Bird Census News

Journal of the European Bird Census Council

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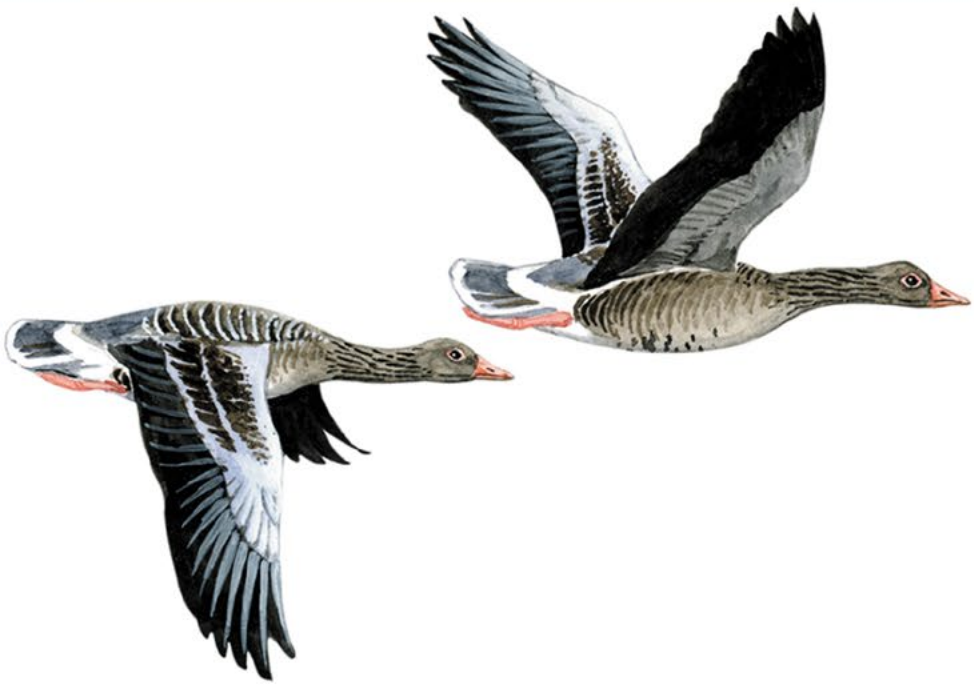

2019
Volume 32 n°1–2

Bird Census News

2019, volume 32 n° 1–2 (published April 2020)
ISSN 1381-5261
Free download pdf from www.ebcc.info

Bird Census News is the Journal of the European Bird Census Council or EBCC. The EBCC exists to promote the organisation and development of atlas, census work and population studies in all European countries; it promotes communication and arranges contacts between organisations and individuals interested in census and atlas work, primarily (but not exclusively) in Europe.

Bird Census News reports developments in census and atlas work in Europe, from the local to the continental scale, and provides a forum for discussion on methodological issues.

Cover illustration by Evgeny Koblik

Bird Census News
Volume 32/1–2, April 2020

EDITORIAL

Birds do not recognise national borders. Most of the bird species in Europe are migratory, which move between their breeding and wintering areas. From a monitoring point-of-view, breeding bird surveys and the international mid-winter waterbird surveys have long tradition, and nowadays information from these schemes are aggregated routinely on the European level. The Euro Bird Portal project of the EBCC has started to gather near real-time information from the migration seasons in recent years and coverage is expanding. One should not also forget that systematic migration monitoring has been on-going at several locations, including bird observatories, in Europe for decades. Counts conducted at migration hotspots or bottlenecks can accumulate very large datasets including birds from a broad breeding range, which enables us to investigate population changes in a large number of species. New online tools have also revolutionised the data entry of migration counts. From the volunteer point-of-view, contributing to international migration data by submitting your observations has never been as easy as it is now.

This volume of Bird Census News has three articles on migration projects. One of them is introducing the rapidly growing online portal, Trektellen.org, which enables contributors to enter systematic migration counts from various locations around the World. Two other papers show cases how migration count data has been collected at the Falsterbo and Hanko Bird Observatories, and what outputs can be calculated. In addition, this volume includes two interesting case studies of breeding birds in Armenia in SE Europe. With these five papers, I wish to reiterate that BCN is open to submissions that cover bird monitoring broadly including counts during the outside the breeding season and single species case studies.

I wish you enjoy the issue!

Aleksi Lehikoinen

Bird Census Editor

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White Storks (*Ciconia ciconia* L.) in Armenia: research for conservation

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Abstract. The entire population of White Storks (*Ciconia ciconia* L.) in Armenia was monitored annually during 2005–2016 and the data were compared with the previous study conducted in 1984. The population increased from 548 to 654 breeding pairs between 2005 and 2016, and there was an increase in average breeding success (number of fledglings per occupied nest). The storks have shifted their preferred nest locations since 1984, from roofs and trees to pylons. Nest sites on pylons are vulnerable to short circuits or wind, thus during 2005–2016 we recorded 450 cases of nest damage.

Introduction

In Armenia the White Storks (*Ciconia ciconia* L., hereafter storks) occupy Ararat Plane, Arpa River Valley, Shirak and Lori Plateau (Adamian 1990, Adamian & Klem 1999), and nest in villages located in close proximity to wetlands. Throughout Europe storks are used as a flagship species, which can encourage citizen scientists to be involved in their census and serve as an indicator of wetland ecosystems (Hötker & Thomsen 2013). Taking that into consideration, in 2005 we started a study of the storks in Armenia, which was dedicated to: (1) the identification of the stork population size and dynamics, (2) the measurement of trends in stork breeding success in Armenia, (3) justification of the conservation status of the species in Armenia and development of conservation measures, if necessary. The species was selected, being a top-level predator, charismatic enough to attract rural people into monitoring, and being an easy-to-survey bird, which can encourage the collection of a large amount of data, thus enabling a cost effective study. Identification of such an easy indicator of the wetlands' health is of particular importance, as the wetlands have been consistently pressured since the Soviet Period; in the Ararat Plain they have declined from 31,000 ha down to about 20,000 ha (Aghababyan 2011). Meanwhile, these wetlands host numbers of breeding waterbirds including some globally and nationally endangered bird species, such as White-headed Duck (*Oxyura leucocephala*), Ferruginous Pochard (*Aythya nyroca*), Common Pochard (*Aythya ferina*), Northern Lapwing (*Vanellus vanellus*), and others.

Methods

During 2005 the nests of storks were inventoried and then monitored annually, from March till September, between 2006 and 2016. The study area covered the Armenian regions of Ararat, Armavir, Aragatsotn, Yerevan, Lori, Shirak and Vayots Dzor provinces (see Figure 1). Data collection involved 284 expeditions lasting a total of 536 days. In total, we visited 245 locations, and detected nests in 116 of them.

In total, data on breeding pairs and nest outputs were collected from 1,026 stork nests, as in many areas the storks often change their nesting sites, build new nests, and abandon some others. In addition during the study period some nests were lost due to fire and wind, which also caused pairs to relocate. The data were collected via direct observations by our team and with the assistance of village inhabitants, which serve as citizen scientists (people who live closest to the storks' nests; hereinafter they are called "nest neighbours"). The nests were labeled with individual numbers and the nest neighbours were encouraged to provide quick feedback on every unusual occasion — e.g. construction of new nests in the village, storks' injury cases and so on.

Such a system of data collection enabled all the known nest sites to be under observation every

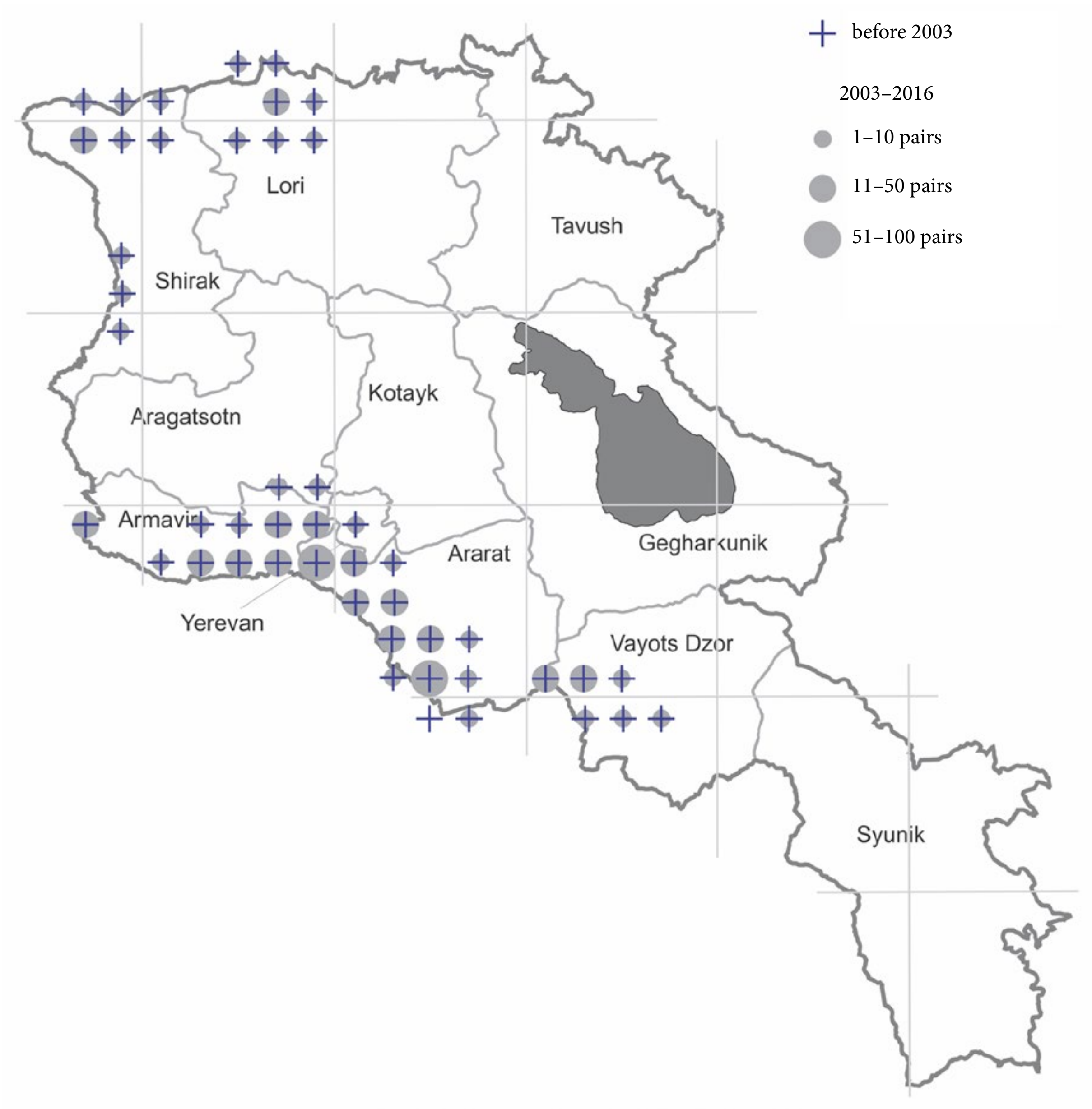

Figure 1. Distribution of the White Stork in Armenia

year; in addition our team travelled the same routes to secure the recording of newly constructed nests. Thus annual censuses of the number of storks in Armenia were based on absolute counts of occupied nests.

For every nest we recorded the following data:

- Geographical coordinates using GPS units.
- Location of the nest, e.g. located on ordinary pylons or high-tension electricity pylons, building roofs, trees, waterworks, statues, and cranes (done once during mapping the nests between 2005 and 2009).
- Data about the nest neighbours, i.e. names, surnames, and phone numbers (done once when the nest was found).
- Number of adult storks occupying the nest, number of nestlings and number of fledglings (recorded annually).
- Accidents that happened to nests were specified with the help of nest neighbours, who also recorded the causes of nest destruction (wind, nest burning by electricity wires, etc.), falling of nestlings and eggs from their nests, deaths of adult storks, etc. (implemented yearly).
- Records of the cases of conflicts between storks and people in the village (implemented yearly).

The data collected by researchers and students were recorded on special forms, while the ob-

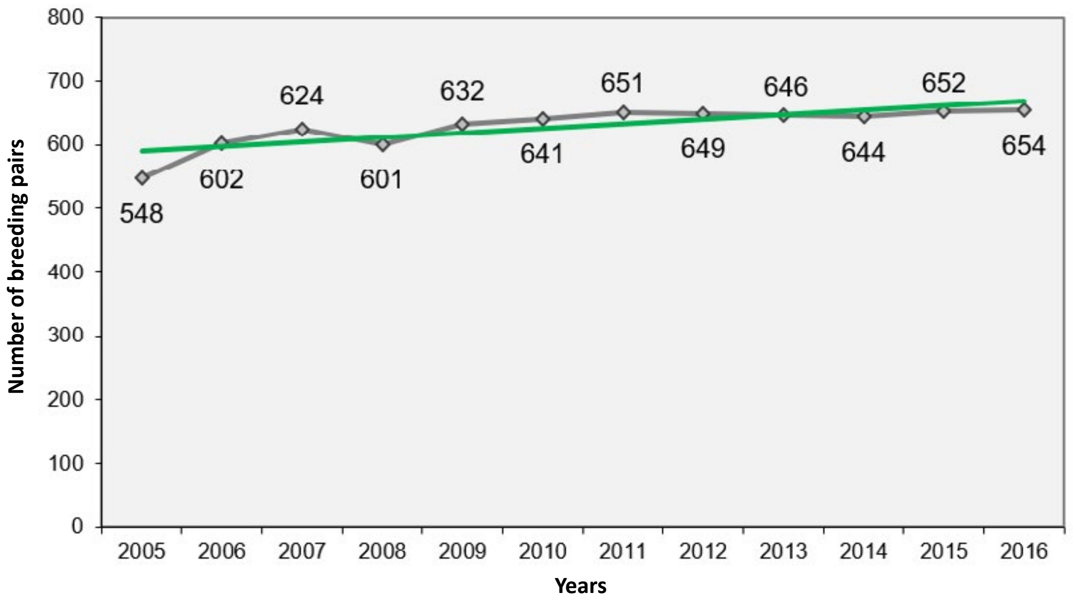

Figure 2. Population trend of the White Stork in Armenia during 2005–2016 (breeding pairs)

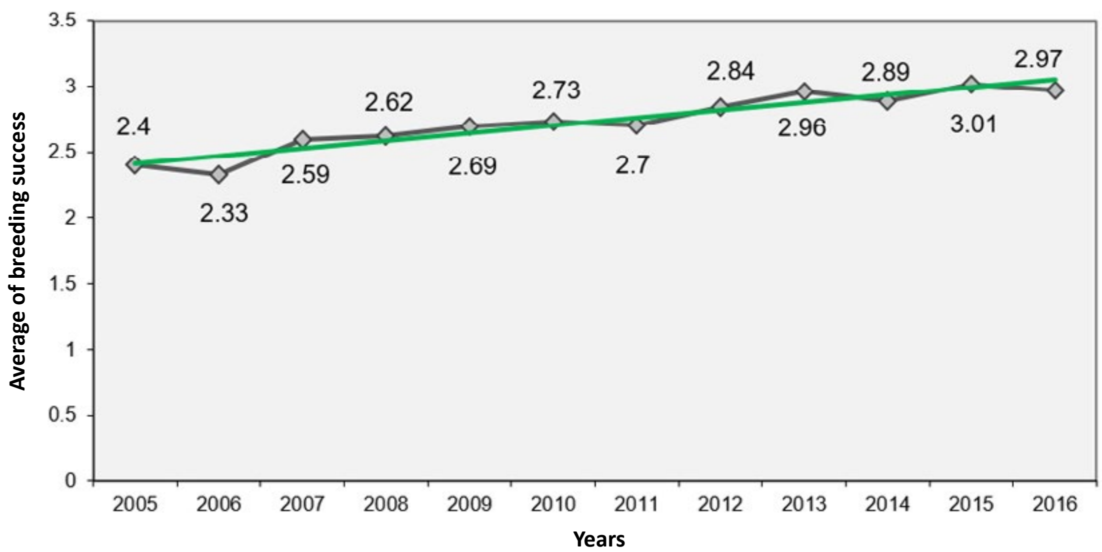

Figure 3. Mean breeding success of the White Stork in Armenia during 2005–2016

servations of nest neighbours were recorded on wall-calendars designed for the storks' nest monitoring.

The collected data were stored in a Microsoft Access 2003 database (later transferred into Microsoft Office 2010) for further data analysis. Statistical analyses were carried out with Excel 2010 (MS Office 2010) program package. The analyses include measurement of central tendencies and calculation and visualization of the trends. We calculated log-linear population growth rate during the period based on population surveys in 2005 and 2016. Mapping was conducted with ArcMap GIS 10.1 (ESRI, Redlands, CA).

Results

Distribution and abundance

During 2005–2016 the cumulative total of the storks' nests detected in Armenia was 1,026; located in Ararat, Armavir, Vayoc Dzor, Shirak, Lori, Aragatsotn and Yerevan provinces of Republic of Armenia (see the Figure 1). However, not all these nests were occupied every year. The population increased from 548 pairs in 2005 to 654 in 2016; the annual growth in breeding numbers is shown in Figure 2. The population growth from 2005 to 2016 was 19% and thus, on average, 1.6% per annum.

