

# Changes in the nest sites of White Stork (*Ciconia ciconia*) in Hungary

Adrienn GYALUS<sup>1\*</sup>, Zsolt VÉGVÁRI<sup>2</sup> & Tibor CSÖRGŐ<sup>1</sup>

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**Abstract** The breeding strategies of the White Stork changed drastically during the past decades: a decreasing number of individuals nest on traditional nest sites – trees, roofs, chimneys, whereas electricity poles are increasingly selected. Here we analysed long-term breeding data of White Storks breeding in six Hungarian counties to detect patterns in nest site preferences in Hungary. According to our results, the shift to preference for electricity poles was shown at the same rate in every county, independently from the proportion of original nest sites. After 2000, although electricity poles dominated everywhere, the proportion of nest on poles without platform increased, despite the abundance of available empty platforms. To explain this pattern, we propose that White Storks show a preference for viewpoints, thus choosing to breed as near as possible to optimal habitats, regardless of nest site types. Therefore, conservation measures concerning the nest sites of this species should include preliminary habitat analysis.

**Keywords:** nest site selection, population dynamics, species conservation, rural area, habitat selection, Hungary

**Összefoglalás** A fehér gólya fészkelési szokásai látványosan megváltoztak az elmúlt évtizedekben: egyre kevesebb egyed költ hagyományos fészkelőhelyeken – fákon, háztetőkön, kéményeken – és egyre több villanyoszlopokon. Hat megye hosszú távú fészkelési adatait elemeztünk annak megválaszolására, hogy Magyarország különböző tájain hogyan zajlott le a fészkelőhely-váltás. Eredményeink alapján mindegyik megyében azonos időben és ütemben kezdődött meg az áttelepülés a villanyoszlopokra, függetlenül a fészkelőhely-típusok eredeti összetételétől. A 2000-es években már a villanyoszlopok domináltak mindenhol, azonban a tartó nélküli villanyoszlopon fészkelő gólyák aránya nőtt annak ellenére, hogy nagy számban voltak elérhetőek üres fészektartók. Ez azzal magyarázható, hogy a gólyák számára a fészkek térbeli elhelyezkedése az elsődleges: a jó táplálkozóterületekhez közelebbet preferálják a fészkealap típusától függetlenül. A fehér gólya fészkelésével kapcsolatos természetvédelmi intézkedésekhez, műfészkek helyének optimális kiválasztásához elengedhetetlen az élőhelyek minőségének előzetes felmérése.

**Kulcsszavak:** fészkelőhely-választás, populációdinamika, fajvédelem, élőhelyválasztás, vidéki térség, habitat-szelekció, Magyarország

<sup>1</sup> Department of Anatomy, Cell- and Developmental Biology, Eötvös Loránd University, 1117 Budapest, Pázmány Péter sétány 1/C, Hungary

<sup>2</sup> HNPI-DE Department of Conservation Zoology 4024 Debrecen, Sumen utca 2., Hungary; e-mail: zsolt.vegvari@gmail.com

\*corresponding author

## Introduction

The White Stork (*Ciconia ciconia*) originally built nest on trees, but since the extent of natural habitats (wetlands, floodplains, steppes with scattered trees) decreased because of human activities and in parallel, extensive agriculture created alternative habitats, White Storks started to show a preference for nest sites in human settlements. Buildings, as artificial nest sites, facilitated the urbanisation of Storks (Cramp & Simmons 1977).

The most drastic change of the past decades is represented by a process including White Storks starting to use electricity poles as nest sites as a dominant strategy. Since environmental and sociological changes occurred at different rates in Europe, this transition in nest sites was also spatially uneven. For instance, in Wielkopolska region of Poland, preference for nesting on electricity poles started and predominantly increased in the western areas, in accordance with the direction of rural electrification (Boguczki & Ożgo 1999). In the former area of Yugoslavia, the dominant nest sites – haystacks – disappeared in a few years due to economical changes. This sudden and compulsory transition impacted the population negatively as breeding success dropped by 50% during the following decade (Pelle 1999). Further, in Vojvodina region, Serbia, the most abundant nest sites are located on electricity poles (Tucakov 2006). In Estonia, significant amounts of nesting events on electricity poles were registered in 1984, and became dominant in 20 years (Ots 2009). The contribution of electricity poles in nest sites grew sixfold in Bulgaria between 1979 and 1994, in parallel, the contribution of trees dropped by 50%, possibly because suitable trees disappeared (Petrov *et al.* 1999). In Turkey, electricity pole was also the most abundant type in the latest census, whereas nest site types were distributed unevenly in regions (Omnuş *et al.* 2016). For example, in the Kızılırmak delta, tree remained the dominant nest site, attributed to the natural stand of the forests (Yavuz *et al.* 2012). In Slovenia, nesting on electricity poles appeared in 1965, the proportion of this type is 40% in 1979 and 80% since 1999 (Denac 2010). In Portugal, the proportion of nesting on electricity poles increased from 1% to 25% between 1984 and 2014, out of this 60% is the proportion of high voltage poles, which can hold multiple nests (Moreira *et al.* 2017). In Latvia, the proportion of nesting on electricity poles increased from 1% to 60% between 1974 and 2004, mostly without support (Janaus & Stipniece 2013). In Belarus, Storks nested exclusively on trees and building in 1967, however, nesting on electricity poles increased to 25% to 2004, but water towers have the same proportion, which is unusual compared to those of other countries (Samusenko 2013).

The breeding population of Hungary was estimated to 15000–16000 pairs, based on the first census in 1941, which was calculated considering a larger historical country size (Homonnay 1964). This estimate can be relatively correct as the areas excluded after the peace treaties of WW-II included mainly mountain habitats, unsuitable for Storks. However, according to the partial censuses, only half of this estimated number was likely to be realistic between 1948 and 1951 (Keve 1957). The population decreased further during the 1970s (4900 pairs), since which period it can be considered stable with 4800–5600 pairs (Magyar *et al.* 1998, Hadarics & Zalai 2008). According to the Common Bird Monitoring scheme, the population trend is uncertain between 1999 and 2012 (Szép *et al.* 2012). A likely reason of mortality for half of the known cases can be related to electrocution or collision with

power lines or electricity poles, with 80% of the victims being juveniles (Lovászi & Rékási 2009).

Electricity pole as new nest site indicates both economical and conservation problems: the incidental shortcuts caused by the nest hinders electricity service, and birds – specially fledglings – are threatened by electrocution (Jakab 1991, Jakubiec 1991, Infante & Peris 2003, Lovászi & Rékási 2009). At local levels, collision with power lines and poles can contribute significantly to mortality rates (Goriup & Schulz 1991, Garrido & Fernandez-Cruz 2003, Galarza & García 2012), and electromagnetic field can decrease breeding success (Vaitkuvienė & Dagys 2014). Prevention or at least mitigation of these threats is an important task. Possible solutions: lifting up nests with nest supports, establishing nest supports on electricity poles (Goriup & Schulz 1991, Mužinić & Cvitan 2001) or setting up independent poles specifically for Storks in potencial habitats (Santopaulo *et al.* 2013).

