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Breeding, dispersal, migration and conservation of the Black-winged Stilt *(Himantopus himantopus)* in Hungary

Csaba Pigniczki[1*], Tamás Nagy[2], János Oláh[3], Gergő Gábor Nagy[4], Zsolt Karcza[5] & András Schmidt[4]

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Abstract The Black-winged Stilt was the bird of the year in Hungary in 2019. The population of the species increased from 20–25 breeding pairs to 550–680 pairs from 1980s to the present. 75–85% of the Hungarian population bred on effluent pools for pigs and settling pools at sugar beet factories in the first half of 1990s. There were significantly more breeding pairs in Hungary in 1999 compared to previous years, and finally 871 breeding pairs of Black-winged Stilts were documented in 2000 and the Hungarian population was estimated at 940–960 pairs. There were 550–680 breeding pairs in Hungary between 2015 and 2017. Significantly more clutches had more than five eggs in the sampled colonies during the influx in 2000 than in the egg collections before 1971 or in the sampled colony in 2008 as well. First arrivals reached Hungary between 5 and 20 March (median: 15 March) between 2005 and 2019. These arrival dates fall approximately a month earlier than the former arrival dates in mid-April during the 1980s. 470 Black-winged Stilts were observed in a single flock during post-breeding dispersal, this flock was the largest ever documented in Hungary. Stilts left Hungary by the first half of September in the 1980s, and in contrast, they left Hungary between 27 August and 4 January (median: 19 October) between 2005 and 2019. Recently, the most departure dates fall one and a half to three months later compared to the departure dates in the 1980s. Black-winged Stilts marked in Hungary disperse in the Carpathian Basin during their post-fledging/post-breeding dispersal. Based on ring readings of two individuals, they start to migrate southwest with stopover sites in Italy, but their wintering areas are unknown. Stilts hatched in Portugal (one individual) and France (two individuals) bred in Hungary during the large influxes in 1999 and 2000. Five Black-winged Stilts hatched in Italy were observed later in Hungary and are supposed to be breeders in Hungary in most cases. Furthermore, one individual captured as an adult in Spain and two trapped in Italy were observed in Hungary. The Hungarian population of Black-winged Stilt is threatened by predation on eggs and chicks, drainage of wetlands, and also by human-induced flooding of artificial wetlands (e.g. fishponds). Stilts regularly occupy artificial breeding islands the first years after habitat restoration. The Hungarian population of Black-winged Stilts is increasing due to habitat management with grazing animals, especially with Mangalica 'Woolly' Pigs and Water Buffalos.

Keywords: influx, joint clutch, habitat shift, habitat management with grazing, wetland management

Összefoglalás 2019-ben a gólyatöcs volt az év madara Magyarországon. Ennek a fajnak az állománya az 1980-as évektől elkezdett emelkedni, ennek eredménye, hogy 20–25 párról napjainkra 550–680 párra nőtt. Az 1990-es évek első felében a hazai állomány 75–85%-a sertéstrágya-szikkasztókon vagy cukorgyári ülepítőtavakon fészkelt. 1999-ben jelentősen több gólyatöcs fészkelt Magyarországon, mint korábban, 2000-ben pedig 871 pár költését dokumentáltuk, a hazai állományt pedig 940–960 párra becsültük, 2015 és 2017 között pedig 550–680 páros volt. Magyarországon a 2000-ben tapasztalt invázió alatt szignifikánsan több volt az öttojásosnál nagyobb fészkek aránya a mintaterületeken, mint az 1971 előtti tojásgyűjteményekben és a 2008-as mintaterületen. A gólyatöcsök 2005 és 2019 között március 5. és március 20. közötti időszakban érkeztek vissza Magyarországra, ami körülbelül egy hónappal korábbi érkezést jelent, mint az 1980-as évek közepére jellemző április középi érkezés. A fészkelést követő gyülekezés alatt 470 példány volt a legtöbb, amit egy csapatban láttak. Az 1980-as években a gólyatöcsök szeptember elejére elhagyták Magyarországot, ezzel szemben 2005 és 2018 között a faj

utolsó példányait augusztus 27. és január 4. között észlelték, így az utolsó észlelési adatok többsége másfél – három hónappal esik későbbre, mint az 1980-as években. A hazai jelölésű gólyatöcsök a fészkelést követően a Kárpát-medencében kóborolnak, majd délnyugatra vonulnak; két egyed megfigyelése alapján megállóhelyeik Olaszországban vannak, de a pontos telelőhelyeket nem ismerjük. A fészkelési invázió alatt 1999-ben és 2000-ben két Franciaországban és egy Portugáliában fiókaként jelölt egyed fészkelt Magyarországon. Későbbi években további öt Olaszországban kikelt gólyatöcsöt figyeltek meg Magyarországon, egy részüknél feltételezhető volt, hogy fészkelnek. Egy Spanyolországban és két Olaszországban, kifejlett madárként, színes gyűrűvel jelölt gólyatöcsöt azonosítottak hazánkban. A gólyatöcs magyar állományát egyes területek kiszáradása veszélyezteti, de komoly gondot jelenthet még a mesterséges vízállások (pl. halastavak) elárasztása, vagy a predáció is. A gólyatöcs az élőhely-rekonstrukciók során kialakított mesterséges szigeteken az első években rendszerint fészkel. Jelentős részben a legeltetéses élőhely-kezelésnek köszönhető, hogy a hazai gólyatöcs-állomány emelkedik, különösen a mangalicákkal és bivalyokkal megvalósított legeltetéseknek van pozitív hatása a faj megtelepedésére.

Kulcsszavak: invázió, összetojás, élőhely-váltás, legeltetéses élőhely-kezelés, vizesélőhely-kezelés

[1] Kiskunság National Park Directorate, 6000 Kecskemét, Liszt Ferenc utca 19., Hungary,
e-mail: pigniczkics@gmail.com
[2] 6767 Ópusztaszer, Rontószél 170., Hungary
[3] Hortobágy Environmental Association, 4060 Balmazújváros, Debreceni út 139., Hungary
[4] Ministry of Agriculture, 1055 Budapest, Kossuth tér 11., Hungary
[5] Hungarian Bird Ringing Centre, 1121 Budapest, Költő utca 21., Hungary
** corresponding author*

Introduction

The five subspecies of Black-winged Stilt *(Himantopus himantopus)* have a vast combined range so that this species is a truly cosmopolitan bird: the species can be found in Europe, Asia, Africa, Australia as well as in North and South America, however, several studies consider two to five distinct species based on recent splits from the nominate race of the Black-winged Stilt (Oláh 2008, del Hoyo & Collar 2014). In spite of the highly complex taxonomy of the species, five subspecies are accepted worldwide. The nominate race *H. h. himantopus* is distributed in Europe, Africa and the majority of Asia: while its westernmost range within Europe is found in France and the Iberian Peninsula, the southern breeding areas are located in sub-Saharan Africa and Madagascar; furthermore, breeders of this subspecies can be found also east to Central Asia and the central part of northern China, in the Indian subcontinent, Sri Lanka, Indochina and Taiwan (del Hoyo & Collar 2014). Northern populations are migratory, while other populations are dispersive or residents under warmer climatic conditions (Cramp & Simmons 1983).

Black-winged Stilts feed on invertebrates, mainly aquatic insects and their larvae – including Coleoptera, Trichoptera, Hemiptera, Odonata and Diptera – spiders, crustaceans, molluscs, worms, amphibian tadpoles and eggs, small fish and rarely some plant materials (Cramp & Simmons 1983).