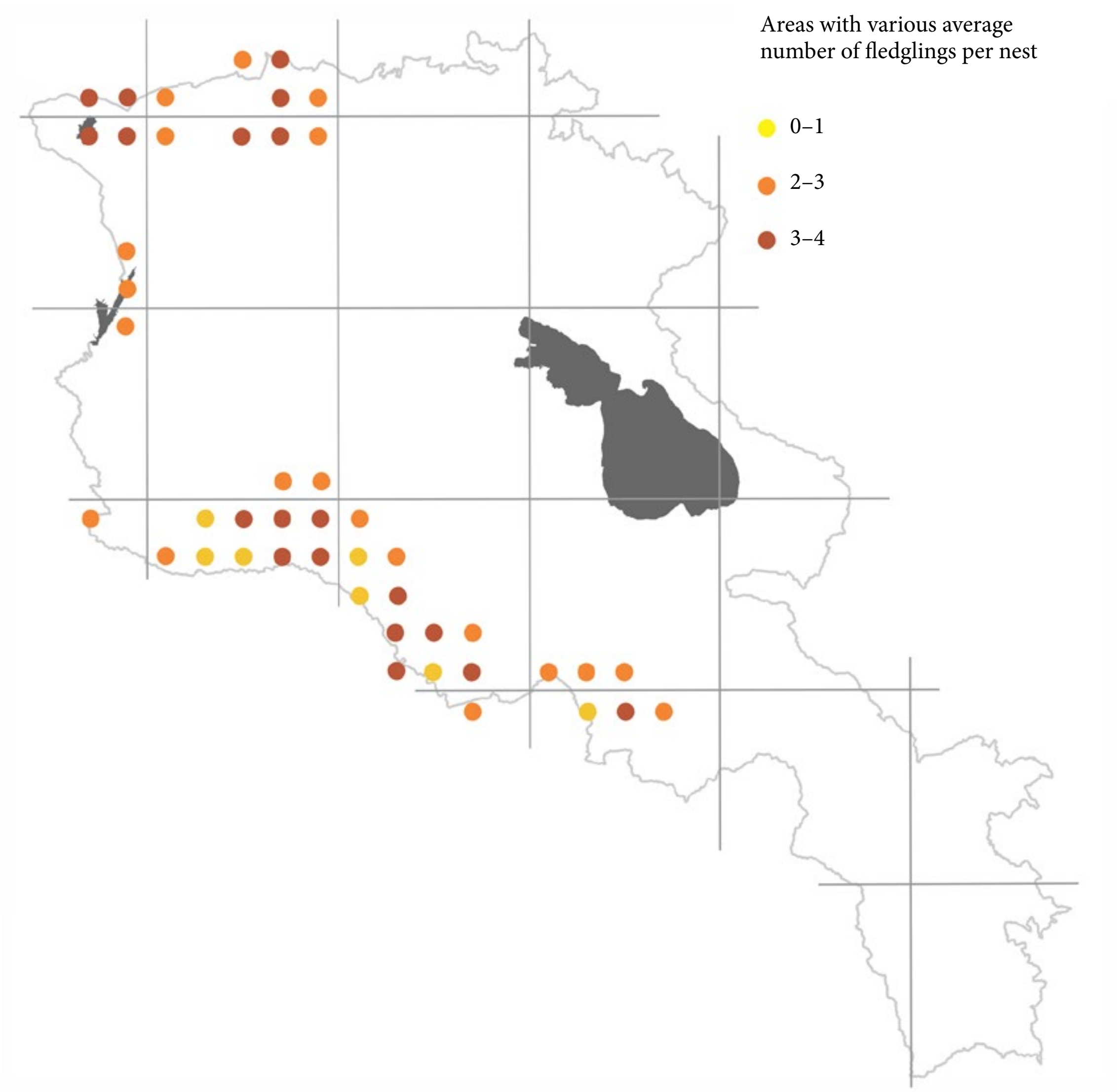

Figure 4. Areas with low White Stork productivity in Armenia during 2005–2016.

Prior to our investigations, storks were surveyed in Armenia in 1984 (Adamian 1990). Figure 2 demonstrates a moderate increase of the population during 2005–2016, but the data from 1984 suggests there had been a decline between 1984 and 2005. However, the methods used in 1984 were different than in our study and thus the apparent decline may be an artefact of this change (see Discussion section for details).

The storks are not uniformly distributed through the republic. Most of the nests are situated in the Ararat valley (562 pairs in 2016, 86%), while small subpopulations are found in the Shirak (32 pairs, 5%) and Lori (44 pairs, 7%) plateaus and Arpa river valley (16 pairs, 2%).

The average breeding success (number of fledglings per occupied nest) has also increased through our study period (see Figure 3). Unfortunately, the historical data on the number of storks' nestlings (Adamian 1990) is more descriptive rather than quantitative, and cannot be used for comparison with our study.

The breeding success has increased due to a rise in the proportion of nests with 4 fledglings, and a decrease in the proportion with 2 fledglings. Breeding success varied spatially, with the areas of lowest productivity being in the south (Figure 4).

Nest locations

In Armenia storks place their nests on electric pylons, roofs, trees, and sometimes even on monuments and on non-working tower cranes. Data for 993 nests available by the end of 2009 (see Table 1) shows that storks mostly bred on various types of electric pylons (82.4%): these included regular wood and concrete pylons, pylons of railway stations and high voltage iron pylons.

Table 1. Nest locations of the White Storks in Armenia in 1984 and in 2005–2009 (from Aghababyan 2011)

Nest location	1984 (Adamian 1990)		2005–2009 (Aghababyan 2011)	
	Number	Percent	Number	Percent
Water cisterns			8	0.8
Building tower cranes			5	0.5
Roofs of newer buildings	142	21.3	113	11.4
Pylons	335	50.1	818	82.4
Monuments			5	0.5
Trees and abandoned buildings	191	28.6	44	4.4
Total	668	100	993	100

Table 2. Number of damaged nests per year

Year	Total number of damaged nests	Number of nests destroyed by wind	Number of nests destroyed by fire
2005	25	20	5
2006	37	29	8
2007	35	27	8
2008	39	30	9
2009	42	33	9
2010	37	29	8
2011	40	30	10
2012	44	35	9
2013	39	31	8
2014	35	24	11
2015	41	32	9
2016	36	26	10
Total	450	346	104

The second most frequently used nest locations are roofs: storks place nests on roofs of schools and local administration buildings (usually the tallest buildings in a village), as well as on roofs of private houses.

Comparison of our data with data collected in 1984 (Adamian 1990) suggests that over the years storks have shifted their preferred nest locations from roofs and trees to pylons (Chi-square statistic $\chi^2 = 66.115$, $p < 0.00001$, n = 668 in 1984, n = 975 in 2005–2009). Nest sites on pylons are vulnerable to fire (due to short circuits) or wind. During 2005–2016 we recorded 450 cases of nest damage (see the Table 2) caused by wind and fire due to short circuits.

Discussion

Tendencies and their explanation

A comparison of data from 1984 and the 2005–2016 period may suggest that there was a decrease in the breeding population of storks in Armenia after 1984, and an increase from 2005 to 2016. However, this decrease may be not genuine, but due to differences in the methods used for data collection. The 1984 study (Adamian 1990) it was conducted by questioning via post: the author sent a simple questionnaire by post with a request to fill them out and send back. Using this method, it is hard to avoid duplication of the data: the 1984 population may have been overestimated. The study of 2005–2016 was done by mapping and providing individual numbers for the nests, which meant that there was no duplication and very low possibility of missing a nest.

The breeding success of storks increased in parallel with the moderately increasing population trend over our 2005–2016 study period. These patterns are probably related to the following factors:

1. From late 1990s – early 2000s there was a continuous increase in the number of fish and poultry farms on the Ararat Plain (e.g. the

largest poultry farm "Araks" was launched in 1997). These farms have poor waste management, and the waste from slaughtered and gutted fish and poultry provides a significant food supply for storks.

2. The increased number of fish-farms has been enabled by pumping deep artesian water from underground; the subsequent release of this water into natural ecosystems has created additional canals, streams, and wetlands and thus created foraging habitat for the storks. The number of fish-farms in Armenia increased from 35 in 2000 to 250 in 2014 (Aghababyan & Khanamirian 2014).
3. There is no limitation in nesting places, since Ararat Plain has high density of settlements, with appropriate infrastructure: pylons, buildings, and so on.
4. The new food supply options at the fish and poultry farms are available throughout the winter, which has supported an increased number of wintering storks of up to approximately 250 individuals per winter (Aghababyan *et al*. 2013), and therefore reduced incidence of mortality on migration.

Conservation Measures

The IUCN Global Red List status of White Stork is Least Concern (BirdLife International 2016), and the last assessment of its National conservation status also qualified it as Least Concern (Aghasyan & Kalashyan 2010). Nevertheless, the species is included in Appendix II of Bern Convention (ETS No.104). At present the breeding populations of the species are protected in Lake Arpi National Park and Gnishik Community-managed Protected Landscape. In addition, a number of the wetland areas in Ararat Plain and lakes in Lori Province have been proposed to be included in the Emerald Sites protected under Bern Convention (Fayvush *et al*. 2016). Even taking the recent increase of population into consideration, there are two threats that the local groups of storks face: first is related to human-wildlife conflicts, and second to the uncontrolled use of pesticides.

Human — Stork conflicts

By building nests on roofs storks can cause serious damage to houses, since they generally place nests on drainage system pipes which then become blocked. As a result, moisture accumulates in the walls, causing damage to homes; eventually this results in conflict between human and the storks. It should be mentioned that although local villagers are displeased by such harm, they avoid destroying nests, being under idea of "damnation for the nest-destroyers". Thus, in this case people suffer damage but cannot take measures to eliminate its source. To solve this dilemma we have suggested use of special constructions to house nests, which will help to preserve the nests, located on the roofs of buildings and at the same time preventing damage to buildings. The nest platform programme is an essential step to improve relationships between humans and storks (Ilichev 1990). These positive steps will lead to the restoration of storks to their status as a cultural symbol and to create a conservation model based on an ethical and respectful attitude of humans toward nature (Borejko & Grishenko 2004).

Nest damage also happens to nests located on pylons, due to fires caused by short circuits. Such cases destroy nests (often with nestlings) and cause problems for the Electricity Company. The solution is in building another type of platform on pylons, which can help to isolate nests from the wires and eliminate the risks. The relocation of the nests on such pylons is profitable for the company in a long-term perspective and beneficial for storks.

Pollution

During this study some areas with low breeding success were recorded (see the Figure 4). Sampling of the soil in those areas showed relatively high concentrations of DDT, DDD, DDE, Dieldrin, and Hexachlorobenzene in the soil; the low breeding success of storks may be related to the high concentration of these persistent organic pesticides, which are well known in this regard (Peakall 1970). Although DDT is officially banned in Armenia, its remains can stay in the soil up to 30 years (World Health Organization 1989). Flooding can stimulate the inclusion of DDTs derivatives into a new cycle of the trophic chain. Our survey showed that in areas with low reproductive success farmers have been irrigating land using flooding.

As it was mentioned above, storks can suffer from Persistent Organic Pesticides. It is also possible that they suffer from the other pesticides, e.g. pyrethroids. Thus, the monitoring of the storks can help in revealing the possible effect of use of the pesticides on the species and therefore on the ecosystems (Cox 1991). Another potential pollutant which can significantly impact storks is lead pollution (Haig *et* al. 2014). Hunting may introduce lead into wetland ecosystems, since in Armenia shooting with lead ammunition is allowed. Over 47,000 ha of official hunting lands are located in Ararat Plain and are visited by at least 10,000 hunters per year (Sevak Baloyan, Bioresources Management Agency, personal communication), so lead pollution could become another significant threat for the local wildlife; however, this issue requires further investigation. Taking the current population increase into consideration, the White Storks can still be considered as Least Concern, and doesn't require any specific conservation measures. However, since the species is a good indicator of wetland ecosystems it is necessary to continue the monitoring of storks in Armenia, especially with regards to the potential impact of various pollutants. Such monitoring, which continues thanks to the network of nest-neighbours, can be an integral component of the management plan of Emerald Sites, like Lake Arpi, Armash, Metsamor, Gnishik, and others. Needless to say that monitoring of the storks across a extensive network of rural communities has a significant educational value. Thus, the stork serves as a flagship species which supports protection of wetland habitats and their endangered biodiversity.

Acknowledgements

We are greatly thankful to: Whitley Fund for Nature, which supported the project by Whitley Award donated by The Friends of Whitley and further — with Continuation Funding; European Bird Census Council for support of general bird monitoring in frames of European Breeding Bird Atlas 2; and Ministry of Nature Protection of the Republic of Armenia for administrative support. Also, we are especially thankful to over 1,000 residential families in the villages of Ararat, Armavir, Lori, Shirak and Vayots Dzor provinces, for their consistent efforts on monitoring White Storks in Armenia.

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Received: 6 October 2019
Accepted: 3 November 2019

Bird Census News 2019, 32/1–2: 11–16

The State of Bearded Vulture, *Gypaetus barbatus* in Armenia

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Abstract. The last update of the conservation status of the Bearded Vulture (*Gypaetus barbatus;* Linnaeus, 1758) in Armenia was undertaken in 2009 for the appropriate edition of Red Book of Animals of Armenia (2010), using data collected in the period 2003–2008. Here, over ten year later, we provide an update on this conservation status using data collected between 2009 and 2019. Results show that the species'population is now 11–12 breeding pairs; there has been a slight increase in the population. The annual breeding success, measured as fledglings per occupied nest, ranged between 0.86 and 1 (mean = 0.96 ± SD = 0.054) during 2003–2019. Current threats are related to direct persecution for trophies or for keeping as pets; poisoning by heavy metals at municipal dumps is also a potential threat. The proposed conservation measures include (1) a change in policies governing the possession of trophy specimens and captive breeding, particularly the requirement for an inventory of all existing specimens and the introduction of obligatory procedure of issuing a certificate of origin for each new specimen; (2) increase of punishments for illegal shooting or trapping; (3) strengthening of the inspection body to improve control; (4) improving public outreach aimed at raising the value of this species nationwide; (5) improving waste management. These measures should be accompanied by species monitoring.

Introduction

Armenia is a relatively small (29,743 sq km), landlocked mountainous country, where elevation varies from 375 to 4090 m above sea level. Such large range in elevations creates various climatic conditions and therefore many different landscapes, including semi-desert, juniper woodland, deciduous forest, mountain steppe, and sub-alpine area. The terrain is rigorous containing number of deep canyons, cliffs, and rocky outcrops (Aghababyan *et al*. 2015). The fauna is rich, including number of ungulates, such as Bezoar Goat (*Capra aegagrus*), Armenian Mouflon (*Ovis ammon gmelini*), Roe Deer (*Capreolus capreolus*), and Wild Boar (*Sus scrofa*). Therefore, the region is quite sufficient for Bearded Vultures (also known as Lammergeyer), which find here both food and nesting places. The Bearded Vulture is distributed across the mountainous regions of Eurasia and in Eastern Africa, however its density can be quite low in some areas (Orta *et al*. 2019). It is classified as Near Threatened in IUCN Global Red List, with a decreasing population trend, and a global population of 1,300–6,700 mature individuals (BirdLife International 2017). Within Europe the situation of the species is worse: it is classified as Vulnerable with a European population varying from 1,200 to 1,600 mature individuals (BirdLife International 2015a).

The Bearded Vultures in Armenia is inhabited by subspecies *G.b. aureus* Hablizl, 1783. Among the four species of Old World Vultures inhabiting Armenia (Adamyan and Klem 1999, Cramp and Perrins 1993), the Bearded Vulture remains one of the most difficult for study and conservation, on account of its huge territories, hardly accessible breeding areas and nests, slow maturation, and narrow diet. Those obstacles have resulted in only fragmentary studies on the species until 2002 (Aghababian *et al*. 2004). As a consequence, in 2002–2003 a country-wide monitoring program of this species was launched. Some preliminary results were published in 2004 (Aghababian *et al*. 2004, Aghababyan & Bildstein 2004) and have been used for Red Book of Animals of Armenia (Aghasyan & Kalashyan 2010), in the assessment of Emerald Sites of Armenia (Fayvush *et al*. 2016), and for a recent multi-species action plan on the African-Eurasian Vultures (Botha *et*

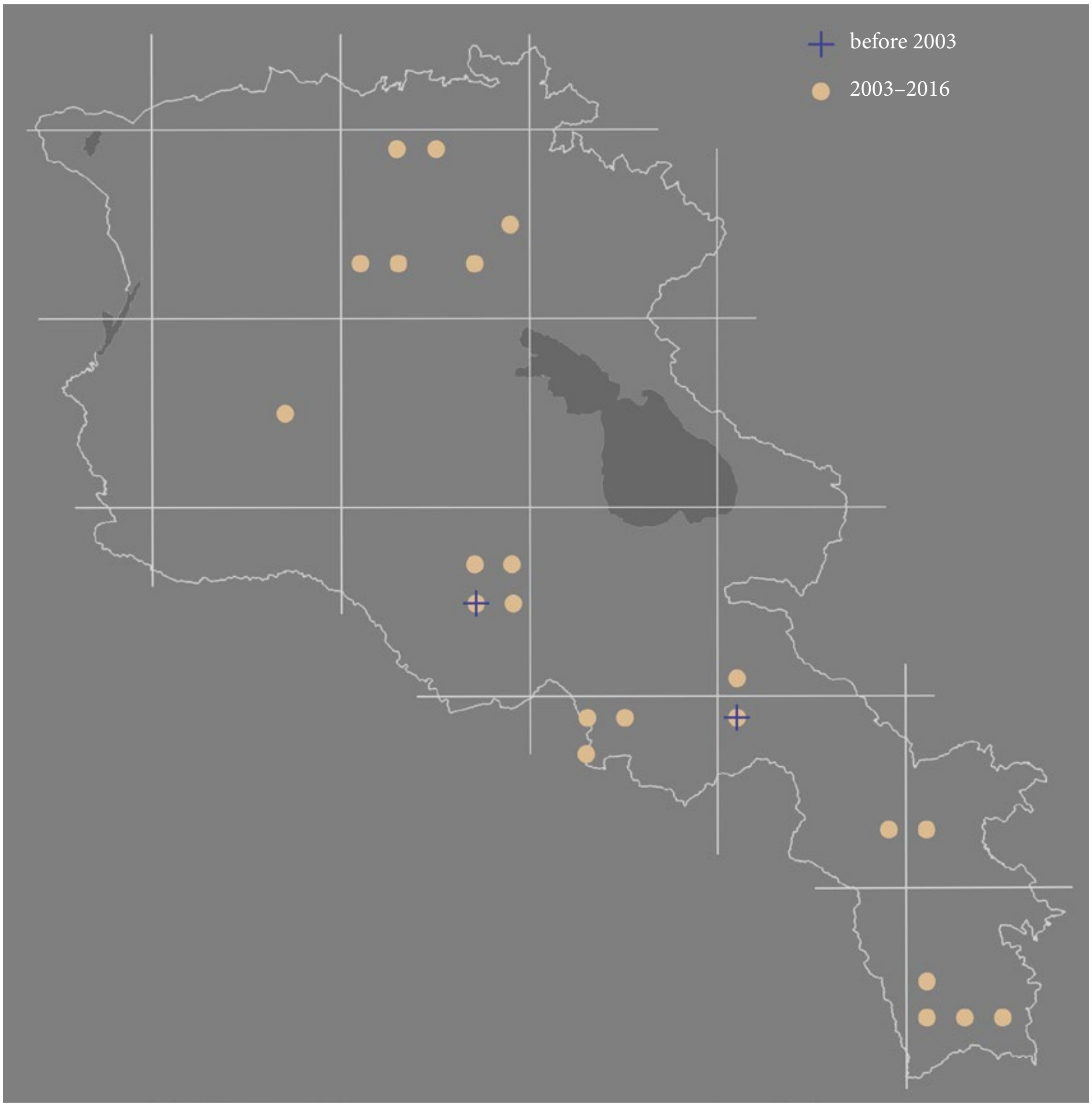

Figure 1. Distribution map of Bearded Vulture in Armenia as of 2019.

al. 2017). After over 15 years of monitoring it is timely to update our knowledge of the status of the species, especially considering the upcoming Red Book of Animals of Armenia, planned for implementation in 2020–2021. Thus, this paper is aimed at describing the population trend of the species during 2003–2019, and the status of the Bearded Vulture in Armenia, including threats and existing and required conservation measures, i.e. a foundation for the assessment of its conservation status.