Conservation measures aimed at nest sites can bring spectacular results, for example, the Calabrian reintroduction succeeded using artificial platforms (Santopaulo 2013). The White Stork population in Europe is stable again, even increasing in a number of regions (BirdLife 2016). The protection of the species can only be efficient by regarding both the nest site and the habitat needs. There could be areas where habitats would be optimal but inhabitation is impossible due the lack of nest sites, or the other way around.

In this paper, we aimed to answer the following questions:

1. How the proportion of nest sites changed in six Hungarian counties during the last fifty years?
2. What are the primary drivers of shifting to electricity poles?
3. How successful were the conservation actions of the past decades?

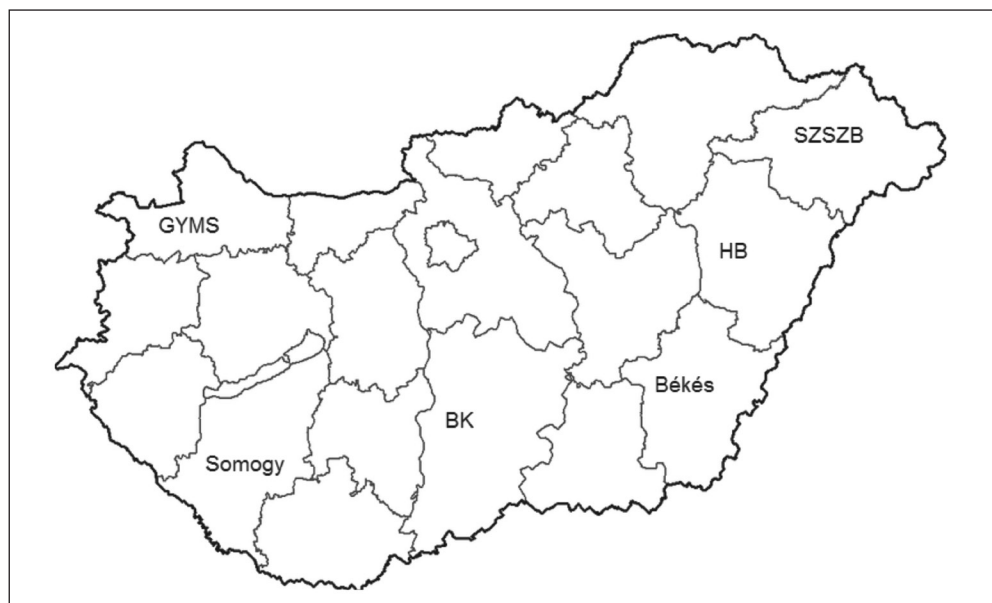
## Materials and Methods

The data were retrieved from two resources. First, between 1958–1989, paper forms of White Stork censuses conducted in every five years, published in the archives of Móra Ferenc Múzeum, Szeged. This information includes two types of protocols: postal forms (po) sent out by post offices, filled out by post workers; and more detailed questionnaires (qu) sent out to forestries, hunting companies, schools, filled out by foresters, hunters, teachers, students etc. Second, between 1994–2013, volunteers of BirdLife Hungary provided the data, and this database is now fully available in electronic format, provided by the Hungarian Monitoring Centre. There was only one observation by every method, so the number of White Stork pairs is probably underestimated and there could be also differences in productivity, but these estimates do not differ significantly from real values, as this study states (Aguirre & Vergara 2009). Nest site types are considered as reliable data, because most of the time nest site can be easily identified and can be surveyed at any time of the breeding season (Boguczki & Özgo 1999).

For this study, we chose six out of the 19 Hungarian counties (namely Győr-Moson-Sopron, Somogy, Bács-Kiskun, Békés, Hajdú-Bihar és Szabolcs-Szatmár-Bereg County). We considered the following criteria: 1. data are available from every year 2. there should be

enough breeding pairs for the analysis 3. they should represent different geographical and socio-economical regions of Hungary. Water permeability of soil types affects the amount of water covered areas which is in relation to the distribution of White Storks, therefore we present the soil types of the counties along with the main water bodies, the typical agricultural use and the human population density (Mezősi 2011, <https://www.ksh.hu/>).

- Győr-Moson-Sopron (GYMS): soil types: fluvisols, gleysols, phaeozems, chernozems (near rivers), luvisols (Transdanubian Mountains). Main waters: Danube, Rába, Rábca. Agricultural usage: 4.8% grassland, 53.5% arable land, 19.2% forest. Density: 107/km<sup>2</sup>.
- Somogy: soil types: fluvisols, gleysols, phaeozems (near rivers and lakes), luvisols, arenosols, cambiosols. Main waters: Dráva, lake Balaton. Agricultural usage: 5.2% grassland, 42.2% arable land, 29.5% forest. Density: 52/km<sup>2</sup>.
- Bács-Kiskun (BK): soil types: regosols, solonchaks, fluvisols (along Danube), chernozems (Bácska region). Main waters: Danube, alkaline, saline lakes. Agricultural usage: 12.3% grassland, 41.3% arable land, 20.9% forest. Density: 61/km<sup>2</sup>.
- Békés: soil types: chernozems, rendzinas, phaeozems, vertisols. Main waters: Körös, Berettyó. Agricultural usage: 5.5% grassland, 67.7% arable land, 4.6% forest. Density: 63/km<sup>2</sup>.
- Hajdú-Bihar (HB): soil types: chernozems, solonetzcs (Közép-Tisza region). Main waters: Tisza, Berettyó, alkaline-saline lakes. Agricultural usage: 17.7% grassland, 53.1% arable land, 11.1% forest. Density: 86/km<sup>2</sup>.
- Szabolcs-Szatmár-Bereg (SZSZB): soil types: regosols, arenosols; phaeozems, fluvisols (along rivers). Main waters: Tisza. Agricultural usage: 10.8% grassland, 44.4% arable land, 21.1% forest. Density: 94/km<sup>2</sup> (*Map 1.*).



Map 1. Location of the examined counties  
1. térkép A vizsgált megyék elhelyezkedése

We categorised nest sites as follows:

- tree (tr): any species of woody plant, either dead or alive
- building (bu): any type of building, including those of economical usage (barns, pens etc.)
- roof (ro): the covering structure of a building of any material
- chimney (ch): the structure of a building used for ventilation
- electricity pole (ep): pole connected to the power line network
  - without support (ep\_ns): electricity pole without nest support
  - with support (ep\_s): electricity pole with nest support
- other (ot): independent poles, haystacks, water towers, ruins etc.

Data were filtered and processed with the R statistical computing software (R Core Team 2015). We summarized the number of nests (both occupied and unoccupied) in every year from the postal forms and the online database to see the overall population changes. We chose the postal forms for the 1958–1989 period because it gives a better estimation, especially for the early years. We applied linear regression to the changes of proportion of nest sites by counties in each data series (namely: the postal forms, the questionnaires and the online data). To investigate overall changes, we used linear mixed model (LMM) implemented in the lme4 R package (Bates *et al.* 2015). One model contained previous data, where the census type was added as a fixed predictor and the county identity provided the random variable, whereas another model contained the new data, including county identity as random effect term.