The Black-winged Stilt is a strictly protected bird species of key conservation importance in Hungary since 1982 (Bankovics 1984). Similarly to Pied Avocet *(Recurvirostra avosetta)* and Kentish Plover *(Charadrius alexandrinus),* the Black-winged Stilt is considered as a characteristic breeding bird of the unique soda pans of the Carpathian Basin (Boros & Ecsedi 2013).

The Black-winged Stilt was the bird of the year in Hungary in 2019, which provides us an exceptional opportunity to summarize our knowledge on this species in Hungary and to emphasize the future research and conservation priorities.

Breeding population in Hungary

Only limited information is available on the breeding number of Black-winged Stilts in Hungary before the 1970s (Cramp & Simmons 1983, Oláh *et al.* 2003). Chernel (1899) described this species as a bird with a declining population in Hungary at the end of the 19th century due to human-induced drainage of wetlands. Molnár (1986) described four large breeding areas of Black-winged Stilt in Hungary until the middle of 1980s: 1.) the area of Lake Fertő (Neusiedler See) and Hanság, 2.) the area of Lake Balaton and Lake Velence, 3.) the area between the river Danube and the River Tisza, 4.) and finally, the area between the river Körös and the river Maros. Beside Kentish Plover and Pied Avocet, the Black-winged Stilt was usually mentioned as one of the character species of the nesting bird communities on soda pans in Hungary before the 1980s (Bankovics 1983).

During the 1980s, 20–30 breeding pairs of Black-winged Stilt were estimated in Hungary (Bankovics 1984, Bankovics *et al.* 1990), and this population size was the lowest for the Hungarian breeding population (Oláh *et al.* 2003). The cause of decline until the 1980s were thought to be complex: 1.) drainage of natural lakes and marshes by intensive canalisation, 2.) decline of ground-water level due to general canalisation and arid years during the 1980s, 3.) the establishment of fishponds on breeding areas of the species and 4.) egg collecting until the early 1970s (Molnár 1986, Oláh *et al.* 2003, Oláh 2014, Pereszlényi *et al*. 2019). Former soda pans of Homokhátság at Bócsa (e.g. Szappanos-szék), Bugac (e.g. Szekercés-szék) and Fülöpháza (e.g. Kondor-tó, Hattyú-szék) were regular breeding areas for Black-winged Stilts when supplied with sufficient quantities of water. However, as soon as those lakes lost their water supply most waterbirds – including Black-winged Stilts – deserted them by the end of 1980s and breeding was no longer observed there (Bankovics 1979, Molnár 1986, Máté & Pigniczki 2015, Pereszlényi *et al.* 2019).

The recovery of the Hungarian Black-winged Stilt population started from the mid-1980s and it became obvious by the 1990s, due to the significant habitat shift of the species: they moved from natural wetlands to artificial habitats (Molnár 1986, Boros 1998, Oláh *et al.* 2003, Oláh 2014). The Hungarian population was estimated at approximately 100–150 pairs during the 1990s (Boros 1998, Nagy 1998). Due to this habitat shift, the Black-winged Stilts started to breed in effluent pools for pigs (Molnár 1986, Bod 1993, 1994, Kotymán 1996), settling pools at sugar beet factories (Ecsedi 1994), fishponds (Berdó 1994, Nagy 1994, Pigniczki 2001), old clay-pits (Kotymán 1996), paddyfields (Oláh 1996), artificially flooded areas and artificial islands of habitat restoration areas (Boros & Pigniczki 2001, 2013). A sizeable part (57–93 pairs) of the Hungarian population bred at effluent pools for pigs near Szentes in 1990–1994 (Bod 1994). Approximately 75–85% of the Hungarian population bred on effluent pools for pigs and settling pools at sugar beet factories in the first half of the 1990s (Oláh *et al.* 2003). Similarly, the Black-winged Stilt became a more regular breeder

in Transdanubia by the 1990s (Nagy 1998). No general estimation is available for the whole of Hungary, but it was clear that there were more breeding Black-winged Stilts in 1999 than in the previous years (Oláh *et al.* 2003).

A large influx of Black-winged Stilts was observed in 2000 in Hungary, probably due to the extreme extension of flooded areas in the Great Hungarian Plain: 871 breeding pairs were reported, and the Hungarian breeding population was estimated at 940–960 pairs in that year (Oláh *et al.* 2003). Interestingly, it was found that the majority (51.0%) of Black-winged Stilts bred again on soda pans, while the breeding population at effluent pools for pigs and settling pools at sugar beet factories was less important, as only 11.3% of the breeding pairs were found in such habitats in 2000. A substantial part of the population bred in flooded areas (17.8%) and flooded agricultural lands (16.3%), while only a small part of the population bred in old clay-pits (3.3%) and paddyfields (0.3%) (Oláh *et al.* 2003). The breeding population of Black-winged Stilts increased quite suddenly in 1999 and 2000. This population growth could not be explained by a mere increase of the Hungarian (or even the Pannonian) local population estimated during the second half of the 1990s. Additionally, several colour-marked individuals were observed in 1999 and 2000, indicating that one individual came from Portugal and two from France (Oláh *et al.* 2003).

As no systematic survey was conducted on the entire Hungarian population of Black-winged Stilts after 2000, the range of estimations show a high variance (depending on

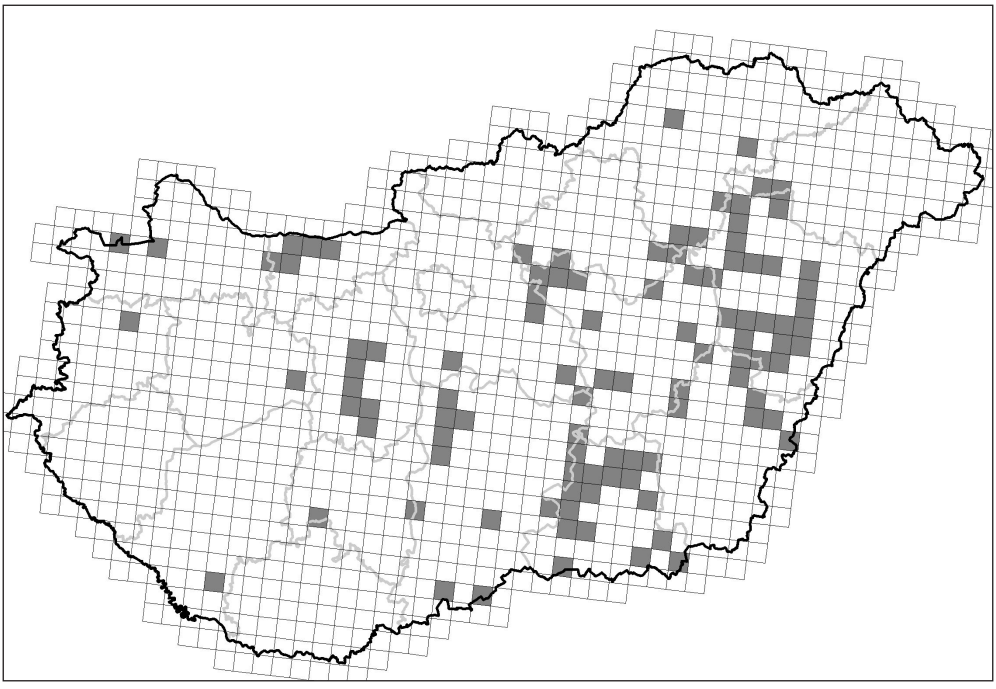

Figure 1. Distribution of Black-winged Stilt in Hungary based on the surveys of national park directorates between 2015 and 2017 in ETRS grids

1. ábra A gólyatöcs elterjedési térképe Magyarországon 2015–2017 között a nemzeti park igazgatóságok felmérései alapján, ETRS-hálózaton bemutatva

authors, 180–950 or 200–1000 pairs) for the breeding populations found during the 2000s and 2010s, noting that there were fewer breeding pairs during the arid years, in contrast to the wet years (Bankovics 2008, Oláh 2014). The staff of Hungarian national park directorates and the members of Hortobágy Environmental Association provided good quality data on the Hungarian breeding population: they reported 628 pairs in 2015, 515 pairs in 2016 and 553 pairs in 2017; based on those records, the total Hungarian population was estimated at 550–680 breeding pairs during 2015–2017. Stilts breed mainly on the Great Hungarian Plain, but they occupied habitats in Transdanubia, too *(Figure 1)*. Breeding Black-winged Stilts were found in a new artificial habitat type, namely in the gravel pits at Ács in 2017 (unpublished data, database of Ministry of Agriculture).