Materials and methods

At the beginning of focused data collection on the species there were three known nests of Bearded Vulture in Armenia (Adamian & Klem 1999, Aghababyan 1999, Geilikman 1965). In 2002, we conducted a pilot study and located three more nests, and in addition several nesting areas were identified by behavior of the species. Subsequently, in 2003, we started systematic data collection on Bearded Vultures in Armenia. Monitoring of the species was implemented via counts of the breeding pairs through occupied nests. Also, road-side vehicular surveys were implemented aimed at estimating the number of non-breeding individuals, which have been differentiated by age and moulting patterns. In addition, we collected data on location of each nest, and to understand some peculiarities of the species' diet we have climbed to the nests of seven pairs of Bearded Vultures 12 times. In total, the study involved over 40 people who covered almost the

Figure 2. Typical habitat of Bearded Vulture in Armenia.

entirety of Armenia: the extreme north-east still requires more detailed surveying.
In order to calculate population trends, we used this multi-year data series processed using TRIM 3.0 software (Van Strien *et al*. 2004). An Index was calculated using log-linear poison regression; then the deviations were calculated and presented as a linear function, showing populations' growth or decline. Statistically significant change is stated at the $p<0.05$ level, otherwise the population is considered stable. Mapping of the population was implemented using ArcGIS 10.0 software. To estimate the threats to Bearded Vultures, we conducted surveys of hunters, and of main online and offline market places where the mounted specimens of raptors are sold; we also conducted questioning of farmers and veterinarians.

Results

Distribution and biological peculiarities in Armenia

The Bearded Vulture breeds almost throughout Armenia (see Figure 1), occupying a wide variety of open and semi-open landscapes with deep gorges and high cliffs taking the elevation range from 600 to 2,200 m a.s.l. (see Figure 2). The species usually avoids dense forests, wetlands and bogs. Bearded Vulture is a year-round resident, breeding in small caves and grottos, or on covered cliff ledges, avoiding south-facing cliffs. Usually each pair changes its nesting place within the range of two kilometers, every 3–5 years (sometimes even after 2 years). The incubation period begins in January; usually Bearded Vultures have one egg in the clutch, although cases of two eggs are known though in such cases only one nestling survives. Fledglings leave the nest in late May – early June, depending on elevation. The principal food is medium to large size carrion, which includes, but is not limited to bezoar goats, domestic sheep (*Ovis aries*), goat (*Capra aegagrus hircus*), donkey (*Equus africanus asinus*), dog (*Canis familiaris*), badger (*Meles meles*), red fox (*Vulpes vulpes*), and wolf (*Canis lupus*); its diet includes up to 85% bones. There are reports of consumption of tortoises and live mammals from the other parts of species' distribution range (Orta *et al*. 2019), but this has never been observed in Armenia.

Population dynamics

The current population estimate for Breaded Vultures in Armenia is 11–12 breeding pairs. The population trend during the last ten years shows slight increase (see Figure 3); in 2007–2009 at least one pair was added in the well-studied

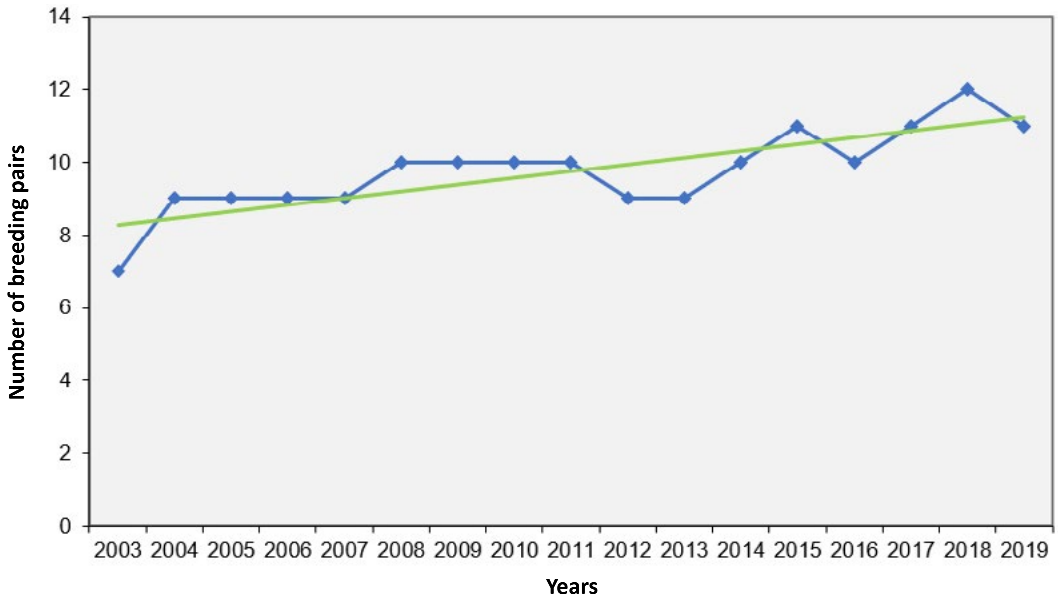

Figure 3. Graph of population dynamic of Bearded Vulture in Armenia during 2003–2019.

Southern Armenia, and in 2010–2019 at least one pair was added in Central-southern region of the country. Since 2003 the annual percentage of breeding success measured as number of nests with fledglings per number of occupied nests, has varied between 0.86 and 1, with a mean of 0.96 (SD = 0.054).

Discussion

Causes of the observed population trend

The slightly increasing population trend and relatively high breeding success are most probably related to ability of the species to find enough food throughout its breeding range in Armenia. All the visited nests were full of remains of the dead animals, and it looks like that the vultures use their nests for the storage of carrion, for consumption during periods of food shortage. During our observations of Bearded Vulture behavior during nestling rearing, very few were observed returning to the nest without food. The population increase in south Armenia, of one pair, is most probably linked to the opening of new poultry farm in that area, which produces significant amounts of waste that is not efficiently utilized. There has been a moderate increase of population of Bezoar Goats in Armenia (WWF Armenia, personal communication), which may possibly support a further increase in the Bearded Vulture population.

The observed cases of non-productive nests have occurred when one of the partners in the pair have been replaced by a relatively young bird (4 and 5 years-old). Often, in such cases, we were informed about a case of poaching in the area, and therefore it can be suggested that such replacements were the result of the death of one of the partners due to illegal shooting. In a very few cases we were informed about stealing of the nestling from a nest; we have never observed dead nestlings in the nest. Thus, it appears, that at current some threats to the breeding population are related to direct persecution for trophy specimens, or to Bearded Vultures being taken to be kept as pets. Another possible threat comes from poisoning by heavy metals at municipal dumps, because due to lack of separate garbage collection, people are disposing the batteries, mobile phones and other devices together with the food remains. Although poisoning by heavy metals from dumps was not considered in global assessment of the species (BirdLife International 2017), cases of lead poisoning of Bearded Vulture have been described from South Africa (Krueger & Amar 2018), although these incidents had another source of lead.

Present conservation measures

The Bearded Vulture in Armenia is evaluated as Vulnerable (Aghasyan & Kalashyan 2010). At current the breeding sites of the species in Khosrov Nature Reserve, Zangezur Biosphere Complex, and Dilijan National Park are protected. All the other breeding sites are included in the Emerald

Network, protected under Bern Convention (Fayvush *et al*. 2016).

Proposed conservation measures

At first, we propose that the conservation status of the species should be changed from Vulnerable to the higher one. It is fitting the criteria of Critically Endangered in accordance to IUCN criteria D1: 25 pairs or less (IUCN Standards and Petitions Committee 2019), however potentially the population also could be rescued from the neighboring countries: Caucasus part of Turkey, Georgia, Azerbaijan and Caucasus part of Iran (BirdLife International 2017), since the Georgian population is estimated as 22–25 breeding pairs and Azerbajan's population — around 30 breeding pairs (Abuladze 1998). The Turkey's total population is estimated as 160–200 breeding pairs, but there is no specific number for the Caucasus part of the country (BirdLife International 2015b).

Therefore, the conservation status is more relevant to Endangered, in accordance to criteria D: number of mature individuals is 250 or less (IUCN Standards and Petitions Committee 2019). Taking into account the current and potential threats, the proposed conservation measures for the species include: (1) a change of the policy on trophy collection and having animals as pets; in particular the introduction of an obligatory procedure of issuing a certificate of origin for every trophy or bird in captivity; (2) increase in punishments for the illegal hunting and trapping of the species; (3) strengthening of Inspectorate for Nature Protection and Mineral Resources and development of its cooperation with the Hunters' Unions in the country; (4) development of a targeted educational and public outreach program aimed at Armenian Hunters; and (5) improvement of waste management at municipal dumps. These conservation measures should be supported by continuous monitoring of the species with two purposes: (i) to track its population trend further, and (ii) to indicate the efficiency of undertaken conservation measures.

Acknowledgements

The inventory and monitoring of Bearded Vultures in Armenia as well as the study of its biological peculiarities is supported by CRDF Global and NFSAT Foundations, Natural Research Ltd., International Avian Research, Hawk Mountain Sanctuary, Ministry of Environment of RA, Inspectorate for Nature Protection and Mineral Resources, Khosrov Forest State Reserve, Dilijan National Park, Arevik National Park, and Zangezur Biosphere Reserve. Significant help was provided by the members of Armenian Birdwatching Association.

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Received: 9 October 2019
Accepted: 23 January 2020

Bird Census News 2019, 32/1–2: 17–26

Trektellen.org — Store, share and compare migration data

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Abstract: Counting migrating birds is fascinating and this is why visible migration counts, seawatch counts and nocturnal flight call monitoring are popular. Making and keeping your results available in a standardized way for research and conservation can be time consuming but it is not when you add your counts to the database of Trektellen, either at your computer or directly in the field on an app. At the moment, counts from over 1,000 migration sites from Europe (and beyond) are entered on a regular basis. In addition, hundreds of bird ringing stations and 'nocturnal migration listening stations' are sharing their daily results. Since the inception of Trektellen in 2002, over 850,000 daily 'lists' of migrants have been submitted. The data is available as an information source in different formats (graphs, maps, tables).

Introduction

Birdwatchers have been conducting migration counts for decades, but data from their efforts have been sparsely distributed and difficult to utilise before the recent time. However, new digitising tools have provided solutions for this.

Trektellen.org is an online database in which organisations such as bird clubs, and individuals, can store their migration counts in a standardized way. The website collects three types of data:

- Visible migration counts from a fixed station (like songbird or raptor migration counts and seawatch counts)
- Ringing results (only start and end time and number of birds caught are recorded)
- Nocturnal flight call monitoring

The data can be submitted both via the website or "live" from the watchpoint via a specially built Android app. The daily results are visible for anyone and can easily be compared to other watchpoints. Trektellen is a private (non-commercial) initiative of the main author of this article but has a formal relationship with organisations such as Sovon — Dutch Centre for Field Ornithology, Natuurpunt, Aves — Natagora and the British Trust for Ornithology (BTO). Trektellen is used by a wide range of institutions like bird observatories and other research and/or conservation organisations.

Introduction and history

In 2000 Gerard Troost started a local website to publish counts from his local migration site "telpost Breskens" in the southwest of The Netherlands (www.trektellen.org/count/view/1). Because Breskens is one of the best visible migration sites in The Netherlands in spring, the website attracted lots of visitors, including people from French-speaking parts of Belgium, France and even the United Kingdom. Therefore all the results were translated (daily and manually) into English, which was a very time-consuming job. After a year, a member of the local bird club, Jethro Waanders, contacted Gerard with an offer of help. Jethro had already built a first concept of a database and based on this they worked together towards the first version of the database. After successfully using the database for three local watchpoints in autumn 2002 and spring 2003, a group of sea-watchers from Le Clipon, France, asked if they could use the software too. Because the system was included into the local birdwatching website it was time for a new website and a new name: "Trektellen" it was. The Dutch word Trektellen is made of two words. **Trek**: migration, and **Tellen**: counting. From then the system could be used by any group of birdwatchers who wanted to store and share their migration counts. Since then hundreds of sites have joined the network and submitted their recent counts. In addi-

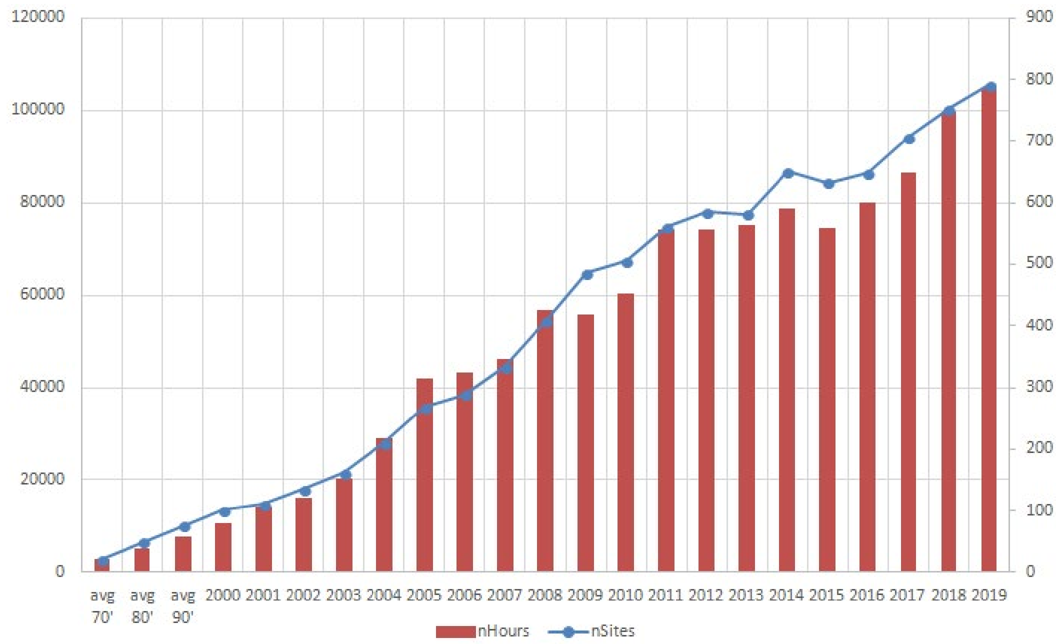

Figure 1. Number of active migration watchpoints and total number of summarized observation hours per year (for 1970–1999 the mean per year is given).

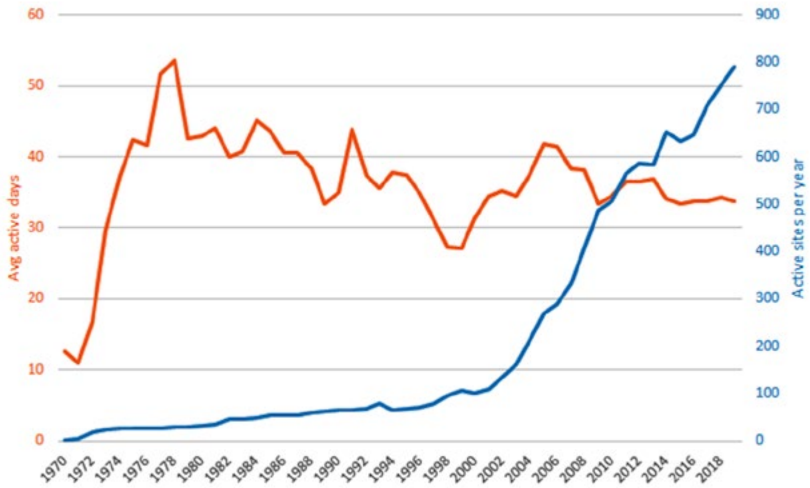

Figure 2. Mean number of days with data for a migration watchpoint and number of active sites over the last 50 years.

tion, lots of historic data has been submitted or imported to the ever growing database. Last year (2019) over 100,000 hours of migration counts were submitted from 791 sites (Figure 1). The amount of data collected each year has grown but the average days with data for an individual migration watchpoint has been more or less stable over the last 45 years (Figure 2).

At the moment the site is available in 15 languages that cover most of Europe but also areas elsewhere Bulgarian, Czech, Danish, Dutch, English, Finnish, French, German, Hebrew, Italian, Polish, Portuguese, Spanish, Swedish and Thai.

Since 2005, additional types of data — different counts — can be stored in the database. Ringing stations wanted to use the system to quickly share the daily results of their ringing sessions, and in 2018 the system was adapted to collect standardized counts of nocturnal flight call monitoring.

In Belgium, France, Germany, Iberia, Fennoscandia, United States and the United Kingdom the main coordination is done by country organizers. Outside these countries the contact is directly with the main Trektellen admin. All sites are created in the database by the national coordinator or the central admin at the request of a user. Most of the sites using Trektellen are in western Europe, although there are some sites in Eastern Europe too (Figure 3). There are approximately 15 sites in North America (not shown on Figure 3).