Since the new database contains the empty nest supports, the role of equipped nest supports, and hereby the success of nature conservation actions can be measured. We compared the proportion of empty nest supports to electricity poles and the proportion of unoccupied nests to electricity poles (where 100% was all of the possible nest sites, so all nests + empty nest supports). We applied linear regression for estimating the proportions by counties. For electricity poles with nest supports, we investigated separately the proportion of empty nest supports and the unoccupied nests.

## Results

### Overall population changes based on numbers of nests

During the span of 10 years of the first three census, the number of Stork nests decreased in every county. The values remained more or less at these values between 1968 and 1984. Between 1994–2013, fluctuations due to insufficient data in the first years affected most counties, but if we take the highest numbers as a basis from this period, we can assume that population increased in every county after 1989 (*Table 1*).

### Changes of nest sites

Here we show the main characteristics of nest site changes; strengths and direction of trends is indicated more in depth in the tables (*Table 2, 3, 4*).

***Between 1958–89***

The most profound change was in all counties, in both data sources, the significant increase on nests on electricity poles.

In the beginning, most common nest sites were trees and buildings in Somogy county. Decrease was more drastic and earlier at trees (in both data sources). Questionnaires show that roofs decreased more affected within the building category. Chimneys remained important even in 1989.

Similar to the previous, tree and building nests dominated in Bács-Kiskun in the early years. Despite the decrease, contribution of trees was still high in 1989 (postal forms). Within the building category, roofs decreased more (questionnaires).

Questionnaires show that greatest proportion of nests originally were on chimneys in Békés. In contrast to other counties, of contribution of roofs and trees remained always low.

In Hajdú-Bihar county, the other category emerged as the most important type, which was driven mainly by the contribution of haystacks (based on the notes of postal forms). The proportion of building nests was also high, especially on chimneys.

The majority of nests was found on buildings in Szabolcs-Szatmár-Bereg counties. The contribution of roofs was a bit higher than in other counties. In case of tree nests, fluctuation was strong in postal forms.

Based on the linear mixed model, the trends of the two data sources differed significantly in the case of other category: the postal forms showed a greater decrease. The difference between the six counties was the lowest at the electricity poles: 4.5% of variance was explained by the county as random variable. This contribution of variance was 47.6% at the trees, 45.9% at the buildings and 17.4% at the other category (*Table 5*).

***Between 1994–2013***

The most striking change was the increase of the proportion of nests on electricity poles without supports in all counties and was significant in 5 out of 6 cases. In parallel, the proportion of nests on electricity poles with support decreased in 5 out of 6 cases. Altogether, this nest site still remained dominant in every county (*Table 6, 7*).

In Győr-Moson-Sopron, the contribution of chimney and other category was 10–15%. Significant decrease was observed in case of the trees.

The overall proportion of nests on electricity poles significantly decreased in Somogy. The proportion of nests on chimneys and other sites amounted to 5–10%. No nest on roof was reported.

The only significant change in Bács-Kiskun was detected in the decrease of nests on roofs. The proportion of chimney nests was around 10–20%. The contribution of other category was 5–10%. No nest on trees was reported.

The overall proportion of nests on electricity poles significantly increased in Békés. There was a significant decrease in case of chimneys, although their contribution is still high (20–25%). There was a significant increase in case of roofs.

The contribution of chimney nests was around 5–10% in Hajdú-Bihar. There was a significant increase in case of tree nests.



The overall proportion of nests on electricity poles significantly decreased in Szabolcs-Szatmár-Bereg. The proportion of other category was higher due to the independent poles (20–10%), but also significantly decreased.

Based on the linear mixed model, the proportion of nests on electricity poles with support decreased significantly overall and 18.9% of the variance is explained by the differences between counties. There was a significant increase in case of electricity poles without support, 9–14.9% of variance provided by county identity as random factor. There was a significant decrease in case of the roofs (variance contribution of counties: 51.8%). A positive trend was observed in case of the chimney and tree category (variance contribution of counties respectively: 41.6% and 17.6%). A negative trend was observed at the other category (variance contribution of counties: 26.7%) (*Table 8*).

The proportion of empty nest supports on electricity poles significantly increased in Bács-Kiskun, Hajdú-Bihar, Somogy és Szabolcs-Szatmár-Bereg. The proportion of unoccupied nests on electricity poles with support significantly increased in Somogy (*Table 9*).

## Discussion

The White Stork population in Europe drastically decreased between 1970 and 1990, which is hypothesised to be the result of decreasing of suitable habitats and nest sites, increasing mortality results by power lines, drought in the wintering areas, chemical crop control and the interactions among these effects (Goriup & Schulz 1991, Jakubiec 1991, Kanyamibwa *et al.* 1993, Schulz 1994). The population size reached its lowest number in 1984 with 135000 pairs and started to increase in the following decades (Thomsen & Hötter 2006). The population in Europe is now estimated to 224000–247000 pairs (BirdLife International 2016). The reasons of increase – between conservation actions – is attributed to the expansion of area to the north (Ots 2009), the occupation of habitats at higher altitudes (Tryjanowski *et al.* 2005b), the reoccupation to original breeding areas (Santopaolo 2013) and locally the advantageous changes in agriculture (Forgách 1997, Vaitkuvienė & Dagys 2015). During the past decades, Storks fed also in rubbish dumps, which allows their permanent colonization in suboptimal habitats (Kruszyk & Ciach 2010), or even allowing wintering in the region (Tortosa *et al.* 2002, Gilbert *et al.* 2016).

The original proportion of the nest sites depended on traditional agricultural technology of the given county. While specialty of Somogy was represented by the woodland pastures, in Bács-Kiskun it was exemplified by loosely connected network of farms. In Győr-Ménfőcsanak, Hajdú-Bihar és Szabolcs-Szatmár-Bereg, storks mainly nested on agricultural buildings inside villages. In Hajdú-Bihar county, the high proportion of nest on haystacks shows the significant use of meadows for mowing: 22–26% of nest was built on haystacks in 1941 (Homonnay 1964), but even in 1963, this category dominated over all the others. In Békés, extended arable lands was typical, which Storks avoid, since these habitats are suboptimal for them (Denac 2006a), that is why the amount of nest was relatively low. These nests were mainly built on chimneys, inside villages.

The changes connected with building practices have been reported worldwide (Goriup & Schulz 1991) and are also well-documented in written resources of Hungarian White Stork conservation (Jakab 1991). The proportion of nests on roofs decreased in a White Stork population in Poland, because the agricultural buildings with thatched roofs preferred by Storks disappeared with the modernisation of agriculture (Daniluk *et al.* 2006, Kosicki 2006). These types of buildings were often classified into the „other” categories in the postal forms, so the proportion of nests on roofs could be underestimated. Thatched roofs are more suitable for Storks than harder roof types from where the nest may easily fall down. However, human preferences are directed towards ceramic tiles and slate roofs, as these require less maintenance and are also more fireproof.