The density (number of breeding pairs/area in hectares of suitable habitat) of breeding pairs of Black-winged Stilts was studied in the soda pans and fishponds of Kiskunság: 13 pairs were observed at Kelemen-szék in 1994, which meant 0.085 pairs/ha density (Boros 1994, Pigniczki 2001). Stilts did not breed at Kelemen-szék in 1995 (density: 0.0 pairs/ha), because that year was dry (Pigniczki 2001). Pigniczki (2001) estimated the density of breeding Black-winged Stilts at 1.146 pairs/ha in 1999 in a fishpond at Akasztó (55 pairs), 0.389 pairs/ha in Kelemen-szék (90 pairs), 0.133 pairs/ha in Fehér-szék (7 pairs) and 0.246 pairs/ha in Zab-szék (32 pairs) in 2000 (Pigniczki 2001).

Breeding biology in Hungary

Most Black-winged Stilts start to form pairs from the second half of April, and generally had full clutches in Hungary between 29 April and 30 June, based on data available from egg collections (Haraszthy 2019a). Field observations indicate that some pairs may start to incubate their eggs even earlier [e.g. one pair incubated eggs on 22 April 2010 and another pair on 24 April 2014 at Pusztaszer and two pairs on 14 April 2005 at Kistelek (T. Nagy unpublished data)]. These data indicate that breeding starts earlier nowadays than it did several decades ago (Haraszthy 2019a).

Black-winged Stilts may build nests using plant materials or only scrape nests into the soil. If their nests are built in shallow water, they are able to mitigate the effect of rising water levels by raising their nests even higher above water levels. They breed colonially in most cases, often together with other species like Pied Avocet, Kentish Plover, Northern Lapwing *(Vanellus vanellus)*, and occasionally they join other species, such as Black-tailed Godwit *(Limosa limosa)*, Common Redshank *(Tringa totanus)*, Little Ringed Plover *(Charadrius dubius)*, Black-headed Gull *(Chroicocephalus ridibundus)* and Common Tern *(Sterna hirundo)* (Haraszthy 2019a, Cs. Pigniczki unpublished data).

Black-winged Stilts lay 3–5 eggs, averaging four eggs most frequently. Nests including less than three eggs are probably incomplete or robbed, while nests with more than five eggs are most likely joint clutches of at least two females (Cramp & Simmons 1983, Snow & Perrins 1998). Clutches collected in Hungary during 1896–1971 contained 8×3, 62×4, 3×5, 3×7 and 1×8 eggs (Pereszlényi *et al.* 2019, L. Haraszthy *pers. com.*) *(Figure 2)*. Joint clutches were found occasionally during the 1990s: 6×7 eggs were reported from

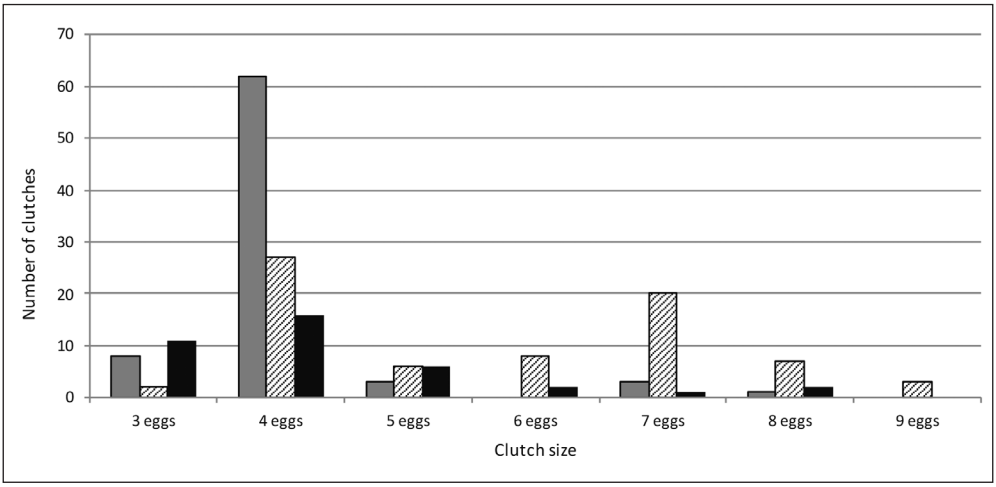

Figure 2. Comparison of clutch sizes of Black-winged Stilts found in egg collections and collected until 1971 (grey) (Pereszlényi *et al.* 2019), observed during the influx in 2000 (striped) (Oláh *et al.* 2003) and observed in 2008 (black) (Haraszthy 2019b). The number of joint clutches with more than five eggs was the highest during 2000 among the three periods

2. ábra Gólyatöcsök fészekalj-méretének összehasonlítása 1971 előtt, tojásgyűjteményekben fellelhető fészkek alapján (szürke) (Pereszlényi *et al.* 2019), a fészkelési invázió alatt 2000-ben (sávozott) (Oláh *et al.* 2003) és 2008-ban (fekete) (Haraszthy 2019b). 2000-ben az összetojásos, ötnél több tojást tartalmazó fészkek aránya magasabb volt, mint a másik két vizsgált időszakban

different locations of the Great Hungarian Plain (Berdó 1994, Bod 1994, Ecsedi 1994, Oláh *et al.* 2003). Interestingly, several joint clutches were detected in the Great Hungarian Plain, during the influx of Black-winged Stilts in 2000: in the case of the four studied colonies 5×1, 2×2, 2×3, 27×4, 6×5, 8×6, 20×7, 7×8 and 3×9 eggs were reported from nests (Oláh *et al.* 2003) *(Figure 2)*. Therefore, while there were only four joint clutches with more than five eggs (5.2%) among 77 collected nests during 1896–1971, there were at least 38 joint clutches with more than five eggs (52.1%) among 73 nests (not calculating with clutches with one or two eggs/nest) in 2000. In this case, there were significantly more joint clutches with more than five eggs during the influx in 2000 than during the period 1896–1971 (chi-square test: $\chi^2 = 40.817$, df = 1, $p < 0.0001$). Haraszthy (2019b) reported nests of Black-winged Stilts built in the marsh of Dinnyés-Fertő in 2008 with the following clutch sizes: 3×1, 7×2, 11×3, 16×4, 6×5, 2×6, 1×7, 2×8 eggs *(Figure 2)*, amounting to a proportion of 13.2% (N = 5 out of 38; nests with one or two eggs/nest excluded) of the nests had joint clutches with more than five eggs. Nests with five eggs were documented in this study as joint clutches due to two different groups of eggs in the same clutch (Haraszthy 2019b). Statistically, there were significantly more joint clutches with more than five eggs in the studied colonies during the large influx in 2000 than in 2008 (chi-square test: $\chi^2 = 15.932$, df = 1, $p < 0.0001$). There was no significant difference between the number of normal nests and joint clutches with more than five eggs if we compared nests documented in 1896–1971 and 2008 (chi-square test: $\chi^2 = 2.2366$, df = 1, $p = 0.135$). Indeed, a Japanese

