HE	E0
Răscruci	46.91472	23.77838	276	HPm1	E1
Răscruci	46.89934	23.77538	276	HPm5	E1
Recea Cristur	47.07453	23.52779	399	uH	E1
Recea Cristur	47.08582	23.52182	404	HPm5	E1
Sălicea	46.67620	23.52385	631	HPm4	E0
Săliştea Nouă	46.87288	23.49073	465	HPm5	E0
Săliştea Veche	46.88649	23.47220	432	uH	E0
Săliştea Veche	46.89245	23.46420	421	HPm3	E0
Sâmboleni	46.80676	24.11115	330	HPm3	E0
Sâncraiu	46.83586	22.97960	570	HPm2	E0
Sâncraiu	46.83001	22.98531	581	HPm3	E1
Sânmărghita	47.15438	23.99221	280	HPm4	E0
Sânpaul	46.86863	23.41848	402	HPm4	E1
Sântioana	46.96343	24.01726	286	uH	E0
Şardu	46.86337	23.38504	409	HPm3	E0
Şaula	46.85200	23.07676	567	HPm3	E0
Sic	46.91901	23.89866	317	uH	E0
Sic	46.92581	23.89670	343	uH	E1
Şoimeni	46.96239	23.52871	353	uH	E0
Suatu	46.77280	23.96894	362	HPm2	T
Sucutard	46.89879	24.06582	295	HPm4	E1
Sucutard	46.89349	24.07005	308	HPm4	E1
Sucutard	46.89298	24.07270	310	HPm3	E1
Topa Mică	46.93191	23.39554	439	HPm2	E0
Turea	46.85792	23.34642	424	HPm2	E0
Vâlcele	47.11188	23.59831	350	HPm3	E0
Vâlcele	46.67794	23.65018	534	HPm4	E0
Vişea	46.86361	23.87197	330	HPm2	E0
Vlaha	46.69631	23.45192	448	HPm2	E1
Vultureni	46.97209	23.54549	347	uH	E0
Vultureni	46.97243	23.53946	346	uH	E0
Vultureni	46.97023	23.54756	350	uH	E0

Altitudinal distribution

In Cluj county, the majority (55.28%) of the nests were found at altitudes between 300-500 m (Fig. 2). The mean altitude of all localities with stork nests was 409.6 m. The highest occupied stork nest was at Mărgău, 755 m above sea level. Between 1996-2014 an uphill shift took place in the altitudinal distribution of White Stork nests. There was a moderate increase in the proportion of nests built in the 301-500 m altitudinal range, from 48.61% in 1996 to 55.28% in 2014. The opposite was true for nests built in the 100-300 m altitudinal range; their share decreased from 30.55% in 1996 to 21.95% in 2014. Similar tendency was observed in other countries (Tryjanowski et al., 2005) and in other regions of Romania (Kósa *et al.,* 2002).
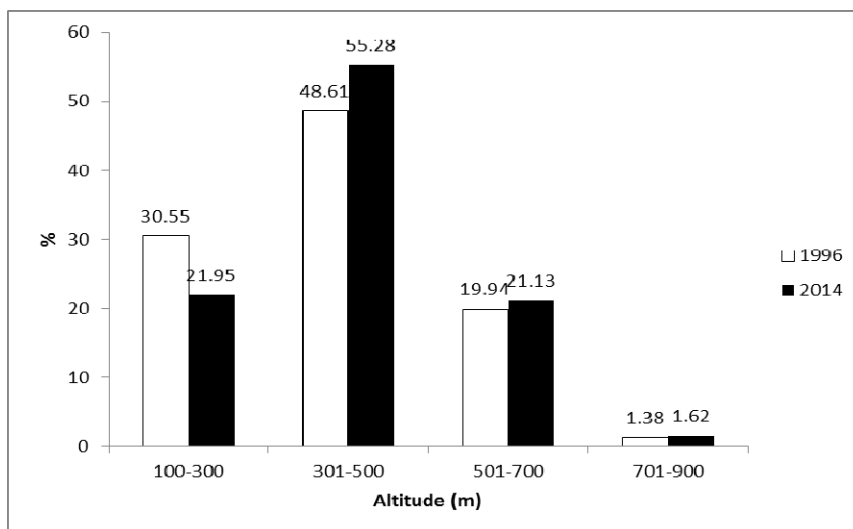
Figure 2. Changes in the altitudinal distribution of White Stork nests
in Cluj county (Kósa *et al.,* 1998)

Uphill shift in distribution of the White Stork is a new phenomenon, started in the first half of the last century. It is believed to be the consequence of anthropogenic changes of habitats resulting in the improvement of food supply (Wuczyński 2006), and possibly also an effect of climate warming (Tryjanowski *et al.,* 2005).