The proportion of nests on chimneys also decreased in almost every county. Based on the notes, the main reason of this is the modified shape of chimneys: the newer types are more slender and opened on the top in contrast with the sturdier ones, with holes on the sides. Sometimes the top is cone-shaped, especially aiming to deter storks.

According to the 1941 census, a certain proportion of the population – in all counties – nested outside the villages, near to small farms, almost exclusively on trees (Homonnay 1964). The possible reason is that the vicinity of these farms was especially rich in optimal habitats, to which storks tried to nest as close as possible (Ožgo & Boguczki 1999). We assume they preferred trees because suitable old trees were more abundant and also – based on the additional notes – because people did not tolerate the Storks on the buildings. This stable pattern was not present in our analysis because of the settlement pattern and agricultural changes. Where the changes occurred later – Bács-Kiskun in our case – the proportion of nests remained high.

In contrast to previous nest sites, it is improbable that the availability of trees drastically decreased for nesting. We did not find records of mass tree logging, although it is true that in primarily open areas, disappearance of even small number of trees can have a substantial impact on Storks. Grasslands without trees, even if considered as optimal habitats, are not occupied by Storks if travel costs from nearest possible nest site are larger than the energy gain of the habitat (Jakab 1989, Olsson & Arvid 2014).

The examined counties showed great differences in the availability and usage of traditional nest sites, in contrast, the shift to nesting on electricity poles happened almost synchronously everywhere. Thus, it is improbable that the disappearance of other nest site was the primary reason of this change. Since the population was already decreasing in the analysed period, it was not caused by the changes in nest sites. The structure of population has changed.

In Hungary, electricity was introduced to the last village in 1963 (<http://mtva.hu/hu/sajto-es-fotoarchivum/5654-50-eve-fejezodoett-be-magyarorszagon-a-falvak-villamositasa>), but electricity poles were used by Storks only occupied in larger amounts from 1968. At that time, the distribution of electricity poles was already equal everywhere, so the swift indeed happened independently from rural electrification. In certain regions of Poland, Storks also started to nest on electricity poles much later after they became abundant (Tryjanowski *et al.* 2009, Janiszewski *et al.* 2015). But in Wielkopolska region, differences in nest site choice remained between the earlier and later electrified western and eastern parts



(Boguczki & Ózgo 1999). Regional differences were also observed in the population of Olt river basin: the proportion of nests on electricity poles is still the highest in the N-NW part where electrification started and the first nest on this nest site was reported in the 1960s (Kósa *et al.* 2002).

The time of electrification explains the differences in patterns of nest site usage, but not the cause of why did electricity poles became attractive for Storks. A possible assumption is that Storks that nest on electricity poles have a higher productivity. In a study in Poland, no differences were found between nest site types neither in the number of fledged young nor in the proportion of occupied nests. However, in the case of electricity poles, productivity was affected by nest support: mean number of chicks was lower as the mean of all nest sites after the year the support was equipped, but significantly higher in the second year. Disturbance of the nest is unfavourable for the chicks for short terms, but in the long run, chicks are safer in nest with supports (Tryjanowski 2009). Based on a study in northern Hungary, productivity was significantly lower in nests on unsupported electricity poles. This could stem primarily from the fact that young and unexperienced individuals nest on these poles (Boldogh 2009). However, this could indicate preference indirectly, because earlier individuals occupy other nest sites sooner. In a former study on the same area, earliest, most experienced individuals occupy nests on chimneys first (Boldogh 1998), so higher productivity on this type is more affected by the age of Storks, not directly the nest site type.

Another assumption for the advantage of electricity poles is lower predation rates as well as human disturbance. The productivity of Storks on trees presumably decreased because of predators in Poland (Tryjanowski 2009). The role of the conflicts between Storks and humans in nest site selection was not examined as far as we know, possibly due to difficulties in sampling data.

Realising the increasing role of electricity poles, Hungarian Birdlife started to put on nest supports in cooperation with the electricity companies in the 1970s. From 1980, 3000 nest supports were equipped either under existing nests or to empty electricity poles or independent poles (Lovászi 2004). Further 650 nest supports were placed in the 1990s, 2000 between 2001–2002 and at least 1000 after that (Horváth *et al.* 2010).

In the 1990s, when the population was increasing, Storks started to occupy the empty nest supports, available in great abundance. At the turn of the millenium, most new nest were built on electricity poles with nest support. Out of the traditional nest sites, only the proportion of nest on chimneys remained significant, although to a different degree between counties.

As the density of population increased, it proved to be a general trend that out of nests on electricity poles, the proportion of nests with supports decreased and the ones without support increased, although empty nest supports were still available in high numbers. The proportion of empty nest supports (on electricity poles) increased in every county. This can be explained the same was as experienced in a study in Middle Poland, where it was found that nesting on electricity poles expanded fastest in the best habitats.

It becomes harder for the newcoming individuals to fit in the high density population, because they have to choose a nest site that is close to the feeding areas but not too close to the other pairs. The number of chicks is positively correlated with the distance of neighbors

in optimal habitats (Nowakowski & Wasilewka 2006) and negatively correlated with the number of neighbors in suboptimal habitats, which is caused by strong intraspecific competition (Denac 2006b). The spatial situation of the nest has priority: the Storks began to use the electricity poles in large amounts because they easily found suitable ones due to the big coverage (Janiszewski *et al.* 2015). In an analogous way, an electricity poles with good situation but without nest support is a better choice than one in a bad place with nest support. The expanding White Stork population in western France started to nest mainly on trees, despite the mass presence of artificial nest platforms (Gadenne *et al.* 2014). The same was experienced in western Poland: first breeders built their nest more often to trees and unusual places, near to feeding areas (Tobolka *et al.* 2013).

The possible substitute for electricity pole is the independent pole erected specifically for Storks. The distraction of Storks from electricity poles with setting of independent poles was successful in Slovakia, where 25.1% and 37% was the respective proportion of these types in 1995, whereas contribution of electricity poles was 38% at the 1984 census (Fulín 1999). In Karkov region, Ukraine, the proportion of electricity pole nests was relatively high (18%) even in 1974 and increasing, possibly due the lack of alternative nest sites in the steppe, but now half of the population breeds on poles made specifically for them (Atemasova *et al.* 2016). However, they are not necessarily suitable for substitution of existing nests: in a German population, after nests from electricity poles were removed, independent poles were offered next to them directly, yet Storks rejected the new poles, so nest supports solved the problem (Köhler 1999). These pole types began to set up in larger numbers from 1989 in Hungary: in the 1994–2013 database, independent poles constitute almost exclusively the „other” nest site category, so it is easy to follow the trend. After the initial upturn, the proportion of nests on independent poles decreased like at the electricity poles. This is especially apparent in Szabolcs-Szatmár-Bereg, where there is a big amount of these poles. We can assume the same as with the electricity poles: after the nest sites with the best location were occupied, the remaining ones did not become more attractive compared to another possible nest sites. In Calabria, Italy, recolonization of White Stork was successfully facilitated with independent poles, the population grew threefold from 2007 to 2012. But the study underlined that it is important to keep distance between the poles, because competition arises within neighbor pairs too close (<600 m) to each other (Santopaulo 2013). This distance is not standard, however, since the quality of habitat affects the size of the territory (Ozgo & Boguczki 1999) and so the density of pairs. Storks still breed colonially in areas with high carrying capacity, for example in Spain (Vergara & Aguirre 2006), in Poland (Tryjanowski *et al.* 2005a) or in Nagyiván next to Hortobágy National Park, Hungary (golya.mme.hu).