study suggests that joint clutches of Black-winged Stilts may occur, when the population is female biased, and females are not able to find single males, therefore unpaired females are also able to breed, if they form bigamous trios including a male and another female and have 1.) a joint clutch or 2.) two simultaneous nests or 3.) several nests successively (Kitagawa 2009, 2011). Haraszthy (2019a, 2019b) treated joint clutches in Hungary as a result of intraspecific nest parasitism. Unfortunately, no data is available on the sex ratio of Black-winged Stilts in Hungary during the influx in 2000, and neither on the exact parental behaviour in case of joint clutches during incubation (including the number of parents incubating a particular joint clutch), therefore, more fieldwork is needed to analyse the role of joint clutches in Hungary. Our results indicate that during the influx of Black-winged Stilts, the number of joint clutches was extremely high (Haraszthy 2019a).

The chicks are precocial (Cramp & Simmons 1983). Bod (1992, 1993) estimated the fledging success at 3.0 and 3.6 fledged juveniles/pairs in two colonies in 1990 and 2.1 fledged juveniles/pairs in 1992 on effluent pools for pigs at Szentes.

Dispersal and migration

Field observations

The Black-winged Stilts arrived back to Hungary approximately on 7–8 April at the end of the 19th century (Chernel 1899). Stilts returned during the first half of April during the

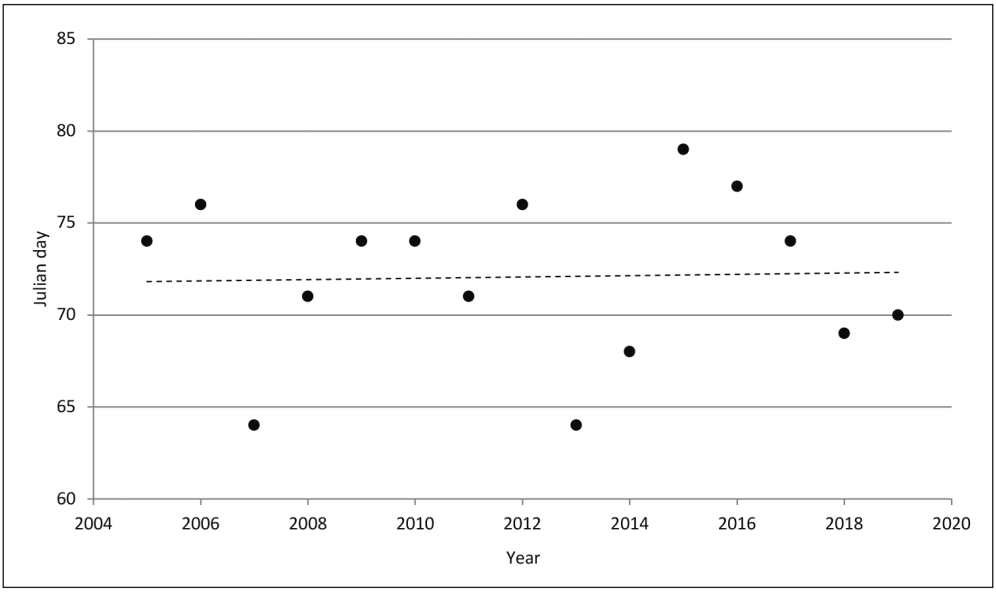

Figure 3. Arrival date of Black-winged Stilts to Hungary between 2005 and 2019 (based on data available from http://map.mme.hu and www.birding.hu)

3. ábra Gólyatöcsök érkezése Magyarországon 2005 és 2019 között (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján)

1980s (Bankovics 1984, Bankovics *et al.* 1990). During the late 1990s and 2000s, the Black-winged Stilts arrived back to Hungary between the end of March and the beginning of April (Oláh *et al.* 2003, Bankovics 2008). The first Black-winged Stilts arrived back to Hungary between 5 March and 20 March during the period between 2005 and 2019 *(Figure 3)* (www.birding.hu, http://map.mme.hu). The median day of first arrival was 74 Julian day (15 March), and the mean and standard deviance of first arrival was found to be 72.1 (13 March) ± 4.5 Julian day. From this it can be inferred that Black-winged Stilts arrived back to Hungary a month earlier by 2010s than during the 1980s. Earlier arrivals could be the result of climate change in the Hortobágy area (Végvári *et al.* 2010). We did not detect a shift in the case of arrival dates of stilts to Hungary between 2005 and 2019 (linear regression: $b > 0.001$, $df = 13$, $p = 0.9999$).

The Black-winged Stilts tend to form large flocks in July and early August, during post-breeding or post-fledging dispersal periods. Large flocks with more than 200 individuals became increasingly regular in Hungary from 1999. The first larger flock was documented in Hungary during the 1990s on the Böddi-szék (near Dunatetétlen): it contained 218 individuals on 16 July 1999 (Pigniczki 1999). The largest flock observed in Kiskunság contained 251 individuals: this flock was observed at Partos-szék (near Fülöpszállás) on 9 July 2000, but only 119 stilts were seen on 15 July 2000 (Cs. Pigniczki unpublished data). The settling pools at a sugar beet factory at Kaba held 237 Black-winged Stilts on 18 July 2004 (J. Oláh in www.birding.hu). The largest flocks ever documented in Hungary were observed

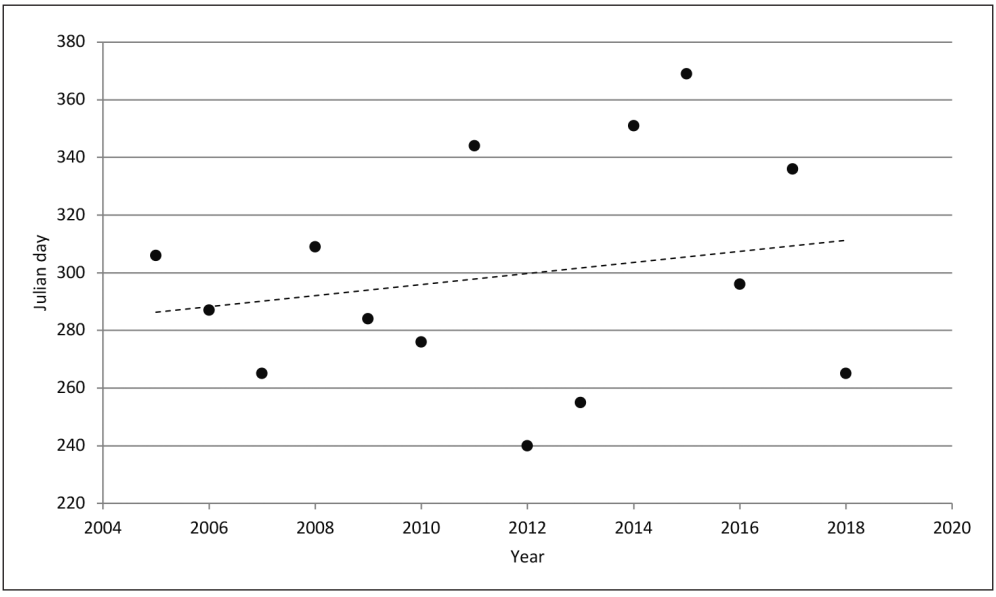

Figure 4. Departure date of Black-winged Stilts from Hungary between 2005 and 2018 (based on data available from http://map.mme.hu and www.birding.hu). The last observation of the season 2015 happened on 4 January 2016, that date was treated as 369 Julian day