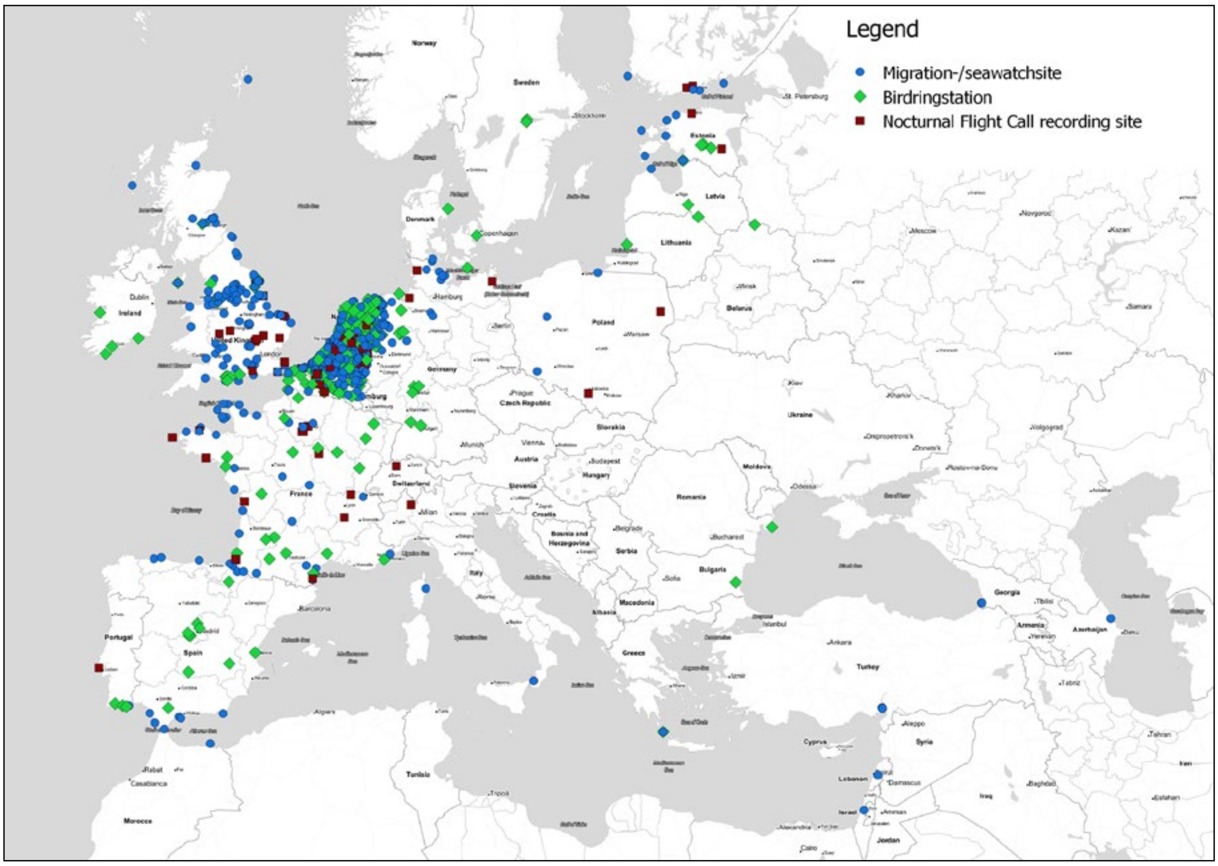

Figure 3. Migration watchpoints with a minimum of 10 days of data in 2019.

The counts in the Trektellen database are submitted via personal user accounts in the website or the app. Each user account needs to be linked to a site by an admin or site coordinator and most of the users can only submit data to one or two sites. While a site normally has multiple accounts linked to it, all users linked can edit all data from this site and the counters work together on the same dataset. For each site there can only be one count for a count period (if possible divided into small count blocks): this is an important difference between Trektellen and other bird recording portals. It prevents duplicate records of the same observation; even if there were 20 counters active at a site every bird will only be included in the count once.

Data types — migration counts

Migration counts contribute by far the largest proportion of the data in the Trektellen database. What is a (visible) migration count? During this type of count an observer counts the "visible" migration of birds whose diurnal migratory flights can be observed directly. Many bird species migrate during daytime — some of these also migrate nocturnally. In the Mediterranean countries these counts are mainly done for species like raptors and storks but in other regions a much wider range of species are counted e.g. ducks and geese, waders, swallows/swifts, pipits, thrushes, etc.

The minimum level of the collected data contains:

- the location (predefined and fixed)
- start and end time of the count (nowadays most sessions are subdivided in sub-sessions of one hour)
- type of count (sometimes only specific species groups are counted like raptors and storks)
- count for each species and main direction of flight (e.g. north- or southbound)

Besides these data a lot of extra information can be collected within the header data, such as detailed data on weather, or site-specific fields.

At the level of individual species or even individual records level very specific data can be collected, including:

- Age/sex/plumage information
- Exact flight direction

Photo 1. Seawatcher counting migration in Cape May, NJ, USA using the Trektellen App (07-04-2017, Gerard Troost).

- Distance and flight height bands (site specific)
- Exact timestamps
- Group composition

Following the introduction of an (Android) app in 2015 the number of records collected per year doubled in 5 years to over 1.5 million in 2019 (c. 774,000 in 2014), accompanied by an increase in the level of associated data.

Data types — ringing results

Many birds, such as warblers, chats and flycatchers are primarily nocturnal migrants. Their journeys begin after dusk, and usually finish well before dawn so it is impossible to count them during visible diurnal migration. Much of what we know about their movements comes from ringing phenology and subsequent ring recoveries. A lot of ringing stations catch birds in a standardized way (Constant Effort) because they always use the same length of nets. The number of caught (or re-captured) birds per metre of net is indicative of the number of (migratory) birds in the area of the ringing site. Sometimes tape recordings are used to lure and attract birds; if used this is recorded. While most of the ringing schemes only store the ring records itself (ring number and species info) the ringing effort is often not recorded. In addition, the daily records (expressed as the number of birds caught) from individually ringing sites are rarely publicly available. In 2019 over 10,000 “lists” (from a given location on a single date) were submitted from 263 ringing sites.

Data types — Nocturnal flight call monitoring

Recording nocturnal flight calls and logging the intensity of movement and species composition at different locations provides valuable data for understanding bird movements at scales ranging from individual sites to continent-wide. These data are most valuable if some basic parameters are standardised. This datatype collects data collected via audio recording at night, with observers submitting records of the species and number of calls per species to Trektellen. Gillings et al. (2018) provide a protocol for the standardised monitoring of nocturnal flight calls, including definitions of which data should be collected. On a listening station the observer records all bird calls and analyses this recording later to deter-

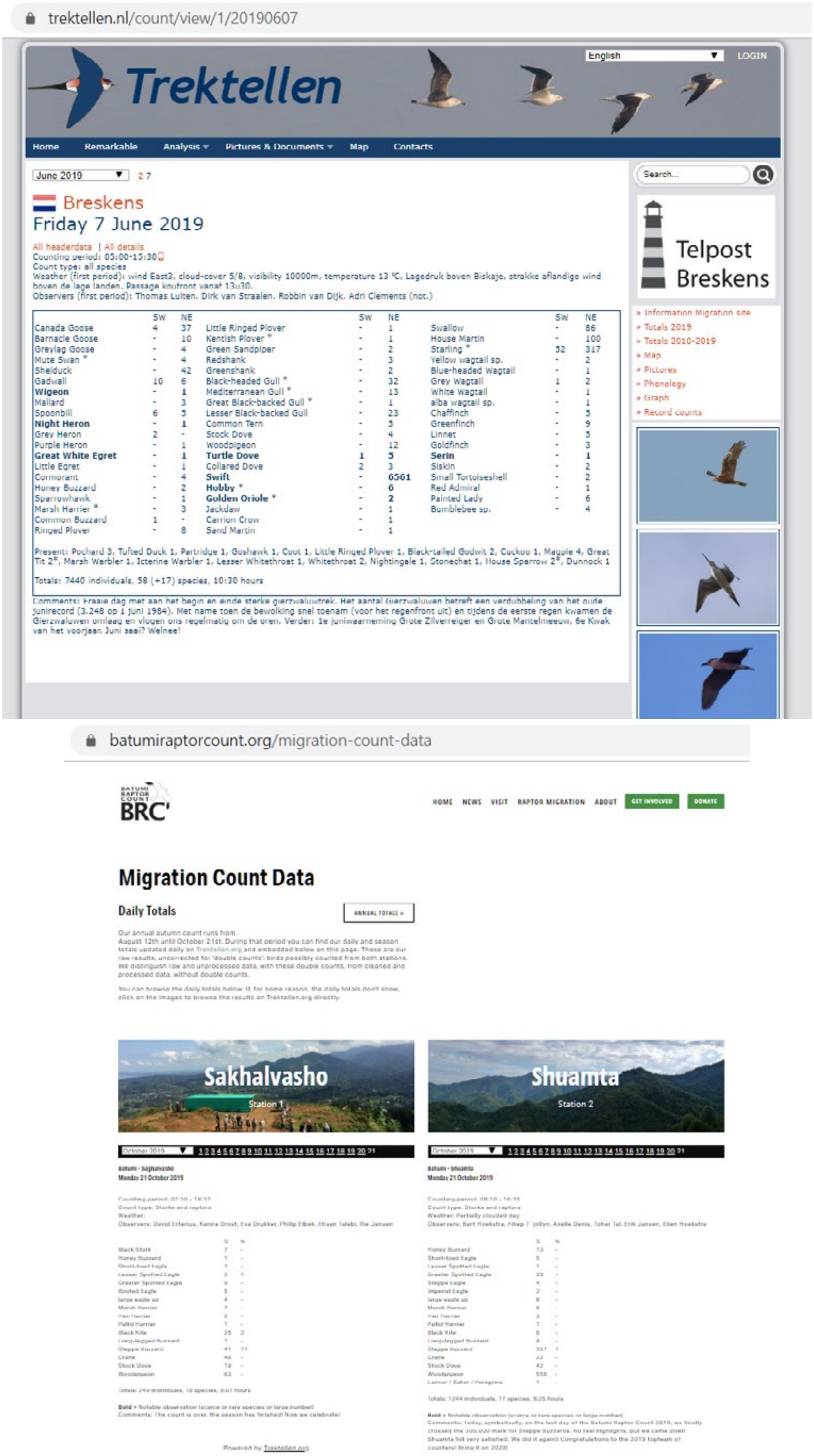

Figure 4. Daily result sheet of a single watchpoint via Trektellen.org or via a plugin included in the website of an organisation.

mine the species. The number of calls and the number of birds are submitted. In 2019 14,472 (mostly hourly) lists were submitted to Trektellen from 111 "listening stations".

Output features

The most important feature and the most visited pages of the website are the daily result sheets of individual sites (Figure 4). On days with good migration the page of a single migration hotspot may be visited thousands of times. The result sheet shows the totals per species for the selected date. For most sites, depending on the settings chosen by the coordinator of the selected site, it is possible to dig into details like age, sex and plumage, open the details to see the hourly counts, find links to photos, watch the season/year totals, etc. Plugins are available for organisations to embed the results and/or year totals live into their own websites.
Although there is no strong coordination, the standardization in the data is quite high. Most of the sites count all migrating species and if they only count a selection of species (e.g. raptors and storks) this is recorded. Because the dataset is large it is possible to visualize patterns within these three monitoring types in a variety of ways. The website has a lot of "visualisation tools" available to play with the data. In all these tools it is possible to filter on species, site, country and period (like time of the year, or between two specific dates). There are three main types of output. Table lists are used to display data for example to find the highest counts for a species / sites / country ('record counts', Figure 5) or earliest or latest date for a species in a year (phenology). It is also possible to output maps where it is possible to filter by dates, species and country (figure 6).
While lists and maps make it easy to dig deeper into the data, graphs give more information about the timing of migration. Users can choose two options to generate graphs; the default option is hourly averages, giving the mean number of birds counted per observation hour. It is also possible to choose to show totals of birds counted, but this option is less useful for comparing data because the effort is not the same at each site or in each year.
Species have different migration strategies; some are mainly seen in spring migration at given sites, others mainly during autumn: these differences can be visualised through the system. For instance, the three main movement periods for the European Starling *Sturnus vulgaris* are visible in The Netherlands (Figure 7). Trektellen also enables the comparison of phenology between sites. For example, Chaffinch *Fringilla coelebs* and Bramblings *Fringilla montifringilla* migrate on average about two weeks earlier at Falsterbo, the

#	Migration site	Totals	Date
1.	Besh Barmag	1440	30 September 2018
2.	Besh Barmag	923	24 September 2018
3.	Digue de Malo - Dunkerque (Nord, 59)	844	27 September 2016
4.	Graaf Visart (Brugge)	841	19 September 2015
5.	Castro Urdiales	760	22 September 2014
6.	Besh Barmag	760	22 September 2016
7.	De Vulkaan (Den Haag)	704	26 September 2016
8.	Cabo Roche	701	28 September 2018
9.	Digue de Malo - Dunkerque (Nord, 59)	636	13 September 2018
10.	Fonteintjes	603	9 September 2008

Figure 5. An example of the highest counts for Spoonbill *Platalea leucorodia* in the Trektellen database https://www.trektellen.org/species/records/0/0/34

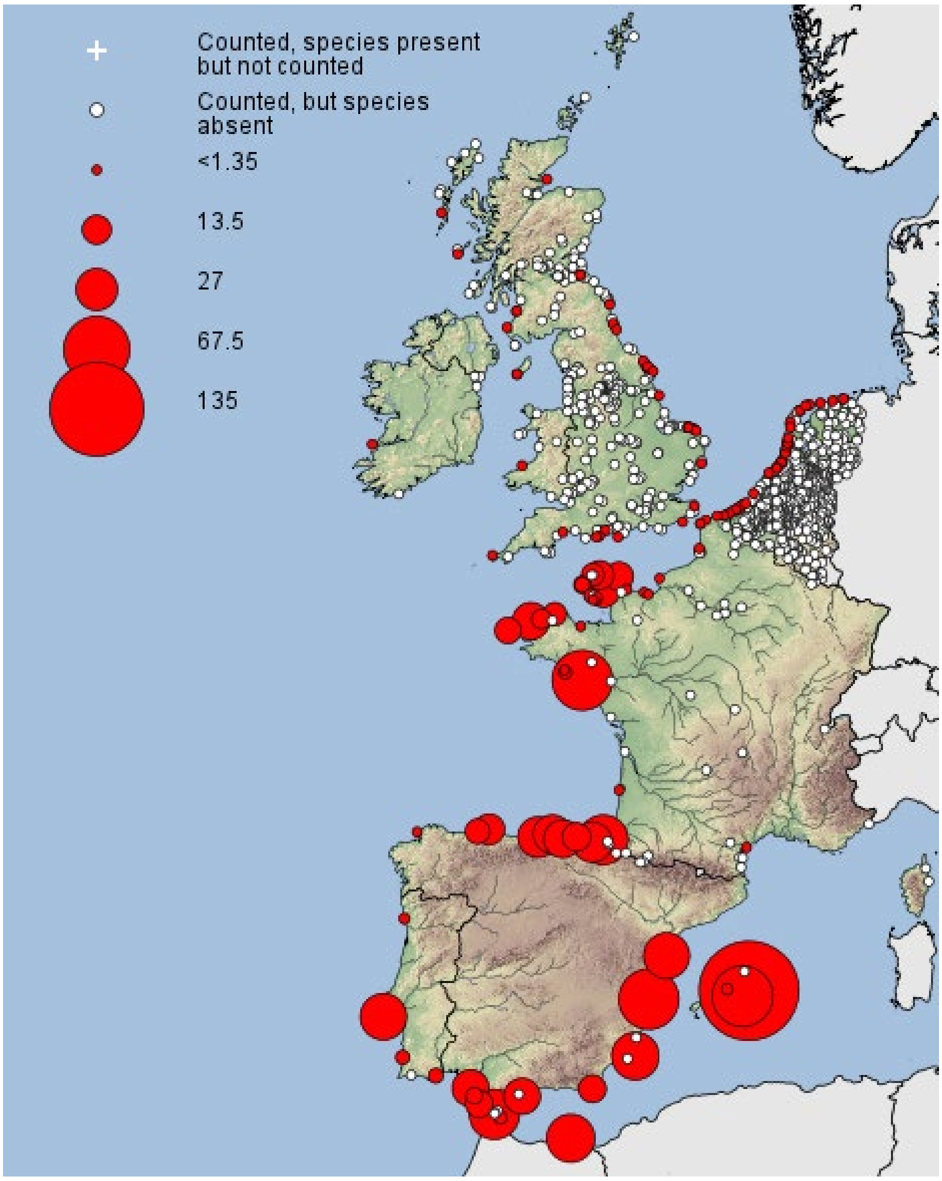

Figure 6. Map with hourly averages for Balearic Shearwater *Puffinus mauretanicus* in western Europe for the years 2015–2019 https://www.trektellen.org/maps/species/-3/-1/454/20150101/20191231/1/0

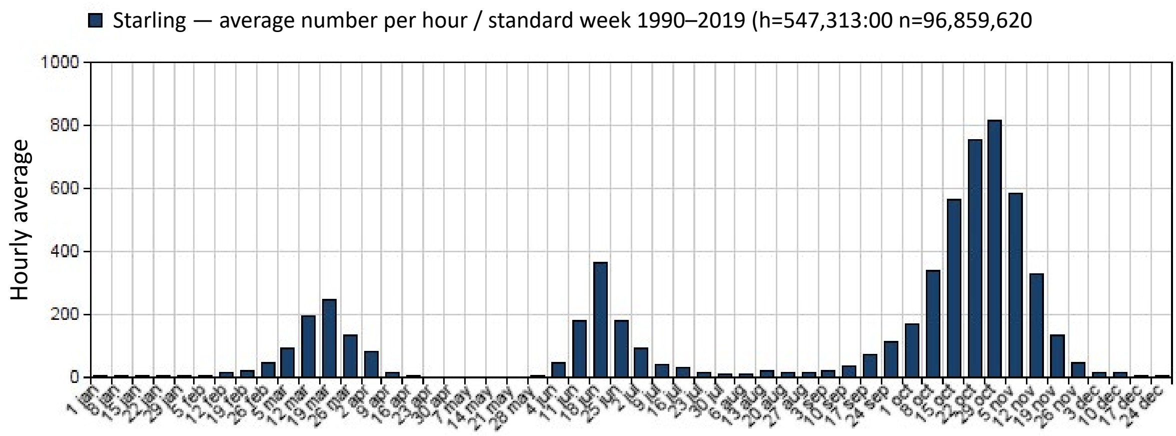

Figure 7. Migration pattern of European Starling *Sturnus vulgaris* over The Netherlands based on migration counts in 1990–2019 https://www.trektellen.org/species/graph/1/-1/397/0? jaar=2019,2018,2017,2016,2015,2014,2013,2012,2011,2010,2009,2008,2007,2006,2005,2004,2003,2002,2001,2000,1999,1998,1997,1996,1995,1994,1993,1992,1991,1990