Therefore, placement of nest supports and/or independent poles can truly be efficient only with the consideration of the habitat needs: it worth setting these tools up where reliable models confirm that the expected number of fledglings is high enough to sustain or even increase the population (Olsson & Arvid 2014). Beside that it is also important to protect and/or maintain the old, big nests, because those are occupied more often (Tryjanowski 2005b) and productivity is higher at those nests (Vergara 2010). White Stork is a good indicator of biodiversity, so by protection of this species, we also help the case of biodiversity of habitats (Latus *et al.* 2000) and farmland birds (Kosicki 2007, Tobolka *et al.* 2012).

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Table 1. Number of nest by counties in every year

1. táblázat A fészkek száma megyénként és évenként

	1958	1963	1968	1974	1979	1984	1989	1994	1999	2000	2001	2002
GYMS	277	202	148	139	130	146	107	109	141	4	157	1
Somogy	586	515	306	263	225	235	177	84	106	9	7	7
BK	530	409	271	262	179	256	150	16	38	6	66	3
Békés	319	202	218	182	196	199	154	0	0	0	2	253
HB	1010	795	466	481	495	402	350	0	261	0	2	243
SZSZB	1026	723	461	424	447	421	349	301	353	218	263	405

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GYMS	21	256	181	177	33	22	183	183	181	182	171
Somogy	154	307	283	298	302	121	139	106	103	119	75
BK	57	241	92	46	127	51	131	92	202	194	149
Békés	32	119	81	278	370	375	387	403	403	423	417
HB	195	225	251	610	471	134	722	581	434	286	140
SZSZB	485	625	535	571	535	578	588	529	385	535	610

Table 2. Proportions of nest sites by counties in the 1958–1989 period, based on postal forms

2. táblázat A fészkealapok arányai megyénként az 1958–1989-es periódusban, a postai adatlapok alapján

GYMS	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.01	0.02	0.08	0.28	0.45	0.60
tr	0.13	0.11	0.05	0.11	0.07	0.04	0.00
bu	0.79	0.83	0.87	0.76	0.62	0.49	0.36
ot	0.08	0.06	0.05	0.04	0.04	0.02	0.04
Somogy	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.03	0.09	0.23	0.53	0.64
tr	0.48	0.45	0.44	0.30	0.21	0.11	0.02
bu	0.49	0.54	0.50	0.56	0.48	0.35	0.33
ot	0.03	0.00	0.02	0.05	0.08	0.00	0.01
BK	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.01	0.09	0.28	0.48	0.60
tr	0.50	0.52	0.47	0.43	0.33	0.19	0.14
bu	0.45	0.46	0.50	0.42	0.33	0.31	0.25
ot	0.04	0.02	0.02	0.06	0.05	0.02	0.02
Békés	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.01	0.07	0.36	0.52	0.49
tr	0.05	0.10	0.07	0.06	0.07	0.02	0.01
bu	0.90	0.88	0.86	0.84	0.56	0.45	0.48
ot	0.05	0.02	0.07	0.03	0.01	0.00	0.02

HB	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.02	0.10	0.30	0.56	0.69
tr	0.12	0.14	0.18	0.19	0.16	0.11	0.04
bu	0.58	0.65	0.64	0.56	0.44	0.30	0.25
ot	0.30	0.21	0.16	0.15	0.09	0.03	0.01
SZSZB	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.00	0.08	0.25	0.48	0.64
tr	0.09	0.12	0.14	0.24	0.19	0.12	0.07
bu	0.84	0.76	0.79	0.57	0.47	0.33	0.26
ot	0.07	0.11	0.06	0.11	0.09	0.06	0.03

Table 3. Proportion of nest sites by counties in the 1958–1989 period, based on questionnaires  
 3. táblázat A fészekalapok arányai megyénként az 1958–1989-es periódusban, a kérdőívek alapján

GYMS	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.01	0.05	0.12	0.27	0.49	0.73
ot	0.03	0.01	0.02	0.03	0.01	0.00	0.04
ro	0.29	0.21	0.32	0.18	0.07	0.02	0.00
ch	0.59	0.63	0.52	0.62	0.61	0.44	0.23
tr	0.09	0.15	0.09	0.04	0.04	0.04	0.00
Somogy	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.05	0.21	0.28	0.58	0.68
ot	0.06	0.06	0.03	0.02	0.00	0.03	0.01
ro	0.11	0.22	0.13	0.09	0.01	0.04	0.03
ch	0.23	0.32	0.61	0.45	0.57	0.29	0.21
tr	0.60	0.40	0.18	0.24	0.14	0.06	0.07
BK	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.05	0.12	0.35	0.44	0.52
ot	0.00	0.02	0.05	0.07	0.05	0.00	0.02
ro	0.00	0.00	0.09	0.09	0.01	0.01	0.11
ch	0.00	0.14	0.27	0.36	0.25	0.32	0.32
tr	1.00	0.84	0.55	0.35	0.34	0.22	0.03
Békés	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.00	0.07	0.29	0.55	0.57
ot	0.00	0.03	0.03	0.07	0.03	0.01	0.05
ro	0.00	0.00	0.03	0.01	0.01	0.02	0.00
ch	1.00	0.90	0.93	0.82	0.64	0.37	0.34
tr	0.00	0.06	0.03	0.03	0.03	0.05	0.03
HB	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.04	0.38	0.50	0.71	0.91

Békés	1958	1963	1968	1974	1979	1984	1989
ot	0.00	0.00	0.05	0.11	0.02	0.03	0.01
ro	0.17	0.00	0.55	0.11	0.09	0.03	0.00
ch	0.75	0.00	0.19	0.28	0.27	0.16	0.06
tr	0.08	1.00	0.17	0.11	0.13	0.06	0.02
SZSZB	1958	1963	1968	1974	1979	1984	1989
ep	0.00	0.00	0.01	0.05	0.44	0.60	0.70
ot	0.00	0.01	0.01	0.01	0.04	0.02	0.16
ro	0.28	0.55	0.68	0.24	0.22	0.14	0.06
ch	0.51	0.32	0.12	0.53	0.17	0.14	0.06
tr	0.21	0.12	0.19	0.16	0.13	0.10	0.03

Table 4. Linear regression of nest sites by counties in the 1958–1989 period. The first abbreviation indicates the nest site, the second the data source in the upper left corners

4. táblázat A fészekalapok lineáris regressziói megyénként az 1958–1989-es periódusban. Az első rövidítés a fészekalapot, a második a felmérés típusát jelzi minden bal felső sarokban