4. ábra Gólyatöcsök utolsó megfigyelése Magyarországon 2005 és 2018 között (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján). A 2015-ös szezon utolsó megfigyelése 2016. január 4-én történt, ezt a 369-es julián napként kezeltük

Table 1. First and last observation dates of Black-winged Stilt individuals in Hungary between 2005 and 2019 (based on data available from http://map.mme.hu and www.birding.hu).
** The last observation of the 2015 season occurred on 4 January 2016.*

1. táblázat Gólyatöcsök legkorábbi és legkésőbbi adatai a 2005–2019-ből (http://map.mme.hu és www.birding.hu adatbázisok adatai alapján).
**A 2015-ös szezon utolsó adata 2016. január 4-én került megfigyelésre*

Season	First data	Last data
2005	15 March	2 November
2006	17 March	14 October
2007	5 March	22 September
2008	11 March	4 November
2009	15 March	11 October
2010	15 March	3 October
2011	12 March	10 December
2012	16 March	27 August
2013	5 March	12 September
2014	9 March	17 December
2015	20 March	4 January 2016*
2016	17 March	22 October
2017	15 March	2 December
2018	10 March	22 September
2019	11 March	not available

on the 95 ha large habitat complex of Vesszős-szék and Hatvani-csatak (near Pusztaszer): 470 Black-winged Stilts were counted on 26 July and 6 August 2015, 380 individuals on 12 July 2016, and 417 on 21 July 2018 (T. Nagy unpublished data). Sárkány-tó (near Sárkeresztúr) is also an important soda pan for Black-winged Stilts, where 370 individuals were seen on 26 July 2013 and 268 birds on 4 July 2018 (N. Kovács in www.birding.hu).

Black-winged Stilts may appear in unusual habitats during their movements. For instance, a group of maximum six individuals fed on the Csukás-ér, a nine-meter wide sewage-water ditch next to the town of Kecskemét in 2018 and in 2019 (Cs. Pigniczki unpublished data).

The last Black-winged Stilts left Hungary by the beginning of September during the 1980s (Bankovics 1984, Bankovics *et al.* 1990). Most Black-winged Stilts leave Hungary during August, however, a few individuals stay in Hungary and they start their autumn migration in September, and the last ones were observed in October and rarely even in November and December in Hungary during the 1990s and the first years of the 2000s (Nagy 1992, Oláh *et al.* 2003, Bankovics 2008). Interestingly, 2 individuals were observed on 21 December 1990 (Nagy 1992). The last Black-winged Stilts were observed in Hungary between 27 August and 4 January during the period between 2005 and 2018 *(Figure 4)* (www.birding.hu, http://map.mme.hu). The median value of the last observation in Hungary was 291.5 Julian day (19 October). The mean and standard deviance of the last observation was 298.8 ± 39.0 Julian day (26 October). Currently, the last Black-winged Stilts leave Hungary one and a half to three months later than during the 1980s, with a substantial inter-annual variance. We found that the departure date of stilts changed, they left Hungary later by the end of the period between 2005 and 2018, but it was not significant statistically (linear regression: $b = 1.919$, $df = 12$, $p = 0.4804$).

Observations of individuals marked in Hungary

345 Black-winged Stilts were marked in Hungary between 1951 and 2018, 285 (82.6%) of them were captured as chicks. Colour marking of the species started in 2015 in Hungary, which resulted in 46 (13.3%) colour-ringed individuals between 2015 and 2018.

Some information is available on the dispersal *(Figure 5)* and the migration *(Figure 6)* strategies of Black-winged Stilts due to colour-ringing. An individual marked at Kis-rét at Szabadszállás in the Kiskunság on 3 June 2015 was observed 54 days later at the Austrian part of Lake Fertő (Neusiedler See), 209 km away from its natal area. Another individual captured at Sós-tó at Bácsalmás on 6 July 2016 was seen 36 days later at Sárkány-tó at Sárkeresztúr, which covered a distance of 116 km. An adult female captured at Seregélyes, in the vicinity of Lake Velence on 2 July 2018 moved 143 km and was observed between 26 July and 10 August 2018 at the Hungarian part of Lake Fertő (Neusiedler See). These ring readings indicate that both juvenile and adult Black-winged Stilts can cover larger distances, while they move from one wetland to another in the Carpathian Basin, during their post-fledging or post-breeding dispersal. On the other hand, a chick captured on 11 July 2017 used the same location around Lake Fertő (Neusiedler See) for a long period, and was observed there eleven times until 3 September 2017. This example suggests that individuals can stick to a suitable site for a long time.

Only one record is known from autumn migration of Black-winged Stilts: a colour-ringed juvenile marked as a chick at Mocsa (Hungary) was observed at Sentina in Italy on 24 August 2018. Another individual captured as juvenile (likely to have hatched in the Carpathian

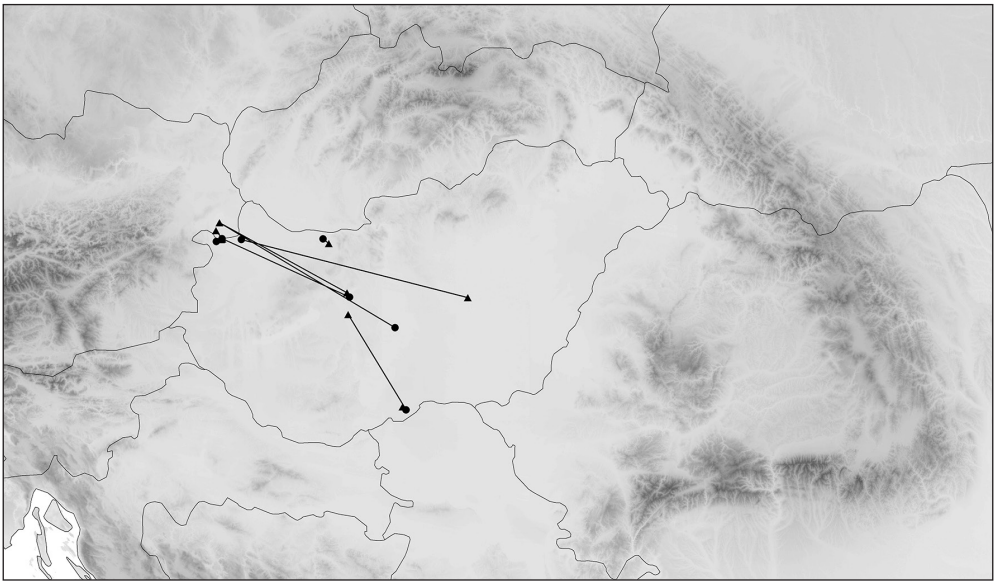

Figure 5. Dispersal of Black-winged Stilts in the Carpathian Basin based on birds marked in Hungary. Circles indicate the location of captures, while triangles show the location of observations

5. ábra Gólyatöcsök diszperziója a Kárpát-medencében a magyar gyűrűs madarak megfigyelési adatai alapján. A körök a befogás, a háromszögek a megfigyelés helyét jelölik