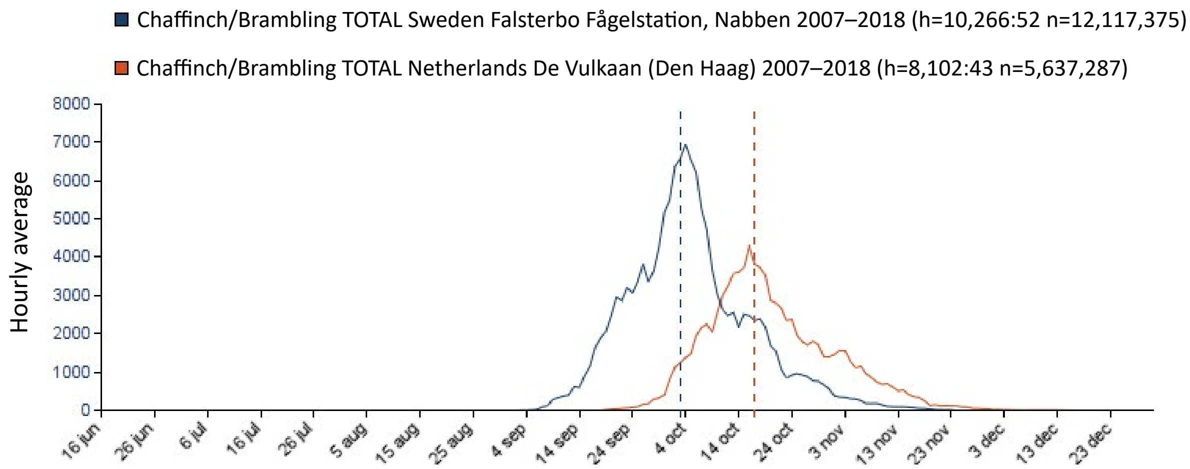

Figure 8. Timing of migrating Chaffinck/Brambling *Fringilla coelebs/montifringilla* in Falsterbo Sweden and The Hague The Netherlands (autumn 2007–2018). Median dates are 3 October and 17 October, respectively. https://www.trektellen.org/species/graph_combo/18/1/2355/28/1923/1923/-2?jaar=2018,2017,2016,2015,2014,2013,2012,2011,2010,2009,2008,2007&t=dag

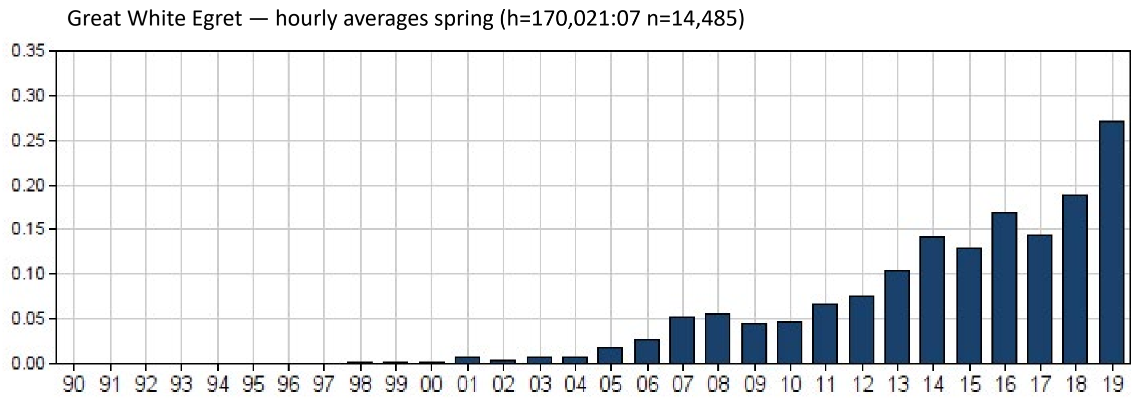

Figure 9. Hourly averages per year for Great White Egret *Ardea alba* during spring migration in The Netherlands in 1990–2019. https://www.trektellen.org/species/trend/1/-1/28/-1/0/1990/2019/

most southern point of Sweden, compared to "De Vulkaan" in the North Sea-dunes near The Hague, The Netherlands (Figure 8).

For sites with a longer period of data, the season/year totals (or average number per hour) can give an idea of the annual variation or long-term changes in abundance for a species. The graph of migrating Great White Egret *Ardea alba* in The Netherlands in spring shows that this beautiful species is now migrating over The Netherlands in hundreds (Figure 9).

Monitoring

It is great to have a lot of data in a database, but can it be used for monitoring? Raptor migration counts are a well-known source for monitoring (populations). In Europe and Asia there are several projects studying raptors in bottlenecks (e.g. Vansteelant et al. 2019) and in North America the numbers are monitored with the Raptor Population Index Project (http://rpi-project.org/technical_publications.php). For other species migration counts can also be used, for example to show the long-term changes in the timing of migration (van Turnhout et al. 2009). By combining data from both ringing stations and migration counts the selection of species that can be studied can be expanded further.

In the Netherlands, Sovon and Statistics Netherlands recently started to use Trektellen data from a selected set of seawatch sites to calculate trends for the waterbird monitoring, both for the whole country and for coastal Natura 2000 areas. For some species the data is combined with data from other surveys, but for 173 species (Red-throated

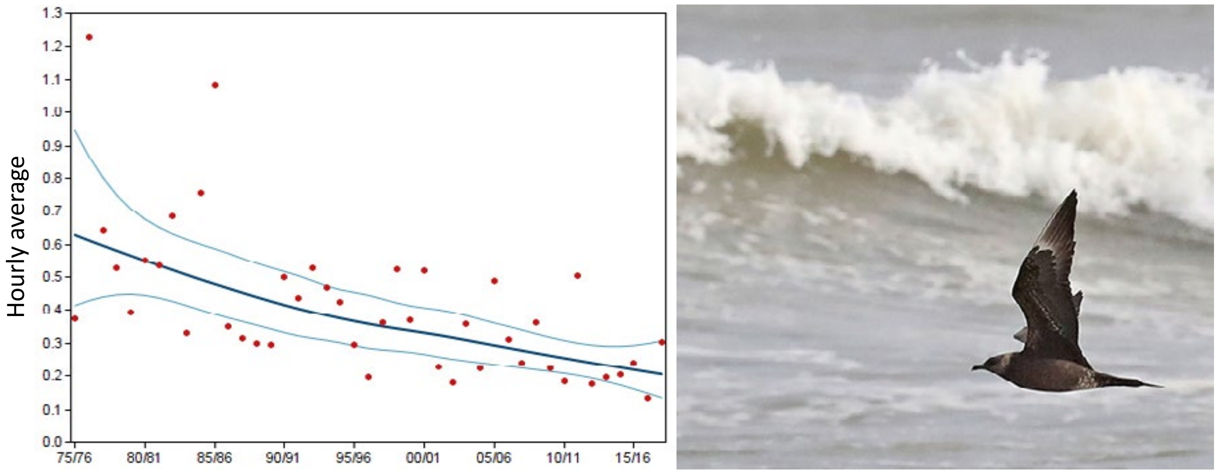

Figure 10. Trend for Arctic Skua *Stercorarius parasiticus* in the Netherlands — Source: NEM (Sovon, CBS, Trektellen). Photo: Arctic Skua (28-07-2017, Katwijk-Savoy, the Netherlands, René van Rossum)

Gavia stellata and Black-throated Diver *Gavia arctica*, shearwaters, skuas, some seaducks, and some terns) the seawatch data from Trektellen is the only source for calculating trends for these species during the season (July-June) and for an additional four species the data is combined with aerial surveys (Hornman et al. 2020). In figure 10 an example is given for the Arctic Skua *Stercorarius parasiticus* (www.sovon.nl/soort/5690).

Outlook and Acknowledgements

Desirable future developments include better protocols, and a greater focus on recording optional details like exact age/sex/plumage and flight direction. In addition we would like to work on giving Trektellen a more official status, by getting more organisations involved officially. We see no role for Trektellen itself in doing scientific analyses, but we hope that with continued increasing and broader coverage of data in the future, large-scale analyses of Trektellen data can be conducted by researchers and that our work can be a small part in the monitoring and conservation of nature.

We want to thank all volunteer counters who use Trektellen.org and add thousands of counts from all over Europe and elsewhere. Special thanks goes to the people like Adri Clements, Clive McKay, Guus van Duin and many others who help in developing and testing new features, checking data, etc. Furthermore we would like to thank the country organizers: Koen Leysen and Rudi Dujardin (Belgium), Nicolas Selosse (France), Kees Koffijberg (Germany), Annika Forsten (Northern-Europe), Xulio Valeiras (Spain, Portugal), Clive McKay (United Kingdom, Ireland), Tom Reed (USA) and Simon Gillings (nocturnal flight call monitoring).
Trektellen.org, a private, non-commercial initiative of the first author, gets support from Sovon — Dutch Centre for Field Ornithology (Sovon.nl) which generously makes their data servers available for Trektellen. Besides this, some financial support is provided by Natuurpunt Studie (Natuurpunt.be) and Dutch Birding Association (Dutchbirding.nl). We are glad to have a good relationship with a wide range of institutions like bird observatories and research and/or conservation organisations.

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Received: 4 January 2020
Accepted: 13 February 2020

Bird Census News 2019, 32/1–2: 27–37

Migration counts at Falsterbo, Sweden

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Abstract: Standardised migration counts have been carried out at Falsterbo in southwestern-most Sweden since 1973 as a part of a National Monitoring Scheme run by the Swedish Environmental Protection Agency. Counts are performed 1 August – 20 November by 1–2 observers. Observations start before dawn and normally continue until 2 p.m. CET. Most species are counted and juveniles are separated from adults in raptors and a number of larger species. In the order of 150 different species are counted allowing for an analysis of demographics of species and migration phenology. Large annual variations, primarily due to the weather and the production of young, mean that longer time series are needed to calculate significant population changes. In general there have been more species increasing than decreasing over the 47 years. Detailed information as well as annual reports can be found on www.falsterbofagelstation.se/index_e.html

History and methods

The Falsterbo peninsula constitutes the southwesternmost point of Scandinavia (Fig. 1). Large numbers of migrants, especially those reluctant to cross large bodies of open water, concentrate here during the autumn. The birds pass over the peninsula in a westerly to southwesterly direction towards Denmark (closest distance 25 km to Stevns klint).

Systematic counts of migrating birds at Falsterbo were carried out for the first time during 1942–1944 by Gustaf Rudebeck (Rudebeck 1950). During 1949–1960 counts were organised by the Ornithological Society of Scania. Most counts were carried out from Nabben, the southwesternmost point of the peninsula (Ulfstrand *et al*. 1974). A large number of observers took part in the counts over the years. Depending in the availability of observers, the coverage of the migration season varied between years.

In the autumn of 1973 strictly standardised counts were introduced, with Gunnar Roos as the responsible observer. The annual observation period was set to 11 August – 20 November. The observations started at about 30 minutes before sunrise every day and continued till 2 p.m. (CET). One single observer at Nabben counted the migrating birds. In 1978, the project was included in the National Monitoring Scheme run by the Swedish Environmental Protection Agency (Naturvårdsverket), and has remained there since then. All migrants were counted except Great Cormorant *Phalacrocorax carbo*, larger gulls and Sandwich Tern *Sterna sandwicensis*. These species feed in large numbers in the area, making it hard to separate true migrants. A number of species, less easy to separate, were put together in pairs: Black-throated/Red-throated Diver *Gavia stellata/arctica*, Common/Arctic Tern *Sterna hirundo/paradisaea*, Chaffinch/Brambling *Fringilla coelebs/montifringilla* and Parrot/Common Crossbill *Loxia curvirostra/pytyopsittacus*. During the first years there were also some groups of species-undetermined birds like goose sp., buzzard sp., swallow sp. etc. No ageing or sexing of the birds was carried out.

During the autumns of 1986–2000 a special study of the raptor migration was carried out by Nils Kjellén (Kjellén 1999). The observation period was 1 August – 20 November and the daily effort was from dawn for as long as significant migration was going on. All raptors were counted and, if possible, aged and sexed. Additionally, when time allowed, a number of other species were counted. Most species occurring in relatively small numbers were always counted, while for example Common Eider *Somateria mollissima* and Wood Pigeon *Columba palumbus* were registered more irregularly and common passerines were left out.

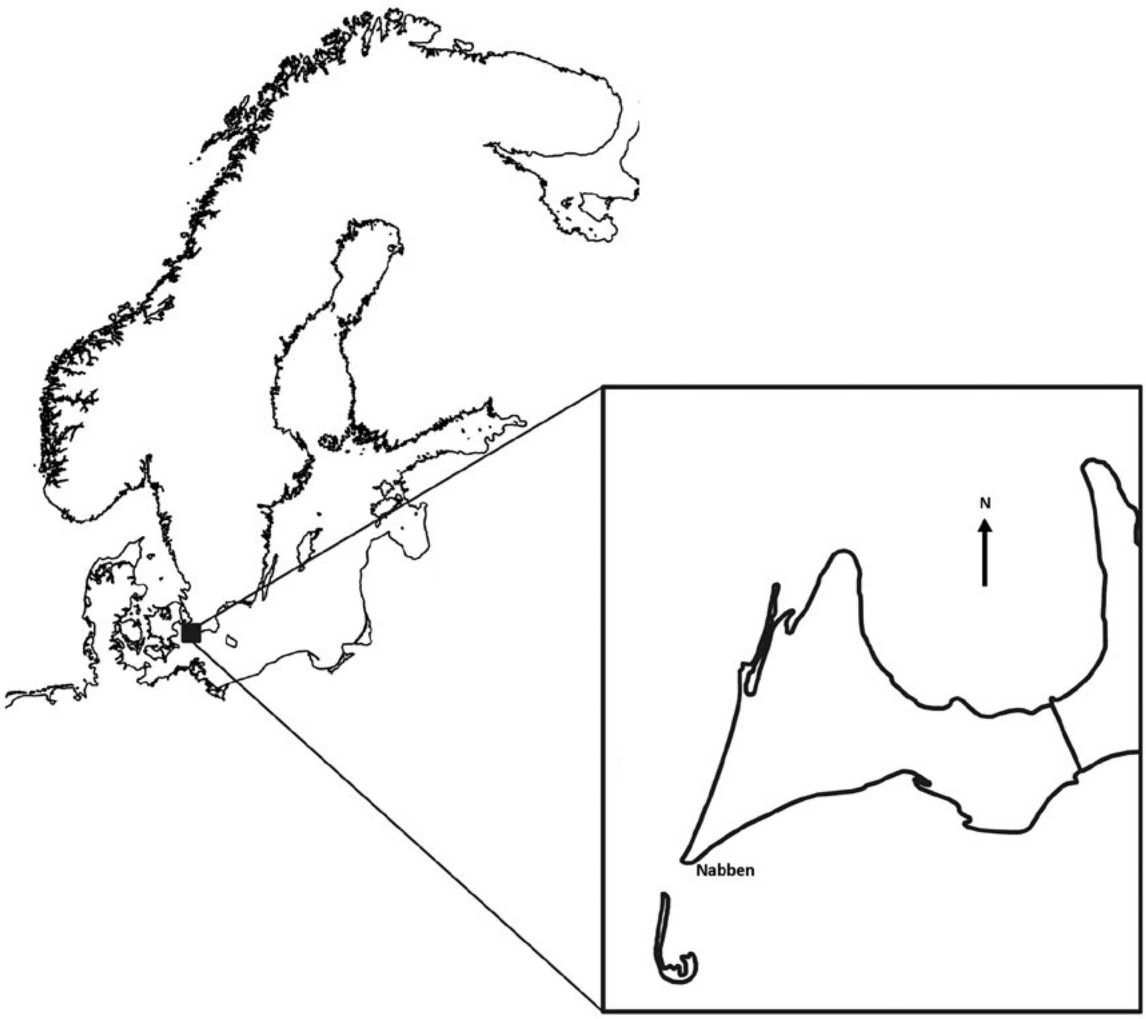


Figure 1. The position of the counting place on the Falsterbo peninsula, Sweden

In 2001 the standardised counts were slightly modified when the author took over. Since then, the counts start on 1 August and two observers work together 11 August – 10 November. The season ends on 20 November as before. All species are counted until 2 p.m. (CET), while raptors are counted for as long as significant migration is going on. Exceptionally, during bad weather conditions when no birds migrate, the counts are stopped before 2 p.m. All migrating species are counted, except Great Cormorant, Herring Gull *Larus argentatus*, Great Black-backed Gull *Larus marinus* and Sandwich Tern. A varied sample of swans, geese, raptors, cranes, gulls and terns are aged in order to get an indication of annual breeding success. The results are presented in an annual report (Kjellén 2019 and earlier reports).

In order to increase the comparability between the standardised counts carried out before and after the change, some recalculations were made. GR's counts were completed with numbers from the Falsterbo Bird Observatory log on days when the species in question was not counted by NK (during 1986–2000). The amount of additional material varies between years, but this should be of less importance in the long-term perspective view. Averages from Gunnar Roos's 1986–2000 counts were then compared to the corresponding numbers in the raptor counts. Most species, that were counted simultaneously by GR and NK show significant correlations and thus they were easy to recalculate, mainly by enumerating GR's numbers with the average difference, since the numbers in the raptor counts generally were larger. In some raptors and sparsely occurring passerines the original figures were tripled with this method of recalculation. It also includes compensation for the first ten days in August and for raptor counts continuing after 2 p.m. (CET). Other groups of species, like waders and terns, migrating already during the first ten days in August, were enumerated with the average percentages from the same period 1986–2000.