GYMS									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-44.45	8.463	-5.252	0.003	(intercept)	-39.433	6.696	-5.889	0.002
year	0.023	0.004	5.28	0.003	year	0.02	0.003	5.919	0.002
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	7.091	1.996	3.553	0.016	(intercept)	6.769	2.069	3.272	0.022
year	-0.004	0.001	-3.522	0.017	year	-0.003	0.001	-3.237	0.023
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	19.274	3.679	5.239	0.003	(intercept)	30.683	6.612	4.64	0.006
year	-0.01	0.002	-5.199	0.003	year	-0.015	0.003	-4.538	0.006
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	17.711	7.228	2.45	0.058	(intercept)	36.985	7.148	5.174	0.004
year	-0.009	0.004	-2.382	0.063	year	-0.018	0.004	-5.085	0.004
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	-0.124	1.08	-0.115	0.913	(intercept)	2.981	0.747	3.992	0.01
year	0	0.001	0.133	0.9	year	-0.001	0	-3.931	0.011

Somogy									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-43.384	6.158	-7.045	0.001	(intercept)	-42.891	8.095	-5.298	0.003
year	0.022	0.003	7.084	0.001	year	0.022	0.004	5.326	0.003
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	28.104	5.95	4.723	0.005	(intercept)	31.224	2.918	10.7	1.23E-04
year	-0.014	0.003	-4.686	0.005	year	-0.016	0.001	-10.6	1.29E-04
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	9.117	3.355	2.718	0.042	(intercept)	12.521	4.617	2.712	0.042
year	-0.005	0.002	-2.693	0.043	year	-0.006	0.002	-2.611	0.048
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	0.835	11.027	0.076	0.943	(intercept)	9.952	10.872	0.915	0.402
year	0	0.006	-0.044	0.967	year	-0.005	0.006	-0.876	0.421
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	2.827	1.047	2.701	0.043	(intercept)	0.147	2.2	0.067	0.949
year	-0.001	0.001	-2.677	0.044	year	0	0.001	-0.054	0.959

BK									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-33.344	4.436	-7.517	0.001	(intercept)	-40.575	6.877	-5.9	0.002
year	0.017	0.002	7.56	0.001	year	0.021	0.003	5.931	0.002
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	60.072	5.441	11.04	1.06E-04	(intercept)	25.914	3.772	6.869	0.001
year	-0.03	0.003	-10.96	1.10E-04	year	-0.013	0.002	-6.772	0.001
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	-3.317	3.528	-0.94	0.39	(intercept)	14.846	3.109	4.775	0.005
year	0.002	0.002	0.953	0.385	year	-0.007	0.002	-4.65	0.006
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	-14.988	6.22	-2.41	0.061	(intercept)	-18.305	9.027	-2.028	0.098
year	0.008	0.003	2.446	0.058	year	0.009	0.005	2.057	0.095
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	-0.362	1.96	-0.185	0.861	(intercept)	0.815	1.374	0.593	0.579
year	0	0.001	0.199	0.85	year	0	0.001	-0.568	0.594

Békés									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-39.41	7.463	-5.28	0.003	(intercept)	-38.636	7.441	-5.192	0.003
year	0.02	0.004	5.307	0.003	year	0.02	0.004	5.22	0.003
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	-0.644	1.527	-0.422	0.691	(intercept)	3.847	1.721	2.235	0.076
year	0	0.001	0.442	0.677	year	-0.002	0.001	-2.204	0.079
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	-0.498	0.731	-0.681	0.526	(intercept)	33.224	6.257	5.31	0.003
year	0	0	0.695	0.518	year	-0.016	0.003	-5.196	0.003
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	47.095	5.98	7.875	0.001	(intercept)	46.598	6.322	7.371	0.001
year	-0.024	0.003	-7.759	0.001	year	-0.023	0.003	-7.259	0.001
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	-1.403	1.666	-0.842	0.438	(intercept)	2.565	1.489	1.722	0.146
year	0.001	0.001	0.86	0.429	year	-0.001	0.001	-1.704	0.149

HB									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-59.628	6.427	-9.278	2.45E-04	(intercept)	-46.585	8.099	-5.752	0.002
year	0.03	0.003	9.332	2.38E-04	year	0.024	0.004	5.781	0.002
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	28.91	23.822	1.214	0.279	(intercept)	4.186	3.434	1.219	0.277
year	-0.015	0.012	-1.204	0.282	year	-0.002	0.002	-1.179	0.291
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	12.439	13.526	0.92	0.4	(intercept)	25.841	5.439	4.751	0.005
year	-0.006	0.007	-0.91	0.405	year	-0.013	0.003	-4.661	0.006
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	22.642	16.464	1.375	0.227	(intercept)	35.081	21.522	1.63	0.164
year	-0.011	0.008	-1.361	0.232	year	-0.018	0.011	-1.613	0.168
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	-0.933	3.097	-0.301	0.775	(intercept)	17.559	1.757	9.994	1.71E-04
year	0	0.002	0.311	0.768	year	-0.009	0.001	-9.916	1.78E-04

SZSZB									
ep (qu)	estimate	std. error	t value	p value	ep (po)	estimate	std. error	t value	p value
(intercept)	-48.538	9.287	-5.226	0.003	(intercept)	-41.858	7.804	-5.364	0.003
year	0.025	0.005	5.253	0.003	year	0.021	0.004	5.391	0.003
tr (qu)	estimate	std. error	t value	p value	tr (po)	estimate	std. error	t value	p value
(intercept)	7.78	2.518	3.09	0.027	(intercept)	0.42	4.567	0.092	0.93
year	-0.004	0.001	-3.041	0.029	year	0	0.002	-0.061	0.953
ro (qu)	estimate	std. error	t value	p value	bu (po)	estimate	std. error	t value	p value
(intercept)	24.5	13.074	1.874	0.12	(intercept)	40.044	3.951	10.135	1.60E-04
year	-0.012	0.007	-1.852	0.123	year	-0.02	0.002	-9.989	1.72E-04
ch (qu)	estimate	std. error	t value	p value	bu (qu)	estimate	std. error	t value	p value
(intercept)	18.423	10.187	1.809	0.13	(intercept)	42.923	10.148	4.23	0.008
year	-0.009	0.005	-1.785	0.134	year	-0.021	0.005	-4.177	0.009
ot (qu)	estimate	std. error	t value	p value	ot (po)	estimate	std. error	t value	p value
(intercept)	-6.792	2.854	-2.38	0.063	(intercept)	2.394	2.037	1.175	0.293
year	0.003	0.001	2.393	0.062	year	-0.001	0.001	-1.137	0.307

Table 5. LMM of nest sites for the 1958–1989 period. First part indicates the nest site, second part the type of variable in the upper left corners. The model compares the postal form to the questionnaires