Nest placement

The majority (91.86%) of all recorded White Stork nests were located on electricity line poles (Fig. 3). The absolute majority of White Stork nests on power lines are located on poles of low-voltage overhead electrical lines that have horizontal placement of the wires, which is particularly suitable for supporting nests. Nests on overhead electricity line poles with artificial nesting platforms accounted for 24.39% of the total. In 2000, the first artificial nest platforms began to be installed on electricity poles in Cluj county in cooperation with the national electricity company, and by 2014 about 30 poles had been equipped with such platforms.

Nests on various buildings accounted for 6.5% of all nests, and only 1.62% were in various other locations (trees etc.).

Particularly prominent and significant changes over the 18-year period took place in the location of White Stork nests (Fig. 3). There was a steep increase in the proportion of nests built on overhead electricity line poles, from 59.72% in 1996 to 91.86% in 2014. The opposite was true for nests built on buildings; their share decreased from 31.94% in 1996 to 6.5% in 2014.

This same tendency has also been observed in Romania, both in the entire country, where the proportion of nests on electricity line poles increased from 51.75% in 1994/1995 to 83.9% in 2004/2005 (Kósa, 2013), and in different regions of the country (e.g. Kósa *et al.,* 2002, Kósa and Papp, 2007).
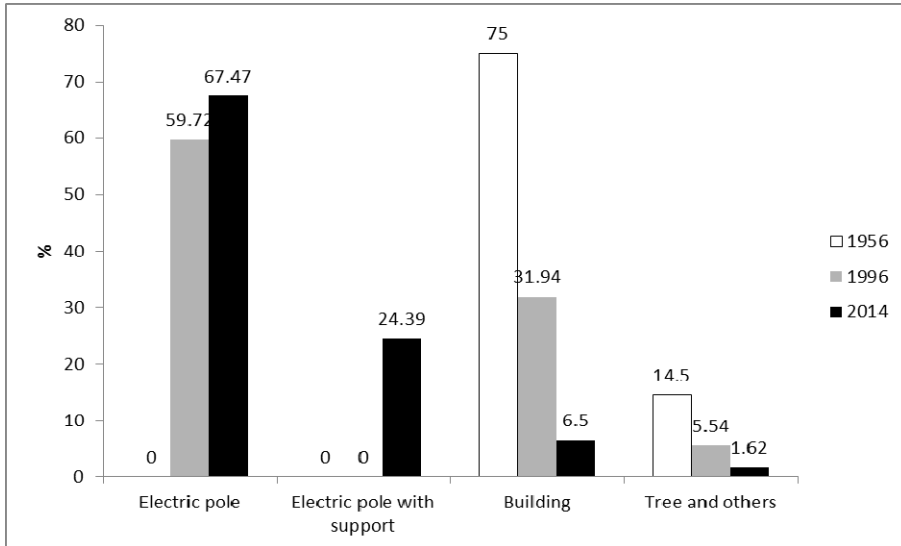

Figure 3. Changes in proportion of White Stork nest localisation in Cluj county
(Béldi, 1959, Kósa *et al.,* 1998)

Breeding parameters

Breeding success was recorded in 86 successful nests (HPm). In total, 291 young (JZG) were raised in these nests, with average breeding success of 3.38 young per successful pair (JZm). This was similar to the value recorded in 1996: 3.14 young per number of successfully breeding pairs (HPm) (Kósa *et al.* 1998).

The number of young per successful pair ranged between 1 (2.32%) and 5 (10.46%), with 3 (32.56%) and 4 (38.37%) being the most common, accounting for 70.93% of all successful nests, while 5 young were registered in 9 nests only.

In 2014 the percentage of breeding failure (%HPo) was low, only 6.66%.

The productivity (JZa), the mean number of fledged young from all breeding pairs (HPa) for Cluj county was 3.12.