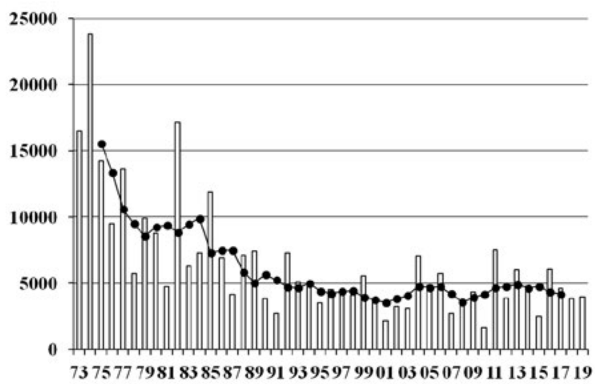
Results

Results are presented on the homepage of Falsterbo Bird Observatory: www.falsterbofagelstation.se/index_e.html. Here you can find totals from single days, years and decades. In addition, long-term trends and correlations for all but the more sparse species are depicted, along with top-ten lists of daily and annual totals. The information is updated in January each year. Also earlier annual reports can be downloaded. During the migration season in autumn daily totals of different migrants and the running annual total as well as the average from earlier years are updated every day on the national report system Artportalen: www.artportalen.se.

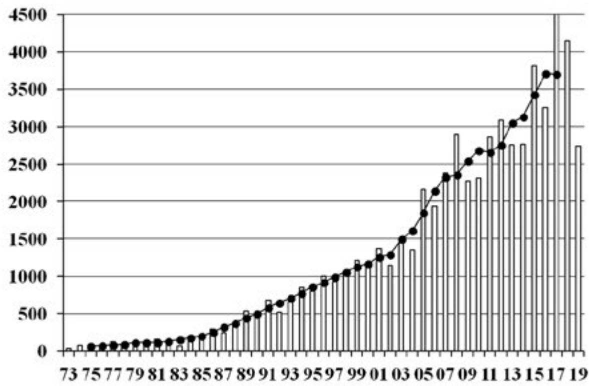
Most visitors come to Falsterbo to view the raptor migration. Compared to places like the Bosphorus and Gibraltar numbers are not as impressive, with an annual average of 46 thousand migrating raptors and falcons. The birds are however generally at a lower altitude and thus more easily studied. The most common species are Eurasian Sparrowhawk *Accipiter nisus* and Common Buzzard *Buteo buteo* with around 10–30 thousand migrants per species annually. In later years the Red Kite *Milvus milvus* has exceeded Eurasian Honey Buzzard *Pernis apivorus* as the third most common species with around 4,000 migrants. Figure 2 shows annual totals with running 5-year averages in the 16 most common raptors and falcons at Falsterbo, 1973–2019. Similar graphs of all regular species can be found on the homepage.

Compared to most other migration sites the passage of non-raptors is more impressive at Falsterbo. In the order of 150 different species are counted in numbers allowing for an analysis of the population trend. Most common is the species-pair Chaffinch/Brambling with an average of around one million annually, of which the great majority are Chaffinch. This is followed by an increasing number of Wood Pigeons, reaching one million for the first time in 2019. On the third place we find Barnacle Goose *Branta leucopsis*, which probably soon will reach half a million in a season. After this Common Starling *Sturnus vulgaris*, Western Jackdaw *Corvus monedula* and Common Eider occur in numbers close to 100 thousand annually. On a good day in the order of half a million Chaffinches or 200 thousand Wood Pigeons are counted, an impressive experience.

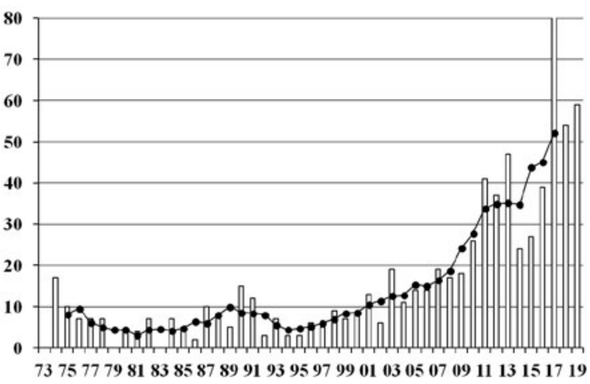
European Honey Buzzard *Pernis apivorus*



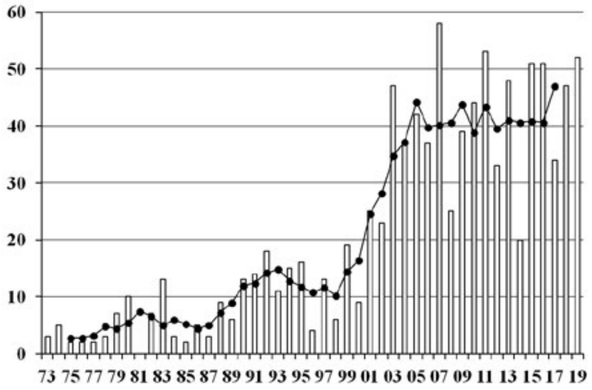
Red Kite *Milvus milvus*



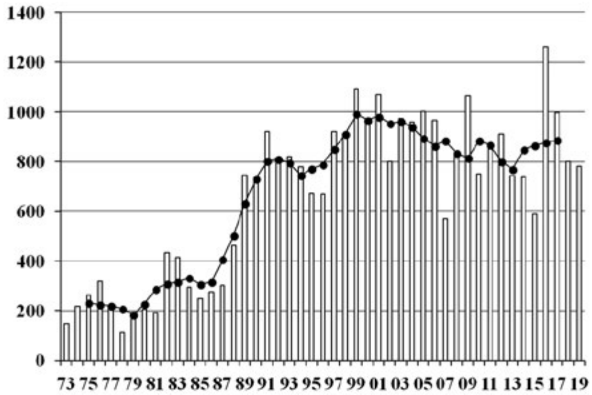
Black Kite *Milvus migrans*



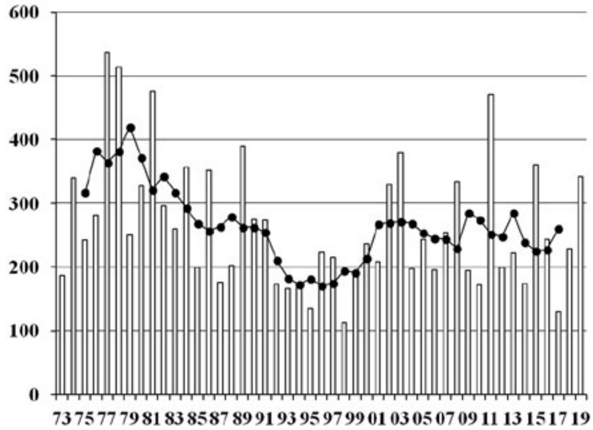
White-tailed Eagle *Haliaetus albicilla*



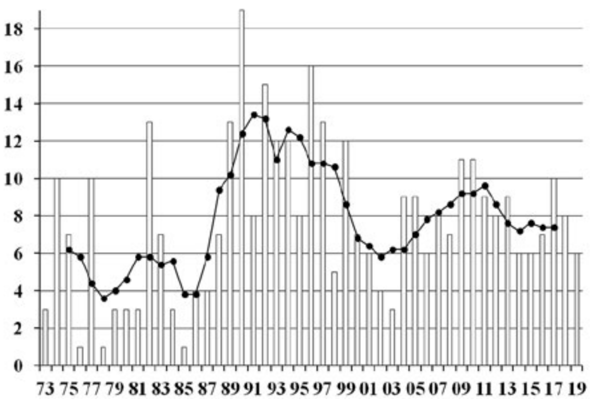
Western Marsh Harrier *Circus aeruginosus*



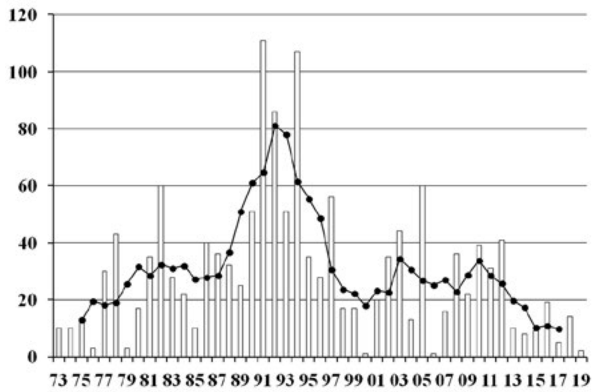
Hen Harrier *Circus cyaneus*



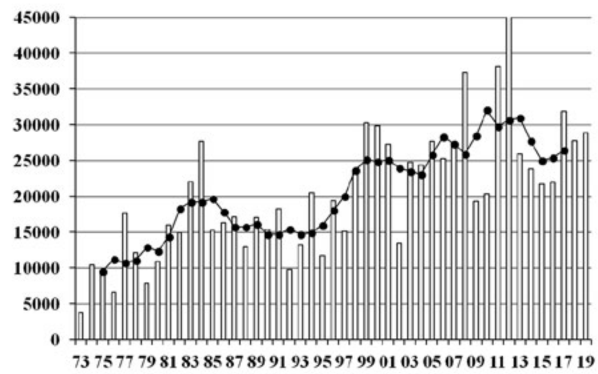
Montagu's Harrier *Circus pygargus*



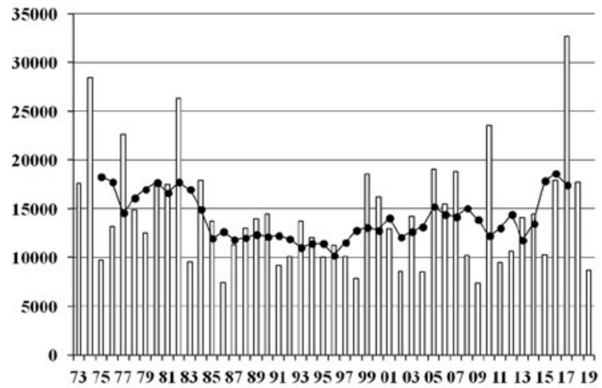
Northern Goshawk *Accipiter gentilis*



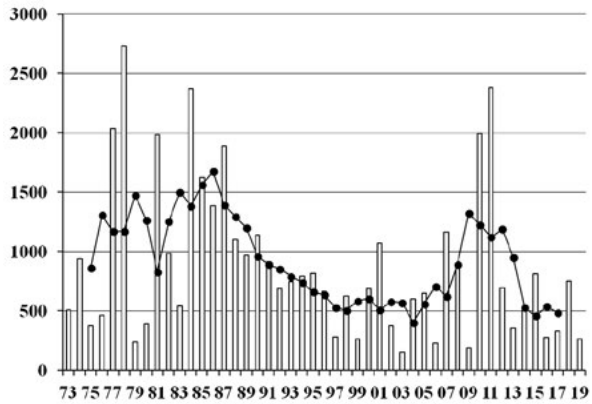
Eurasian Sparrowhawk *Accipiter nisus*



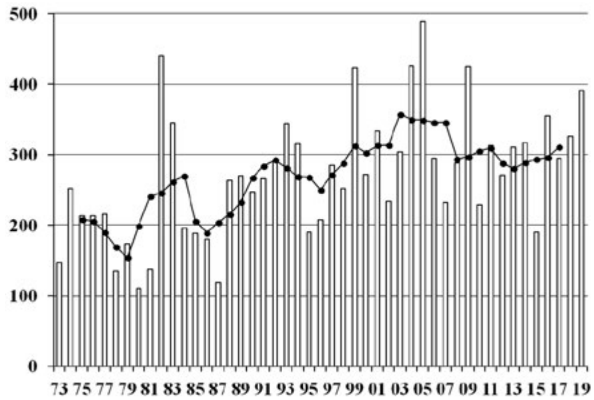
Common Buzzard *Buteo buteo*



Rough-legged Buzzard *Buteo lagopus*



Osprey *Pandion haliaetus*



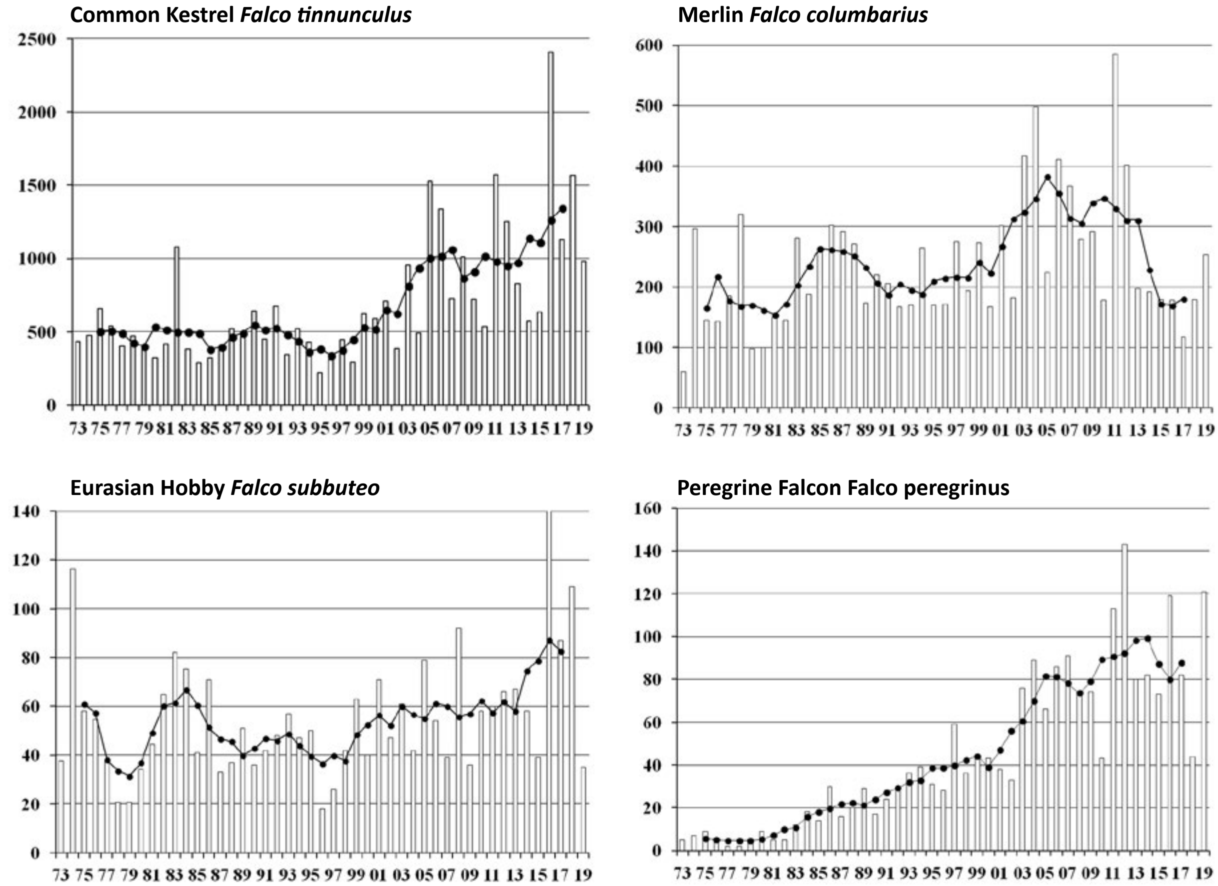


Figure 2. The migration of 16 different raptors at Falsterbo 1973–2019 with rolling five-year averages

Trends

There are two main factors affecting the numbers counted in a single year. Most important is the weather. Normally more birds are seen in westerly winds, when migrants travel against the wind and thus generally fly at a lower altitude. This makes them more visible for the observers. In easterly and in weaker northerly winds birds tend to fly at a higher altitude, making them harder to observe from the ground. The other main factor is that productivity can vary quite a lot between years in some species. For instance, raptors like Eurasian Honey Buzzard and Rough-legged Buzzard *Buteo lagopus* produce varying numbers of juveniles depending on the number of wasps and rodents respectively. The general temperature and precipitation during summer may also affect the production of young in many passerines. Thus, annual totals at Falsterbo may vary quite a lot from one season to the next. It is therefore necessary to have longer series when comparing population trends. In Table 1, the annual averages during the 47 years are presented. Also given is the trend over the whole period as well as for the last ten years. This is measured by Spearman Rank correlation. Many species have fluctuated up and down to a varying degree.

In general, there were more species with decreasing numbers from the 1970's up to the turn of the century, especially during the last decade. After this there has been an increase in the majority of migrants. In a few species this may be partially explained by a better coverage with two observers, but the general trend is similar in the Fennoscandian breeding censuses. The table shows examples of general increases (like Red Kite, Barnacle Goose and Grey Heron *Ardea cinerea*) as well as long-term decreases (for example Hooded Crow *Corvus corone cornix*, Tawny Pipit *Anthus campestris* and Ortolan Bunting *Emberiza hortulana*). Rather pronounced changes in the trend over the period are found in species like Canada Goose *Branta canadensis*, Rook *Corvus frugilegus*, Common Starling, Yellow Wagtail *Motacilla flava* and Black Tern *Chlidonias niger*.