5. táblázat A fészekalapok lineáris vegyes modellje az 1958–1989-es periódusra. Az első szó a fészekalapot, a második a változó típusát jelzi minden bal felső sarokban. A modell a postai adatlapot hasonlítja a kérdőívekhez

bu, random:	variance std. dev.			ep, random:	variance std. dev.		
county	(intercept)	0.01957	0.1399	county	(intercept)	0.000475	0.0218
residual		0.02307	0.1519	residual		0.010079	0.1004
bu, fixed:	estimate	std. error	t value	ep, fixed:	estimate	std. error	t value
(intercept)	25.8368	3.136143	8.238	(intercept)	-43.2131	2.0725	-20.851
year	-0.01284	0.001589	-8.083	year	0.02202	0.00105	20.969
source (po)	0.058383	0.033146	1.761	source (po)	-0.02919	0.02191	-1.332
tr, random:	variance std. dev.			eg, random:	variance std. dev.		
county	(intercept)	0.0175	0.1323	county	(intercept)	0.000387	0.01967
residual		0.01926	0.1388	residual		0.001837	0.04286
tr, fixed:	estimate	std. error	t value	eg, fixed:	estimate	std. error	t value
(intercept)	16.97768	2.865058	5.926	(intercept)	1.62465	0.88471	1.836
year	-0.00851	0.001451	-5.862	year	-0.00081	0.000448	-1.804
source (po)	-0.01018	0.030281	-0.336	source (po)	0.029663	0.009352	3.172





Békés	1994	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ep_s	n.a.	n.a.	n.a.	0.50	0.65	0.50	0.63	0.60	0.57	0.59	0.59	0.57	0.55	0.53	0.53	0.53
ep_ns	n.a.	n.a.	n.a.	0.00	0.09	0.09	0.08	0.07	0.14	0.15	0.16	0.18	0.21	0.22	0.22	0.22
ot	n.a.	n.a.	n.a.	0.00	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
ro	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ch	n.a.	n.a.	n.a.	0.50	0.21	0.38	0.26	0.30	0.26	0.22	0.21	0.21	0.20	0.20	0.21	0.21
tr	n.a.	n.a.	n.a.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HB	1994	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ep_s	n.a.	0.81	n.a.	0.50	0.84	0.85	0.79	0.81	0.77	0.78	0.77	0.75	0.75	0.74	0.70	0.62
ep_ns	n.a.	0.08	n.a.	0.00	0.11	0.06	0.09	0.08	0.12	0.11	0.10	0.15	0.17	0.16	0.19	0.15
ot	n.a.	0.03	n.a.	0.00	0.02	0.03	0.02	0.07	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.10
ro	n.a.	0.01	n.a.	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
ch	n.a.	0.06	n.a.	0.50	0.03	0.05	0.09	0.03	0.07	0.07	0.10	0.06	0.06	0.06	0.06	0.10
tr	n.a.	0.00	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
SZSZB	1994	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ep_s	0.68	0.72	0.80	0.76	0.73	0.71	0.72	0.74	0.74	0.73	0.73	0.73	0.71	0.64	0.72	0.72
ep_ns	0.04	0.06	0.03	0.05	0.07	0.07	0.08	0.07	0.07	0.10	0.10	0.10	0.13	0.17	0.15	0.17
ot	0.24	0.17	0.11	0.16	0.17	0.18	0.15	0.15	0.15	0.15	0.14	0.14	0.13	0.16	0.10	0.09
ro	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
ch	0.02	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
tr	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

*Table 7.* Linear regression of nest sites by counties in the 1994–2013 period. The abbreviation indicates the nest site in the upper left corners

*7. táblázat* A fészekalapok lineáris regressziói megyénként az 1994–2013-as periódusban. A rövidítés a fészekalapot jelzi minden bal felső sarokban

GYMS					Békés				
ep	estimate	std. error	t value	p value	ep	estimate	std. error	t value	p value
(intercept)	12.055	23.511	0.513	0.616	(intercept)	-27.214	8.605	-3.163	0.009
year	-0.006	0.012	-0.48	0.638	year	0.014	0.004	3.245	0.008
ep_s	estimate	std. error	t value	p value	ep_s	estimate	std. error	t value	p value
(intercept)	25.291	21.79	1.161	0.265	(intercept)	6.802	6.998	0.972	0.352
year	-0.012	0.011	-1.129	0.278	year	-0.003	0.003	-0.891	0.392
ep_ns	estimate	std. error	t value	p value	ep_ns	estimate	std. error	t value	p value
(intercept)	-13.236	3.459	-3.827	0.002	(intercept)	-34.016	3.434	-9.907	8.12E-07
year	0.007	0.002	3.847	0.002	year	0.017	0.002	9.948	7.79E-07
ro	estimate	std. error	t value	p value	ro	estimate	std. error	t value	p value
(intercept)	1.153	1.226	0.941	0.363	(intercept)	-0.684	0.146	-4.692	0.001
year	-0.001	0.001	-0.936	0.365	year	0	0	4.704	0.001
ch	estimate	std. error	t value	p value	ch	estimate	std. error	t value	p value
(intercept)	-15.258	13.921	-1.096	0.292	(intercept)	31.495	9.817	3.208	0.008
year	0.008	0.007	1.106	0.287	year	-0.016	0.005	-3.182	0.009
tr	estimate	std. error	t value	p value	tr	estimate	std. error	t value	p value
(intercept)	0.632	0.293	2014.02.16	0.049	(intercept)	0.089	0.487	0.183	0.858
year	0	0	-2.15	0.05	year	0	0	-0.178	0.862
ot	estimate	std. error	t value	p value	ot	estimate	std. error	t value	p value
(intercept)	2.418	12.595	0.192	0.851	(intercept)	-2.686	1.157	-2.321	0.041
year	-0.001	0.006	-0.185	0.856	year	0.001	0.001	2.346	0.039
Somogy					HB				
ep	estimate	std. error	t value	p value	ep	estimate	std. error	t value	p value
(intercept)	6.401	2.523	2.537	0.024	(intercept)	-8.79	14.672	-0.599	0.56
year	-0.003	0.001	-2.202	0.045	year	0.005	0.007	0.658	0.523
ep_s	estimate	std. error	t value	p value	ep_s	estimate	std. error	t value	p value
(intercept)	27.541	4.871	5.654	5.95E-05	(intercept)	32.357	4.362	7.417	2.27E-05
year	-0.013	0.002	-5.502	7.80E-05	year	-0.016	0.002	-7.242	2.79E-05
ep_ns	estimate	std. error	t value	p value	ep_ns	estimate	std. error	t value	p value
(intercept)	-21.141	4.162	-5.08	1.68E-04	(intercept)	-18.344	3.896	-4.709	0.001
year	0.011	0.002	5.105	1.60E-04	year	0.009	0.002	4.741	0.001
ro	estimate	std. error	t value	p value	ro	estimate	std. error	t value	p value
(intercept)	0	0	NA	NA	(intercept)	-0.286	0.641	-0.447	0.665
year	0	0	NA	NA	year	0	3.20E-04	0.453	0.661
ch	estimate	std. error	t value	p value	ch	estimate	std. error	t value	p value
(intercept)	-7.547	3.642	-2.072	0.057	(intercept)	-5.164	3.566	-1.448	0.178
year	0.004	0.002	2.094	0.055	year	0.003	0.002	1.466	0.173
tr	estimate	std. error	t value	p value	tr	estimate	std. error	t value	p value
(intercept)	-0.756	0.355	-2.128	0.052	(intercept)	-2.041	0.841	-2.427	0.036
year	0	1.77E-04	2.14	0.051	year	0.001	4.19E-04	2.43	0.035
ot	estimate	std. error	t value	p value	ot	estimate	std. error	t value	p value
(intercept)	2.902	3.549	0.818	0.427	(intercept)	-5.522	3.706	-1.49	0.167
year	-0.001	0.002	-0.797	0.439	year	0.003	0.002	1.501	0.164