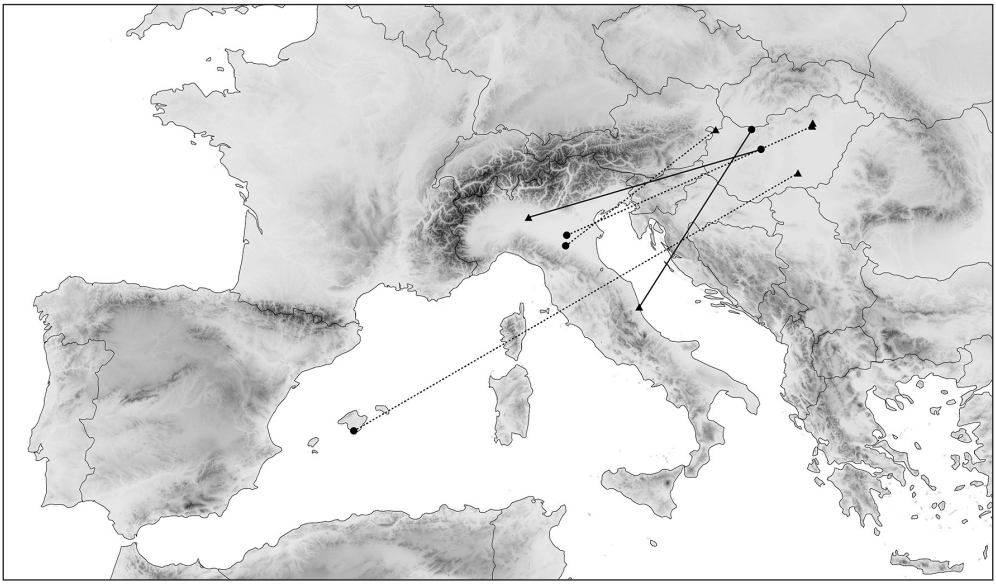

Figure 6. Migration of Black-winged Stilts related to Hungary. Circles indicate the location of captures, while triangles show the location of observations. Movement of stilts captured in Hungary are indicated by continuous lines, while interrupted lines show the movement of birds marked abroad

6. ábra Gólyatöcsök magyar vonatkozású vonulási adatai. A körök a befogás, a háromszögek a megfigyelés helyét jelölik. A Magyarországon gyűrűzött madarak elmozdulását folytonos vonal, a külföldön gyűrűzöttekét szaggatott vonal mutatja

Basin) was observed at Crema in Italy on 26 March 2010 during spring migration *(Figure 6)*. These two records are very limited but suggest that Black-winged Stilts may move southwest from Hungary to their wintering areas. It seems that telemetry-based studies and colour-marking projects are needed to identify the key wintering areas and migration routes of this species. We suppose that at least a part of Black-winged Stilts hatched in Hungary follow similar migration routes as individuals hatched in Italy: three birds with Italian origin crossed the Sahara and moved to Mali to winter there (Spina & Volponi 2008).

Observations of individuals marked abroad

Ring readings of colour-ringed Black-winged Stilts marked abroad indicate connection between the Carpathian Basin and southwestern Europe: two ringed as chicks in France, one captured as chick in Portugal, one marked as adult in Spain and finally seven individuals – two captured as adults and five as chicks – from Italy were observed in Hungary.

Black-winged Stilts captured in Italy in late March and early April as adults could be individuals returning to the Carpathian Basin in their spring migration *(Figure 6)*. One of those birds was captured in Italy in 2010 and was observed in Hungary in 2016 and 2019 as well, and we suppose that it was an individual breeding around Mezőkövesd and Mezőszemere. The adult bird trapped in Spain in May 1993 was most likely a local breeder there, and a year

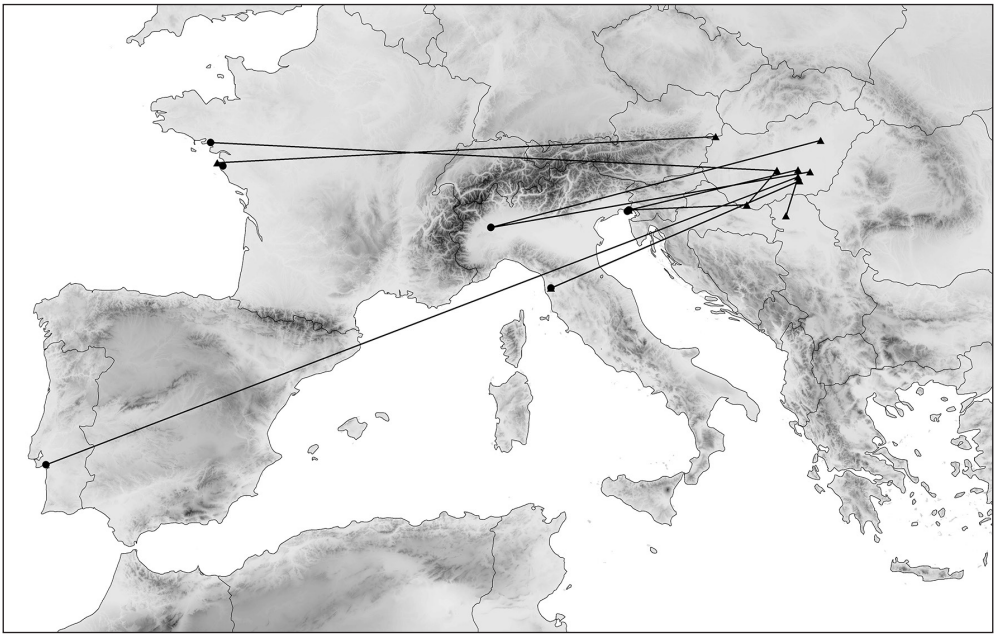

Figure 7. Origin of Black-winged Stilts captured as chick outside Hungary and observed later in Hungary during breeding period. Circles indicate the location of captures, while triangles show the location of observations

7. ábra Gólyatöcsök származási helye, melyeket külföldön, fiókaként fogtak be és Magyarországon költési időben figyeltek meg. A körök a befogás, a háromszögek a megfigyelés helyét jelölik

later was observed in Hungary on 28 July 1994 during post-breeding dispersal, however, it is not known where that individual bred *(Figure 6)*.

We know the natal area of eight Black-winged Stilts marked abroad, all of which were observed in Hungary during breeding season (between 24 April and 16 July) *(Figure 7)*. Interestingly, two individuals hatched abroad were identified in Hungary during the first influx in 1999 and another one during the large influx in 2000. Therefore, the ring recoveries proved that not only the local individuals, but also some Southwest and West European stilts started to breed in Hungary, and provided strong evidence for the origin of birds when the Hungarian breeding population increased suddenly. Similar connections were found and a similar influx was observed in the case of Pied Avocets, a close relative of stilts during extremely wet years: three avocets, including one hatched in Italy and two hatched in Spain, bred later in Hungary (Boros & Lengyel 2009).

Black-winged Stilts with foreign natal area were observed at Hortobágy, Szentes, Gátér, Pusztaszer, Fülöpszállás (2 individuals) and Sarród during breeding season. The largest distance between the natal area and Hungary was 2507 km (Vaia, Portugal – Gátér, Hungary). The mean distance (± s.d.) between natal areas and supposed breeding sites was 1163.4 ± 634.2 km, while the median distance was 978 km.