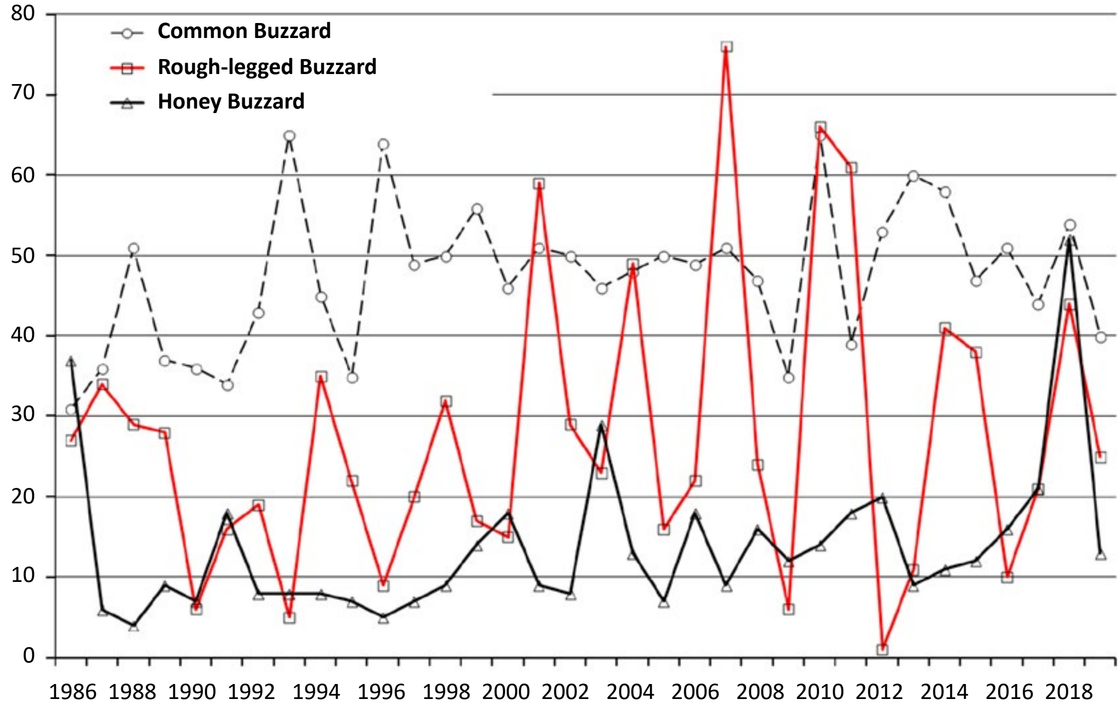


Figure 3. Proportion of juveniles at Falsterbo in Common Buzzard *Buteo buteo*, Rough-legged Buzzard *Buteo lagopus* and European Honey Buzzard *Pernis apivorus* 1986–2019

Proportion of juveniles

Since 1986 the proportion of young birds among the migrants have been studied in a number of larger species (Table 2). In general, a varying sample of migrants are aged and then unaged birds are converted according to the proportion of aged birds of the same species in different decades. In most species the proportion of young varies without any general trend. One exception is Red Kite, where an increase in proportion of adults since 1986 most likely reflects decreasing numbers of fledged juveniles per breeding attempt in the rapidly increasing Swedish population. On the other hand, it is promising to see a slightly better result over the period in European Honey Buzzard, for which a long-term negative trend has stopped the last ten years (Tables 1–2). Figure 3 shows the variation over 35 years in three species of buzzards. The annual production is much lower in European Honey Buzzard, compared to a more stable production on a higher lever in Common Buzzard. The production of Rough-legged Buzzard has much greater fluctuation than the two other species, depending on rodent numbers in Northern Scandinavia.

The concentration rate of different raptors and falcons i.e. proportion of birds migrating through Falsterbo in relation to the overall breeding population in Sweden, as well as between adults and juveniles, varies to a certain degree (Kjellén 1997). The highest concentration rate is found in Red Kite, where a majority of the Swedish population is found in Scania close to Falsterbo. In many other species a varying degree of the migrants at Falsterbo have their origin in other countries in Fennoscandia or Russia.

Timing of migration

The temporal passage, i.e. autumn phenology, at Falsterbo varies between species. One way to compare this is to talk about the median date, indicating when 50 % of the annual total has passed. In these days of climate change it is interesting to investigate if this migration peak has changed over the years. Table 3 shows the species with the most obvious change towards a later or earlier passage over the 47-year period. One general explanation may be that short-distance migrants stay longer on the breeding grounds if temperature and food availability makes this possible, with Greylag Goose *Anser anser* and Hen Harrier *Circus cyaneus* as good examples. In extreme cases, the later passage may lead to a higher proportion spending the winter north of Falsterbo, as in Whooper Swan *Cygnus cygnus* and Mallard

Anas platyrhynchos, leading to declining migration numbers. In Afro-Palearctic migrants such as Wood Sandpiper *Tringa glarelola* and Tree Pipit *Anthus trivialis* an earlier breeding due to rising temperatures makes it possible to migrate earlier in order to secure a good winter territory and/or have time for the energy-demanding moult (Jenni & Kery 2003, Lehikoinen & Jaatinen 2012).

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Received: 19 December 2019
Accepted: 13 February 2020

Table 1. Average number of migrants at Falsterbo 1973–2019 in regular species. The correlation trend measured by Spearman Rank (r) is given for the whole period as well as for the last ten years: * = p < 0.05, ** = p < 0.01, *** = p < 0.001.

Species	Scientific name	Av. 73-19	r (47 y.)	r (10 y.)
Brent Goose	*Branta bernicla*	11219	0.65***	0.00
Canada Goose	*B. canadensis*	128	0.63***	-0.72*
Barnacle Goose	*B. leucopsis*	60054	0.94***	0.79**
Greylag Goose	*Anser anser*	3913	0.79***	-0.41
Bean Goose	*Anser fabalis*	219	0.05	-0.05
Greater White-fronted Goose	*A. albifrons*	739	0.80***	0.20
Mute Swan	*Cygnus olor*	605	-0.02	-0.20
Tundra Swan	*C. columbianus*	221	0.70***	0.01
Whooper Swan	*C. cygnus*	194	0.66***	-0.11
Common Shelduck	*Tadorna tadorna*	433	0.32*	-0.03
Northern Shoveler	*Anas clypeata*	194	0.66***	0.50
Gadwall	*A. strepera*	17	0.71***	-0.14
Eurasian Widgeon	*A. penelope*	8018	0.83***	0.24
Mallard	*A. platyrhynchos*	422	0.07	0.18
Northern Pintail	*A. acuta*	1032	0.69***	0.04
Eurasian Teal	*A. crecca*	1078	0.35*	0.46
Common Pochard	*Aythya ferina*	43	-0.23	-0.24
Tufted Duck	*A. fuligula*	466	-0.06	0.35
Greater Scaup	*A. marila*	213	-0.48***	0.12
Common Eider	*Somateria mollissima*	92294	-0.17	-0.16
Velvet Scoter	*Melanitta fusca*	330	0.48***	0.32
Common Scoter	*M. nigra*	6623	0.87***	0.61
Long-tailed Duck	*Clangula hyemalis*	55	0.12	0.37
Common Goldeneye	*Bucephala clangula*	325	-0.46**	0.17

Common Merganser	*Mergus merganser*	39	0.00	0.09
Red-breasted Merganser	*M. serrator*	1528	0.36*	0.13
Red-throated Diver	*Gavia stellata*	381	0.73***	0.31
Black-throated Diver	*G. arctica*	123	0.30	-0.06
Red-necked Grebe	*Podiceps grisegena*	23	0.68***	0.11
Grey Heron	*Ardea cinerea*	190	0.94***	0.64*
Great Egret	*A. alba*	10	0.70**	0.89***
Osprey	*Pandion haliaetus*	270	0.55***	0.49
European Honey Buzzard	*Pernis apivorus*	6491	-0.61***	-0.08
Lesser Spotted Eagle	*Clanga pomarina*	3	0.12	-0.18
Greater Spotted Eagle	*Clanga c.*	1	0.31	0.02
Golden Eagle	*Aquila chrysaetos*	2	0.05	0.06
Eurasian Sparrowhawk	*Accipiter nisus*	20364	0.75***	0.14
Northern Goshawk	*A. gentilis*	30	-0.15	-0.75**
Western Marsh Harrier	*Circus aeruginosus*	659	0.73***	0.20
Hen Harrier	*C. cyaneus*	264	-0.24	0.14
Pallid Harrier (86-19)	*C. macrourus*	7	0.85***	0.46
Montagu's Harrier	*C. pygargus*	8	0.24	-0.48
Red Kite	*Milvus milvus*	1305	0.98***	0.47
Black Kite	*M. migrans*	16	0.73***	0.62
White-tailed Eagle	*Haliaaetus albicilla*	21	0.88***	0.14
Rough-legged Buzzard	*Buteo lagopus*	889	-0.29*	-0.69*
Common Buzzard	*B. buteo*	14383	-0.08	0.05
Common Crane	*Grus grus*	2191	0.84***	-0.04
Eurasian Oystercatcher	*Haematopus ostralegus*	300	0.03	-0.18
Pied Avocet	*Recurvirostra avosetta*	64	0.04	-0.08
Northern Lapwing	*Vanellus vanellus*	603	-0.15	0.14
European Golden Plover	*Pluvialis apricaria*	704	0.61***	0.47
Grey Plover	*P. squatarola*	331	0.56***	0.31
Common Ringed Plover	*Charadrius hiaticula*	1176	0.43**	0.53
Lesser Ringed Plover	*Ch. dubius*	4	0.40*	0.30
Whimbrel	*Numenius phaeopus*	20	0.27	-0.09
Eurasian Curlew	*N. arquata*	234	0.10	0.10
Bar-tailed Godwit	*Limosa lapponica*	297	0.57***	-0.12
Ruddy Turnstone	*Arenaria interpres*	37	0.42**	-0.37
Red Knot	*Calidris canutus*	595	0.36*	0.00
Ruff	*C. pugnax*	214	0.33*	0.25
Curlew Sandpiper	*C. ferruginea*	112	0.25	0.32
Temminck's Stint	*C. temminckii*	4	0.57***	-0.08
Sanderling	*C. alba*	65	0.14	-0.47
Dunlin	*C. alpina*	5553	0.09	0.33
Little Stint	*C. minuta*	94	-0.13	0.02
Common Snipe	*Gallinago gallinago*	271	-0.51***	-0.49
Common Sandpiper	*Actitis hypoleucos*	44	0.38*	-0.19
Green Sandpiper	*Tringa ochropus*	16	0.51***	0.66*
Common Redshank	*T. totanus*	194	0.06	-0.14
Wood Sandpiper	*T. glareola*	110	0.32*	0.25
Spotted Redshank	*T. erythropus*	71	0.10	0.10
Common Greenshank	*T. nebularia*	183	0.28	0.11
Black-legged Kittiwake	*Rissa tridactyla*	11	0.17	-0.26

Black-headed Gull	*Croicocephalus ridibundus*	7659	-0.05	0.16
Little Gull	*Hydrocoloeus minutus*	455	0.57***	0.03
Common Gull	*Larus canus*	3562	0.85***	0.26
L. Black-backed Gull (01-19)	*L. fuscus*	110	0.73	0.20
Caspian Tern	*Hydroprogne caspia*	11	0.39**	0.37
Little Tern	*Sternula albifrons*	67	-0.19	0.64*
Common Tern	*Sterna hirundo*	2890	0.80***	0.64*
Arctic Tern	*S. paradisaea*	340	0.57***	0.21
Black Tern	*Chlidonias niger*	54	0.30*	-0.43
Pomarine Skua	*S. pomarinus*	8	-0.05	-0.08
Arctic Skua	*S. parasiticus*	44	0.30*	0.00
Long-tailed Skua (86-19)	*S. longicaudus*	11	0.45**	-0.11
Common Guillemot	*Uria aalge*	216	-0.65***	-0.43
Razorbill	*Alca torda*	48	-0.14	-0.07
Stock Dove	*Columba oenas*	8783	0.21	0.67*
Common Wood Pigeon	*C. palumbus*	311922	0.70***	0.60
Eurasian Collared Dove	*Streptopelia decaocto*	45	-0.62***	0.09
Common Cuckoo	*Cuculus canorus*	2	-0.31	0.25
Short-eared Owl	*Asio flammeus*	3	-0.15	0.06
Common Swift	*Apus apus*	7212	0.09	0.45
Common Kestrel	*Falco tinnunculus*	690	0.60***	0.33
Merlin	*F. columbarius*	236	0.28	-0.45
Eurasian Hobby	*F. subbuteo*	55	0.27	-0.11
Red-footed Falcon	*F. vespertinus*	2	-0.15	0.79**
Peregrine Falcon	*F. peregrinus*	45	0.93***	0.17
Great Grey Shrike	*Lanius excubitor*	21	0.05	-0.10
Western Jackdaw	*Corvus monedula*	40291	0.46**	0.83**
Rook	*C. frugilegus*	6315	-0.47***	0.78**
Carrion Crow	*C. corone*	2942	-0.93***	-0.60
Coal Tit	*Periparus ater*	628	0.19	-0.18
Eurasian Blue Tit	*Cyanistes cyanus*	28899	0.32*	-0.07
Great Tit	*Parus major*	860	0.09	-0.26
Eurasian Penduline Tit	*Remiz pendulinus*	5	0.75***	-0.57
Bearded Reedling	*Panurus biarmicus*	40	0.68***	0.59
Wood Lark	*Lullula arborea*	1336	0.57***	0.41
Eurasian Skylark	*Alauda arvensis*	1871	0.32*	0.29
Horned Lark	*Eremophila alpestris*	9	-0.49***	0.38
Sand Martin	*Riparia riparia*	3365	-0.22	0.65*
Barn Swallow	*Hirundo rustica*	25566	0.09	0.28
Common House Martin	*Delichon urbicum*	4693	-0.51***	-0.21
Common Starling	*Sturnus vulgaris*	113260	-0.45**	0.41
Fieldfare	*Turdus pilaris*	9385	-0.27	-0.52
Redwing	*T. iliacus*	4235	-0.25	-0.02
Song Thrush	*T. philomelos*	948	-0.08	-0.15
Mistle Thrush	*T. viscivorus*	647	0.73***	0.17
Eurasian Tree Sparrow	*Passer montanus*	320	-0.22	0.42
Yellow Wagtail	*Motacilla flava*	39768	0.01	0.70*
Grey Wagtail	*M. citreola*	211	0.73***	0.39
White Wagtail	*M. alba*	1235	-0.11	-0.02
Tawny Pipit	*Anthus campestris*	24	-0.90***	-0.63*

Meadow Pipit	*A. pratensis*	10653	0.38**	0.10
Tree Pipit	*A. trivialis*	25047	0.41**	0.49
Red-throated Pipit	*A. cervinus*	52	-0.65***	-0.67*
Rock Pipit	*A. petrosus*	36	0.00	0.35
Chaffinch/Brambling	*Fringilla coelebs/montif.*	844621	0.23	0.14
Hawfinch	*Coccotraustes coccotraustes*	16	0.62***	-0.53
Eurasian Bullfinch	*Pyrrhula pyrrhula*	970	0.18	-0.29
Common Rosefinch	*Carpodacus erythrinus*	4	-0.36*	-0.70*
European Greenfinch	*Chloris chloris*	35183	-0.05	-0.64*
Twite	*Linaria flavirostris*	1978	-0.27	0.84**
Common Linnet	*L. cannabina*	26331	0.04	0.69*
Redpoll	*Acanthis flammea*	3722	0.61***	-0.08
Parrot Crossbill	*Loxia pytyopsittacus*	787	0.26	-0.16
Red Crossbill	*L. curvirostra*	3276	0.23	-0.20
European Goldfinch	*Carduelis carduelis*	4659	0.86***	0.23
European Serin	*Serinus serinus*	8	0.76***	0.73*
Eurasian Siskin	*Spinus spinus*	42706	0.64***	-0.72*
Yellowhammer	*Emberiza citrinella*	2703	-0.46**	-0.40
Ortolan Bunting	*E. hortulana*	32	-0.74***	-0.86**
Common Reed Bunting	*E. schoeniclus*	1626	0.25	0.03
Lapland Longspur	*Calcarius lapponicus*	14	-0.30*	-0.58
Snow Bunting	*Plectrophenax nivalis*	137	-0.32*	-0.10

Table 2. Proportion of juveniles (%) among some migrants at Falsterbo 1986–2019.

Species	Mean	1986–1990	1991–2000	2001–2010	2011–2019
Brant Goose *Branta bernicla*	13	19	12	9	14
Mute Swan *Cygnus oler*	5	-	-	6	5
Tundra Swan *C. columbianus*	10	15	10	12	6
Whooper Swan *C. cygnus*	9	6	9	11	8
Osprey *Pandion haliaetus*	49	50	56	46	45
European Honey Buzzard *Pernis apivorus*	14	13	10	14	19
Golden Eagle *Aquila chrysaetus*	71	43	72	88	69
Eurasian Sparrowhawk *Accipiter nisus*	79	79	77	79	82
Northern Goshawk *A. gentilis*	94	96	97	89	96
Western Marsh Harrier *Circus aeruginosus*	73	76	78	71	66
Hen Harrier *C. cyaneus*	66	60	62	71	70
Pallid Harrier *C. macrourus*	52	25	43	59	59
Montagu's Harrier *C. pygargus*	58	51	60	66	51
Red Kite *Milvus milvus*	71	83	75	71	61
Black Kite *M. migrans*	21	15	8	26	33
White-tailed Eagle *Haliaaetus albicilla*	38	36	32	45	38
Rough-legged Buzzard *Buteo lagopus*	28	25	19	37	28
Common Buzzard *B. buteo*	48	38	49	49	50
Common Crane *Grus grus*	12	25	18	11	10
Black-legged Kittiwake *Rissa tridactyla*	87	84	73	92	96

Little Gull *Hydrocoloeus minutus*	50	62	65	45	33
Lesser Black-backed Gull *Larus fuscus*	29	-	-	30	28
Caspian Tern *Hydroprogne caspia*	15	15	14	14	17
Little Tern *Sternula albifrons*	55	-	-	-	55
Common Tern *Sterna hirundo*	32	34	39	28	29
Arctic Tern *S. paradisaea*	37	26	39	37	41
Black Tern *Chlidonias niger*	88	77	96	81	91
Pomarine Skua *Stercorarius pomarinus*	64	29	46	77	89
Parasitic Skua *S. parasiticus*	54	55	62	54	43
Long-tailed Skua *S. longicaudus*	98	80	95	100	100
Common Kestrel *Falco tinnunculus*	78	70	77	81	81
Red-footed Falcon *F. vespertinus*	79	50	97	75	74
Merlin *F. columbarius*	84	88	84	86	81
Eurasian Hobby *F. subbuteo*	86	89	86	86	83
Peregrine Falcon *F. peregrinus*	32	40	26	32	33

Table 3. Species showing an obvious positive or negative trend in median migration date at Falsterbo 1973–2019. Spearman Rank (r): * = p < 0.05, ** = p < 0.01, *** = p < 0.001.