Thus the average breeding success (JZm) and productivity (JZa) values for the region were above 2.5 and 2.0, values which are higher than the estimated JZm and JZa values needed to keep the population stable (Burnhauser, 1983; Lakeberg, 1995).

Population dynamics

The Romanian breeding White Stork population underwent a large decline between 1958 and 1978 (Klemm, 1983). Among the causes of the decline Klemm listed the disappearance of wetlands due to drainage and river regulation following a systematic government plan and structural changes of the human settlements.

A large population decline could be observed also in Cluj county for the 1956-1996/1997 time interval: the number of occupied White Stork nests decreased by -47.36% (Kósa *et al.,* 2002).

After decades of decline of the White Stork population, the 2014 census revealed a positive development in Cluj county. Comparing the breeding pairs for the 56 localities surveyed in both years (1996 and 2014) we can see (Table 2), that in comparison to the last census in 1996, the 2014 survey shows a moderate 5.35% increase in the number of the breeding pairs (HPa).

Table 2.

Changes in the number of the breeding pairs (HPa) of the White Stork in the localities of Cluj county between 1996 (Kósa *et al.*, 1998) and 2014

Localities	1996	2014
Aghireşu	1	1
Aghireşu Fabrici	0	1
Apahida	1	0
Aşchileu Mare	1	2
Aşchileu Mic	0	1
Băbuţiu	1	1
Băgara	1	1
Băiţa	0	1
Bologa	1	1
Brăişoru	3	4
Bucea	0	0
Buneşti	1	2
Căianu Vamă	0	1
Călăraşi-Gară	1	0
Călata	1	2
Cămăraşu	1	0
Câmpia Turzii	1	0
Căpuşu Mare	1	1
Căpuşu Mic	1	1
Chinteni	1	1
Ciurila	0	1
Cluj-Napoca	0	1
Cojocna	1	0
Crăeşti	1	2
Cuzdrioara	0	1

Table 2 continued

Localities	1996	2014
Dârja	1	2
Fodora	2	1
Fundătura	1	1
Geaca	1	1
Gheorgheni	1	0
Gilău	1	1
Hodaie	1	1
Iclod	1	1
Livada	1	1
Luna	1	1
Mănăstirea	1	1
Mihăieşti	1	2
Mintiu Gherlii	1	1
Morlaca	2	4
Nădăşelu	1	1
Negreni	0	0
Nima	1	2
Păniceni	1	1
Panticeu	1	1
Răscruci	2	2
Recea Cristur	2	1
Sălicea	0	1
Sâncraiu	1	2
Sânpaul	1	1
Şoimeni	1	0
Suatu	1	1
Sucutard	3	2
Şutu	1	0
Ţaga	1	0
Turda	1	0
Viişoara	3	0
Total	56	59

In the last 18 years the White Stork disappeared from Apahida, Cămăraşu, Câmpia Turzii, Cojocna, Gheorgheni, Şoimeni, Şutu, Ţaga, Turda and Viişoara, but appeared as nesting bird in the following localities: Aghireşu Fabrici, Aşchileu Mic, Băiţa, Căianu Vamă, Ciurila, Cluj-Napoca, Cuzdrioara, Sălicea.

Conclusions

In 2014 at 90 localities 123 White Stork nests were identified. The population of the White Stork in Cluj county in 2014 was estimated at 110-120 breeding pairs (HPa), and the total density amounted to 1.39 pairs/100 km^2.

The majority (55.28%) of the nests were found at altitudes between 300-500 m. Between 1996-2014 there was a moderate increase in the proportion of nests built in the 301-500 m altitudinal range, from 48.61% in 1996 to 55.28% in 2014.

During the last 18 years there was a steep increase in the proportion of nests built on overhead electricity line poles, from 59.72% in 1996 to 91.86% in 2014.

The average breeding success (JZa) and productivity (JZm) values for the county were 3.12 and 3.38, values which are higher than the estimated JZa and JZm values needed to keep the population stable. In comparison to the last survey in 1996, the 2014 census shows a moderate 5.35% increase in the number of the breeding pairs (HPa).

From a conservational point of view it is necessary to continue the monitoring of the White Stork populations in Cluj county and to continue the installation of artificial nest platforms on electricity poles.

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