BK					SZSZB				
ep	estimate	std. error	t value	p value	ep	estimate	std. error	t value	p value
(intercept)	-5.68	11.229	-0.506	0.621	(intercept)	6.401	2.523	2.537	0.024
year	0.003	0.006	0.575	0.575	year	-0.003	0.001	-2.202	0.045
ep_s	estimate	std. error	t value	p value	ep_s	estimate	std. error	t value	p value
(intercept)	-2.008	11.434	-0.176	0.863	(intercept)	3.434	3.251	1.056	0.309
year	0.001	0.006	0.236	0.817	year	-0.001	0.002	-0.834	0.419
ep_ns	estimate	std. error	t value	p value	ep_ns	estimate	std. error	t value	p value
(intercept)	-3.671	5.195	-0.707	0.491	(intercept)	-15.267	1.949	-7.833	1.75E-06
year	0.002	0.003	0.723	0.482	year	0.008	0.001	7.88	1.63E-06
ro	estimate	std. error	t value	p value	ro	estimate	std. error	t value	p value
(intercept)	4.3	1.492	2.883	0.012	(intercept)	1.476	0.376	3.932	0.002
year	-0.002	0.001	-2.876	0.012	year	-0.001	1.87E-04	-3.918	0.002
ch	estimate	std. error	t value	p value	ch	estimate	std. error	t value	p value
(intercept)	-2.404	6.362	-0.378	0.711	(intercept)	1.541	0.582	2.647	0.019
year	0.001	0.003	0.399	0.696	year	-0.001	2.90E-04	-2.603	0.021
tr	estimate	std. error	t value	p value	tr	estimate	std. error	t value	p value
(intercept)	0	0	NA	NA	(intercept)	0.422	0.241	1.748	0.102
year	0	0	NA	NA	year	0	1.20E-04	-1.726	0.106
ot	estimate	std. error	t value	p value	ot	estimate	std. error	t value	p value
(intercept)	4.784	7.264	0.659	0.521	(intercept)	9.394	2.364	3.974	0.001
year	-0.002	0.004	-0.647	0.528	year	-0.005	0.001	-3.911	0.002

Table 8. LMM of nest sites for the 1994–2013 period. First part indicates the nest site, the second the type of variable in the upper left corners

8. táblázat A fészekalapok lineáris vegyes modellje az 1994–2013-es periódusra. Az első szó a fészekalapot, a második a változó típusát jelzi minden bal felső sarokban

ep, random	variance		std. dev.	ch, random	variance		std. dev.
megye	(intercept)	0.002	0.047	megye	(intercept)	0.006	0.075
residual		0.015	0.122	residual		0.008	0.089
ep, fixed	std. error		t value	ch, fixed	estimate		t value
(intercept)	-2.879	5.361	-0.537	(intercept)	-0.293	3.904	-0.075
year	0.002	0.003	0.685	year	2.06E-04	0.002	0.106
ep_s, random	variance		std. dev.	tr, random	variance		std. dev.
megye	(intercept)	0.003	0.056	megye	(intercept)	2.62E-06	0.002
residual		0.013	0.116	residual		1.23E-05	0.004
ep_s, fixed	estimate		t value	tr, fixed	estimate		t value
(intercept)	13.034	5.081	2.565	(intercept)	-0.073	0.154	-0.474
year	-0.006	0.003	-2.429	year	3.77E-05	7.65E-05	0.493
ep_ns, random	variance		std. dev.	ot, random	variance		std. dev.
megye	(intercept)	2.90E-04	0.017	megye	(intercept)	0.002	0.039
residual		0.002	0.041	residual		0.004	0.064
ep_ns, fixed	estimate		t value	ot, fixed	estimate		t value
(intercept)	-16.1	1.78	-9.036	(intercept)	3.298	2.825	1.168
year	0.008	0.001	9.093	year	-0.002	0.001	-1.14
ro, random	variance		std. dev.				
megye	(intercept)	4.47E-06	0.002				
residual		8.54E-05	0.009				
ro, fixed	estimate		t value				
(intercept)	1.331	0.404	3.298				
year	-0.001	2.01E-04	-3.287				

Table 9. Linear regressions of the unoccupied nests on electricity poles with support (left column) and the empty electricity poles with support (right column) by counties

9. táblázat Lineáris regresszió a lakatlan fészkekre fészektartós villanyoszlopon (bal oszlop) és az üres fészektartókra villanyoszlopon (jobb oszlop)

ep_t, unoccupied					ep_t, empty				
GYMS	estimate	std.error	t value	p value	GYMS	estimate	std.error	t value	p value
(intercept)	12.743	23.652	0.539	0.599	(intercept)	-5.012	7.136	-0.702	0.494
year	-0.006	0.012	-0.532	0.603	year	0.003	0.004	0.709	0.49
Somogy	estimate	std.error	t value	p value	Somogy	estimate	std.error	t value	p value
(intercept)	-23.561	8.829	-2.669	0.018	(intercept)	-42.858	8.704	-4.924	2.24E-04
year	0.012	0.004	2.689	0.018	year	0.021	0.004	4.938	2.18E-04
BK	estimate	std.error	t value	p value	BK	estimate	std.error	t value	p value
(intercept)	-10.625	5.191	-2.047	0.06	(intercept)	-14.806	3.804	-3.892	0.002
year	0.005	0.003	2.063	0.058	year	0.007	0.002	3.909	0.002
Békés	estimate	std.error	t value	p value	Békés	estimate	std.error	t value	p value
(intercept)	-5.923	7.007	-0.845	0.415	(intercept)	0.234	3.146	0.074	0.942
year	0.003	0.003	0.86	0.407	year	0	0.002	-0.069	0.946
HB	estimate	std.error	t value	p value	HB	estimate	std.error	t value	p value
(intercept)	15.972	14.53	1.099	0.293	(intercept)	-44.326	7.456	-5.945	6.76E-05
year	-0.008	0.007	-1.088	0.298	year	0.022	0.004	5.967	6.54E-05
SZSZB	estimate	std.error	t value	p value	SZSZB	estimate	std.error	t value	p value
(intercept)	-0.528	4.419	-0.119	0.907	(intercept)	-31.262	4.187	-7.466	3.03E-06
year	3.19E-04	0.002	0.145	0.887	year	0.016	0.002	7.514	2.82E-06