A bird hatched in Portugal was observed at Lake Fehér at Gátér with chicks on 7 July 1999, and four years later that bird was observed on a nest at Kula in Serbia on 17 May 2003.

This is an indication that this individual became a breeder of the Carpathian Basin *(Figure 7)*. A bird with Italian origin marked in 2006 was observed on 13 August 2010 at Páprád, Hungary, and a year later it was seen at Kelemen-szék at Fülöpszállás, Hungary on 20 June 2011, as a potential breeder *(Figure 7)*. There is an example for breeding dispersal: a bird hatched in the Atlantic area of France in 1992 nested two years later 19 km away from her natal area but she was observed three times in the Hungarian part of Lake Fertő (Neusiedler See) at Sarród between 24 April and 31 May 1999 *(Figure 7)*.

Conservation in Hungary

The population of Black-winged Stilts in Hungary largely depends on water conditions in its habitat, therefore, dry years and human-induced drainage of natural habitats could prevent many pairs from breeding in Hungary.

Black-winged Stilts and other shorebirds may start to breed on drained fishponds or other drained artificial wetlands. In these cases, it is necessary to provide enough time for these birds to incubate the eggs and lead their chicks away before refilling the fishponds (Molnár 2019).

Loss of breeding sites due to overgrowth with marsh vegetation on the shoreline and in the water-course of lakes and the growth of trees, especially *Eleagnus angustifolia* on breeding islands and in the vicinity of soda pans prevent the breeding of shorebirds (Ecsedi & Boros 2013).

Eggs and chicks are threatened by predators: several species of predators were documented and observed regularly in the colonies of Black-winged Stilts in Hungary while the predators were looking for eggs and chicks, like Western Marsh Harriers *(Circus aeruginosus)*, Caspian Gulls *(Larus cachinnans)*, Hooded Crows *(Corvus cornix)*, Rooks *(Corvus frugilegus)*, Magpies *(Pica pica)*, Red Foxes *(Vulpes vulpes)*, Golden Jackals *(Canis aureus)*, Dogs *(Canis lupus familiaris)*, Badgers *(Meles meles)* and Wild Boars *(Sus scrofa)* (Ecsedi & Boros 2013, Cs. Biró pers. com., Cs. Pigniczki unpublished data). It was observed on the habitat restoration area of Lake Kolon at Izsák, that a swimming chick of Black-winged Stilt was preyed on by a Northern Pike *(Esox lucius)* (Cs. Biró pers. com.).

Habitat management

Black-winged Stilts use a wide variety of wetlands with shallow water, both for breeding and foraging.

Breeding islands created for waterbirds during habitat restorations were often occupied by Black-winged Stilts during the first years after the interventions. For example, a pair of Black-winged Stilts together with 35 pairs of Pied Avocets bred on the island of Fehér-szék at Fülöpszállás in 1999, in the second year followed by works on that area (Boros & Pigniczki 2001, 2013, Pigniczki 2001).

Lake Kolon is a large peat bog area with a huge reedbed. Open water surfaces were created in the reedbed, and an island was built from soil by the autumn of 2011. There was a

breeding pair of Black-winged Stilts in 2012, eleven pairs in 2013, four pairs in 2014 but no pair during the following years (Cs. Biró pers. com.). Generally, Black-winged Stilts occupy islands during the first years after the earthworks of habitat restorations.

Grazing of livestock (e.g. Hungarian Grey Cattle, Hungarian Flecked Cattle, Water Buffalo, Mangalica 'Woolly' Pig, Racka Sheep, Goat, Donkey and Horse, etc.) on Hungarian wetlands is a very important tool to control marsh vegetation and to create suitable breeding and foraging areas for many species of waterbirds, including Black-winged Stilts (Ecsedi & Boros 2013, Pigniczki *et al.* 2013).

Habitat management in Pusztaszer Landscape Protection Area is an example of the important role that grazing by Water Buffalos can play in removing reedbeds and thus creating lakes with open water for breeding shorebirds. The Vesszős-szék at Pusztaszer was used as a domestic duck and goose farm for a long time, and that soda pan was overgrown by marsh vegetation, therefore, Vesszős-szék was not suitable for breeding shorebirds anymore (Tajti 2013). The grazing of the first twelve buffalos started on a 60 ha area of Vesszős-szék in 2004 (0.2 grazing animal/ha), and the number of buffalos increased to 41 individuals by 2006. A spectacular habitat change took place in Vesszős-szék and Hatvani-csatak from 2007, when 110, and later 130 buffalos grazed on a 120 ha area. Due to this grazing management, the density of marsh vegetation became scarce and finally disappeared from the area by the end of 2009, when buffalos grazed on a 160 ha area, including the marsh of Büdös-szék. However, *Typha latifolia* reappeared in the Vesszős-szék in 2010 due to extremely wet conditions, but 150 individuals of grazing buffalos were able to control the vegetation. The open water surface of Vesszős-szék and Hatvani-csatak was stable between 2011 and 2019, due to the grazing of 120–160 buffalos and the marsh of Büdös-szék started to be opened. Black-winged Stilts occupied the opened habitat and 19 pairs started to breed in 2006, and their number increased from zero in 2005 to 20.5 ± 17.0 pairs (mean ± SD) in the

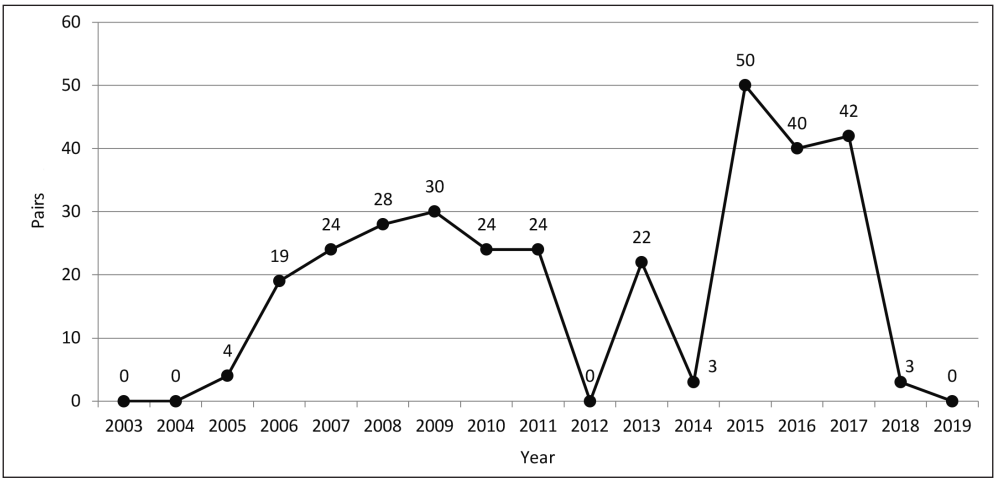

Figure 8. Breeding population of Black-winged Stilts in Vesszős-szék and Hatvani-csatak at Pusztaszer, during grazing of Water Buffalos

8. ábra A gólyatöcs állományának alakulása a pusztaszeri Vesszős-széken és Hatvani-csatakban, bivalylegeltetés mellett

following years; 0–50 breeding pairs *(Figure 8)*, depending on the winter precipitation of the particular year (Tajti 2013, T. Nagy unpublished data). Vesszős-szék and Hatvani-csatak are important for Black-winged Stilts during post-breeding/post-fledging dispersal as well with a maximum of 470 individuals on the study area (T. Nagy unpublished data). Buffalos started to graze in the marsh of Büdös-szék at Pusztaszer in 2009, and the first breeding of Black-winged Stilts in that area was documented a year later there (T. Nagy unpublished data). Habitat management with a similar grazing method of buffalos was implemented at Lake Nagy-Széksós at Mórahalom, its result was a maximum of 28 breeding pairs of Black-winged Stilts in the area (Krnács 2013, Gy. Krnács pers. com.). Cattle are also able to create similar areas for shorebirds: 55 breeding pairs of stilts bred at Bába-szék at Dunatetétlen in 2018 (S. Kovács pers. com.).

Another example indicates the importance of Mangalica 'Woolly' Pigs for shorebird habitat management in the Hortobágy area. The Nagy-Vókonya wetland was a degraded part of the Hortobágy National Park, where the original steppe habitat was destroyed by the creation of a rice field system in the 1950s. That area was also used later for domestic goose farming during the 1980s. The Hortobágy Environmental Association carried out a Life Project in the area (LIFENAT02/H/8638). In the frame of the project, a total of 100 km of paddyfield dykes was eliminated, and due to this activity, several temporary spring wetlands were created in the steppe habitat. Furthermore, a 200 ha semi-permanent wetland was formed and an ecologically high level of grazing was introduced to the area employing mixed livestock. The livestock included Hungarian Grey Cattle, Mangalica 'Woolly' Pig, Racka Sheep and Donkey (Pigniczki *et al.* 2013). Throughout the project, a minimum of 0.8 grazing animal unit/ha grazing level was introduced. If the grazing effect of an adult cattle or buffalo means 1.0 grazing animal unit, then compared to that value the rate of grazing effect of a sheep or goat is 0.15, in the case of a pig is 0.3–0.5 and in the case of a donkey is 0.6 (Borza *et al.* 2017). Some years after the project, the grazing density was raised to 1.2 grazing animal unit/ha. The original base survey for breeding shorebirds revealed almost no breeding shorebirds in the area before the project. This changed significantly after the project especially for Lapwing, Common Redshank and Black-tailed Godwit, moreover, Black-winged Stilt, Pied Avocet and Common Snipe *(Gallinago gallinago)* became regular breeding shorebirds in Nagy-Vókonya. As soon as the 200 ha wetland was flooded for the first time in 2004, immediately 7 pairs of Black-winged Stilts bred in the area. Stilts were the first species that colonized that area, although the Hortobágy population was small in those years. In the following years, an increasing number of stilts was seen foraging in the area. Stilts only became regular breeders after 2010 with a peak of 72 pairs in 2013 *(Figure 9)*. It was found that an ecologically high level of grazing was essential to maintain the right balance of open water surface, short grass, and muddy or open-soiled habitat. Anything above 0.8 grazing animal unit/ha was beneficial for shorebirds. In the case of Nagy-Vókonya Mangalica 'Woolly' Pigs were used for entering and feeding in deeper water.

The impact of grazing in landscape-scale on the breeding population of Black-winged Stilts can be followed in the example of the Hortobágy. Generally, the Hortobágy had an insignificant breeding population of Black-winged Stilts until 1999, and the first important year in the case of the Hortobágy population of this species was noted in 1999 with 30

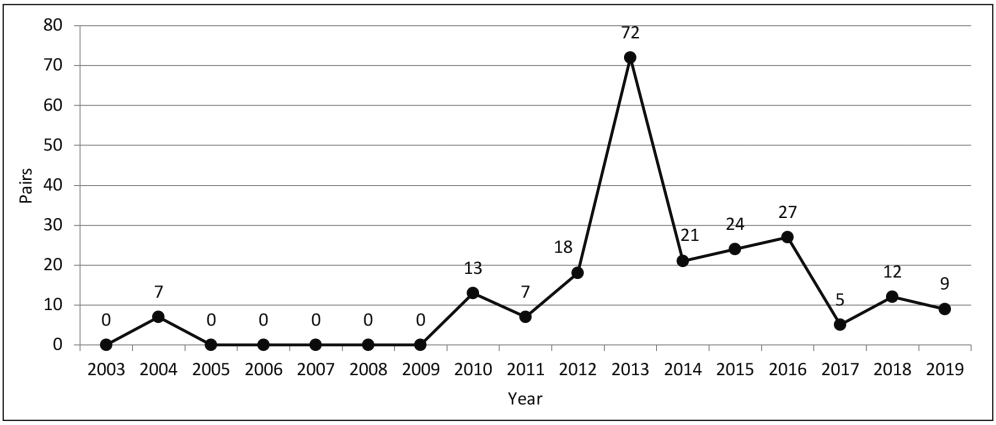

Figure 9. Breeding population of Black-winged Stilts in Nagy-Vókonya at Hortobágy during grazing of Mangalica 'Woolly' Pigs

9. ábra A gólyatöcs állományának alakulása a hortobágyi Nagy-Vókonyán, a mangalicatartás mellett

pairs (Borza *et al.* 2017), but with no documented breeding attempt during the large influx in 2000 (Oláh *et al.* 2003). The majority of habitat recreation and rehabilitations occurred in the late 1990s and the early 2000s and by 2010 there were several suitable breeding habitats for the species where both ecologically high level of grazing and suitable water cover were maintained. The number of breeding pairs of Black-winged Stilts reached a hundred pairs during the 2010s in Hortobágy (Borza *et al.* 2017). This increase of the species was the result of changing habitat due to intensive grazing activity in the Hortobágy: grazing livestock opened shallow lakes covered by vegetation, mainly by *Phragmites australis*, *Typha latifolia*, and *Bolboschoenus maritimus*, and created wetlands with open water surfaces, which are important not only for Black-winged Stilts but also for other breeding shorebirds. The effect of grazing activity was the most spectacular on the breeding population of shorebirds

Table 2. Breeding population of Black-winged Stilts between 2009 and 2019 in the northeastern part of Hortobágy (HEA, unpublished data)

2. táblázat Az Északkelet-Hortobágyon fészkelő gólyatöcsök állománya 2009 és 2019 között (Hortobágy Természetvédelmi Egyesület, nem publikált adatok)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Nyárijárás & Nyírő-lapos	0	4	0	4	4	1	0	4	0	40	0
Magdolna-puszta	1	0	0	0	0	2	1	53	4	1	0
Daru-Karinkó-puszta	0	0	0	0	0	0	0	2	0	0	0
Kerek-fenék	0	3	2	0	0	0	0	9	2	0	0
Nagy-szik	0	0	9	16	16	8	0	21	76	4	3
Nagy-Vókonya	0	13	7	18	72	21	24	27	5	12	9
Total/Összesen	1	20	18	38	92	32	25	116	87	57	11

if at least 1.5 grazing animal units of livestock were in 1 ha area (Borza *et al.* 2017). Due to intensive grazing activity on Nagy-szik, the breeding population of Black-winged Stilts increased from 0–4 breeding pairs to 8–21 pairs, and they breed regularly in that area, and their population is stable with some fluctuation (Ecsedi *et al.* 2017). The increase of the breeding Black-winged Stilts in the Northeast Hortobágy area *(Table 2)* (HEA database, unpublished data) coincide with habitat restorations and increased level of grazing. Especially, those wetlands were important where either Water Buffalos or Mangalica 'Woolly' Pigs were used for habitat management because both can forage on the shore and in the water as well, where they are the best type of livestock for creating breeding habitat for shorebirds. In the case of Black-winged Stilt, these types of livestock did not only create important mudflats for foraging, but also turned the vegetation more tussocky, with clusters of vegetation interspersed with patches of water, hence perfect for the breeding stilts.

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