Later median				Earlier median			
English name	**Scientific name**	**r**	**Sign**	**English name**	**Scientific name**	**r**	**Sign**
Tundra Swan	*Cygnus columbianus*	0.66	***	Black-throated Diver	*Gavia arctica*	-0.57	***
Greylag Goose	*Anser anser*	0.56	***	Common Shelduck	*Tadorna tadorna*	-0.56	***
Coal Tit	*Periparus ater*	0.53	**	Common Scoter	*Malanitta nigra*	-0.54	***
Western Jackdaw	*Corvus monedula*	0.48	**	Wood Sandpiper	*Tringa glareola*	-0.54	***
Red-throated Diver	*Gavia stellata*	0.43	**	Greater Ringed Plover	*Charadrius hiaticula*	-0.51	***
Red Kite	*Milvus milvus*	0.42	**	Canada Goose	*Branta canadensis*	-0.48	**
Gadwall	*Anas strepera*	0.41	*	White-tailed Eagle	*Haliaaetus albicilla*	-0.47	**
Eurasian Widgeon	*A. penelope*	0.40	**	Eurasian Oystercatcher	*Haematupus ostralegus*	-0.47	**
Hen Harrier	*Circus cyaneus*	0.39	**	Lesser Ringed Plover	*Charadrius dubius*	-0.45	*
Stock Dove	*Columba oenas*	0.37	*	Grey Plover	*Pluvialis squatarola*	-0.42	**
Great Crested Grebe	*Podiceps cristatus*	0.35	*	Arctic Skua	*Stercorarius parasiticus*	-0.41	**
Common Merganser	*Mergus merganser*	0.35	*	Green Sandpiper	*Tringa ochropus*	-0.40	**
White Wagtail	*Motacilla alba*	0.34	*	Whimbrel	*Numenius phaeopus*	-0.38	*
Greater Scaup	*Aythya marila*	0.34	*	Common Sandpiper	*Actitis hypoleucos*	-0.36	*
Whooper Swan	*Cygnus cygnus*	0.33	*	Barn Swallow	*Hirundo rustica*	-0.36	*
Black Stork	*Ciconia nigra*	0.29		Rook	*Corvus frugilegus*	-0.36	*
Common Buzzard	*Buteo buteo*	0.29	*	Tree Pipit	*Anthus trivialis*	-0.35	*
Eurasian Bullfinch	*Pyrrhula pyrrhula*	0.28		Red Crossbill	*Loxia curvirostra*	-0.35	*
Northern Shoveler	*Anas clypeata*	0.28		Grey Heron	*Ardea cinerea*	-0.34	*
Northern Pintail	*A. acuta*	0.26		Dunlin	*Calidris alpina*	-0.33	*
Hawfinch	*C. coccothraustes*	0.25		Pied Avocet	*Recurvirostra avocetta*	-0.32	*
Tawny Pipit	*Anthus campestris*	0.24		Eurasian Sparrowhawk	*Accipiter nisus*	-0.31	*
Common Crane	*Grus grus*	0.23		Lesser Spotted Eagle	*Clanga pomarina*	-0.29	
Black Kite	*Milvus migrans*	0.23		Marsh Harrier	*Circus aeruginosus*	-0.28	
Common House Martin	*Delichon urbica*	0.23		Little Tern	*Sternula albifrons*	-0.28	
Mallard	*Anas platyrhynchos*	0.22		Common Guillemot	*Uria aalge*	-0.28	
Eurasian Tree Sparrow	*Passer montanus*	0.20		Sand Martin	*Riparia riparia*	-0.28	

Bird Census News 2019, 32/1–2: 38–44

Long-term monitoring at the Hanko Bird Observatory

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Abstract: Bird populations are typically monitored through breeding or winter monitoring schemes, such as breeding bird surveys or international mid-winter waterbird counts. However, systematic counts are conducted also during other seasons especially during migration periods at the bird observatories. The benefit of migration counts are that they can provide information on species which are difficult to monitor during breeding or winter seasons on a larger scale, such as arctic breeders. In addition, migration counts can provide information on shifts in phenology, which may have population consequences. This article provide information about long-term monitoring at the Hanko Bird Observatory (Halias), Finland, where bird counts have been conducted since 1979. A method how to calculate population trends from bird migration data and a new data visualisation tool (haahka.halias.fi) are introduced.

Introduction

A large number of European bird species are migratory, and the number of migratory species increases towards higher latitudes (Newton 2008). Populations of European species have typically been monitored through breeding or wintering monitoring schemes such as breeding bird surveys (Gregory et al. 2005, Stephens et al. 2016) or international mid-winter waterbird counts (IWC) (Omano et al. 2018). However, there are large number of sites in Europe and beyond where migratory birds are counted or trapped in a standardised way during the migration period (Hobson et al. 2015, Lehikoinen et al. 2019, Osenkowski et al. 2012, Wehrmann et al. 2019). The benefit of migration counts is that survey sites are often situated in migratory hot spots and can thus aggregate large number of birds from a broad area (Kjellén 1997, Verhelst et al. 2011). Counts from a single site can give valuable information on the population trends from large breeding areas, which can be difficult to monitoring with breeding bird surveys (Hobson et al. 2015). In addition, migration data enables investigation in changes in phenology and demographics which can be linked with population dynamics (Kjellén 1992, Lehikoinen et al. 2008, 2019).

Data from migration sites has also disadvantages. For instance, the data may have observation gaps or local or large-scale weather conditions may cause large annual variations in the detectability of migrants during counts. Furthermore, not all the observed birds are identified at species level, and for example, genus level identification (e.g. geese species) are common. Here I present a simple method, where I have attempted to take these potential biases into account in the analysis of long-term monitoring data from Hanko Bird Observatory (Halias), Finland. In addition, I present examples of changes in population abundances and phenology of species, and introduce an online data visualisation tool for the collected data.

Material and methods

The Hanko Bird Observatory was established to the tip of the Hanko Peninsula SW corner of Finland in February 1979 (Vähätalo et al. 2004; Fig. 1) and the observatory is run by the ornithological society of Helsinki region (Tringa, www.tringa.fi). Since 1979, counts of local and migratory birds have been conducted by volunteer birdwatchers throughout the year. The counts have typically been conducted during migration seasons from early March to mid-June in spring and from mid-July to mid-November in autumn, but also counts during other time of the year have been done. The daily routines include four hour standardised visual migration counts starting from the sunrise. The counts continue if the migration is still occurring after four hours. In the winter, the

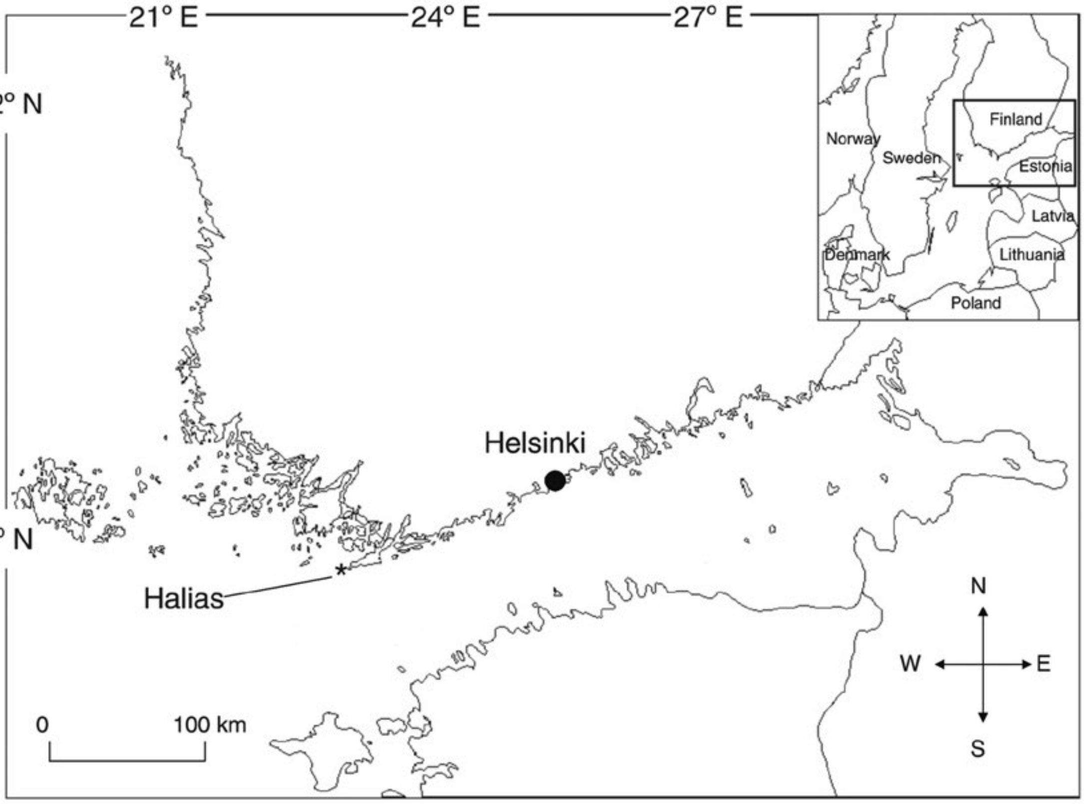

Figure 1. Location of the Hanko Bird Observatory

standardised period is two hours, because the migration is very limited. In addition, the number of staging birds has been counted using standardised protocol from the same area (Vähätalo et al. 2004, Lehikoinen 2011). Furthermore, birds have been trapped using mistnets in the standardised sites especially during the autumn season from 25 July till 5 November (Lehikoinen 2011).

The daily counts include all observed species, but also e.g. unidentified birds from the migration counts such as geese *Anser/Branta*, ducks *Anas sp*, buzzards *Buteo/Pernis*, small and larger waders and small passerines are counted. These are typically individuals which are too distant to make the identification to species level. These unidentified birds form a significant part of all observed birds at the observatory (c. 10%). A list of these categories is provided in the database of the observatory. These unidentified individuals can be an important source of information and it is recommended they are included in further analyses, because this increases the sample sizes and also the proportions of indentified birds may vary e.g. due to changes in optic quality or weather conditions (e.g. heath haze can complicate identification of distant birds).

The numbers of individuals identified to such broad groups were divided among the common species in the group, and added to the numbers of each species according to the proportions in which the exactly identified individuals had been seen during nearby days. Observations of identified birds from five days (two days before and two days after the particular calendar day) were used to calculate the proportions. This calculation also included weighting so that the observations of the exact calendar day had more weight and observations from two days apart had least weight. The exact equation for calculating the proportion scores of each identified species was $X_{t-2} + 2*X_{t-1} + 3*X_t + 2*X_{t+1} + X_{t+2}) / 9$, where X_t is abundance of a species in the calendar day t. For example 117 unidentified buzzards (*Pernis* / *Buteo*) were observed on 11th September 1999 and the number of Honey Buzzards *Pernis apivorus* and Common Buzzards *Buteo buteo* were 76, 3, 49, 35 and 3, and 19, 12, 118, 10 and 4 for 9th–13th September 1999, respectively. Only one Rough-legged Buzzard *Buteo lagopus* was observed on 12th September 1999. Using the above mentioned equation, abundance scores of Honey, Common and Rough-legged Buzzards were 302, 421 and 2,

Table 1. Long- and short-term population trends of 20 most rapidly increased and decreased bird species based on changes in their annual mean abundances during three periods: long-term from 1979–1999 to 2011–2019. In addition short-term changes from 2000–2010 to 2011–2019, and calendar day sums of three different periods are provided.

Species	Long-term (%)	Short-term (%)	N, 1979–1999	N, 2000–2010	N, 2011–2019
Passer montanus	8537	680	25.4	281.5	2196.6
Branta leucopsis	3681	498	1073.5	6784.1	40593.6
Dendrocopos leucotos	1658	318	1.6	6.6	27.8
Phalacrocorax carbo	1530	-30	3429.5	80386.2	55908.9
Anas strepera	1238	55	8.6	74.1	114.8
Falco peregrinus	1218	66	3.3	26.5	44.0
Haliaeetus albicilla	987	72	153.3	968.8	1666.5
Ardea cinerea	979	55	118.9	827.8	1283.4
Melanitta nigra	866	33	1252.7	9102.6	12103.0
Mergellus albellus	496	142	64.0	157.3	381.4
Branta canadensis	476	48	54.5	211.9	313.8
Grus grus	425	8	5030.0	24394.8	26425.1
Corvus monedula	376	39	2979.1	10225.7	14175.3
Circus aeruginosus	356	1	21.4	96.9	97.9
Phylloscopus inornatus	339	225	1.1	1.5	5.0
Anser albifrons	336	46	534.9	1601.8	2332.8
Garrulus glandarius	323	21	490.1	1712.0	2071.6
Falco subbuteo	270	36	54.9	148.6	202.8
Alca torda	254	-13	96.3	393.2	340.6
Dryocopus martius	234	9	51.5	157.7	171.9
Anthus pratensis	-67	-29	6932.3	3289.1	2319.3
Luscinia svecica	-68	-44	21.7	12.3	6.9
Riparia riparia	-69	-60	485.5	376.5	150.2
Saxicola rubetra	-69	-62	63.4	52.6	20.0
Nucifraga caryocatactes	-69	-38	863.9	428.9	265.9
Plectrophenax nivalis	-69	-51	289.9	186.2	91.3
Podiceps cristatus	-70	-58	582.9	411.7	173.2
Aythya ferina	-71	-40	81.7	39.6	23.8
Larus fuscus	-77	-42	1024.0	403.3	235.0
Arenaria interpres	-78	-47	111.1	47.2	24.8
Calcarius lapponicus	-78	-69	37.1	26.5	8.3
Bubo bubo	-80	-48	17.4	6.8	3.5
Calidris minuta	-82	-36	46.7	13.3	8.6
Sylvia nisoria	-82	215	62.5	3.6	11.4
Streptopelia turtur	-85	2	11.5	1.6	1.7
Emberiza rustica	-86	-52	16.2	4.6	2.2
Corvus frugilegus	-87	-60	266.5	88.8	35.7
Passer domesticus	-94	-88	446.4	200.2	24.9
Emberiza hortulana	-95	-68	67.9	10.9	3.5
Fulica atra	-96	-88	58.6	20.9	2.6

respectively. Therefore, from the 117 unidentified buzzards, 42% (117*302/(302+421+2) = 49 individuals) were added to the Honey Buzzards and 58% (117*421/(302+421+2) = 68 individuals) to Common Buzzards on 11th September 1999. A five day window was used because often there was no identification of the particular species from the calendar day. If there was no species

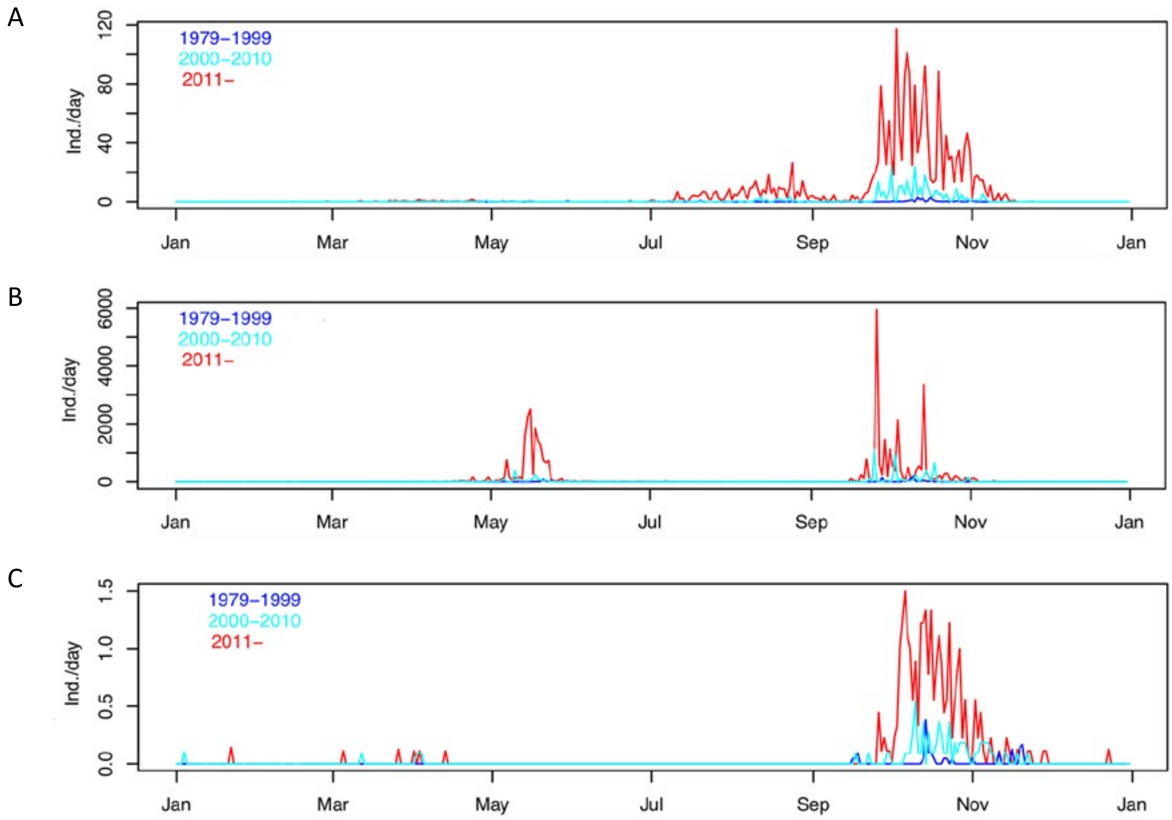

Figure 2. Mean abundances of (A) Tree Sparrow *Passer montanus*, (B) Barnacle Goose *Branta leucopsis*, and (C) White-backed Woodpecker *Dendrocopos leucotos* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red) (see also Table 1).

level identification during these five days, the observed unidentified individuals of the particular group were ignored.

The daily counts of migratory and staging birds from the observatory and the list of common species including the unidentified bird groups are freely available in a csv-file from the web-page of the observatory (https://www.halias.fi/pitkaaikaisaineisto/) and the Finnish Biodiversity Information Facility (laji.fi). In addition, an R code, which helps for the data handling is provided.

To calculate the population trends and shifts in phenology the data from all calendar days of across multiple years is used. Because there has also been observation gaps especially during the non-migration season, the data has been aggregated into three different periods: 1979–1999, 2000–2010 and 2011 onwards. The first period includes more to compensate for larger number of observation gaps especially during winter season. For each species the mean number of birds per calendar day was calculated for each of these three periods separately. This procedure creates three calendar day phenology distributions throughout the year (Figs 2–4). The population trends were calculated by comparing the sum of calendar day counts of different periods. This could be done separately for birds observed during active migration or local staging birds, but when calculating the trends typically both these data types were combined. For instance doubling or halving of calendar day count sums would in general mean corresponding changes in the estimated population abundance. The long-term trend refers to changes in abundance from period 1979–1999 to 2011–2019 and short-term trend was obtained by comparing periods 2000–2010 and 2011–2019. The population trends could be calculated for all the species, but here only those species are included, which had on average at least one observation per year during each period according to cumulative sums (Table 1).

Results and online visualisation tool

The population changes were calculated for 210 species of which 97 species showed increasing (more than 10% increase) and 85 species decreasing trends (more than 10% decline) in the long-term analyses. The corresponding short-

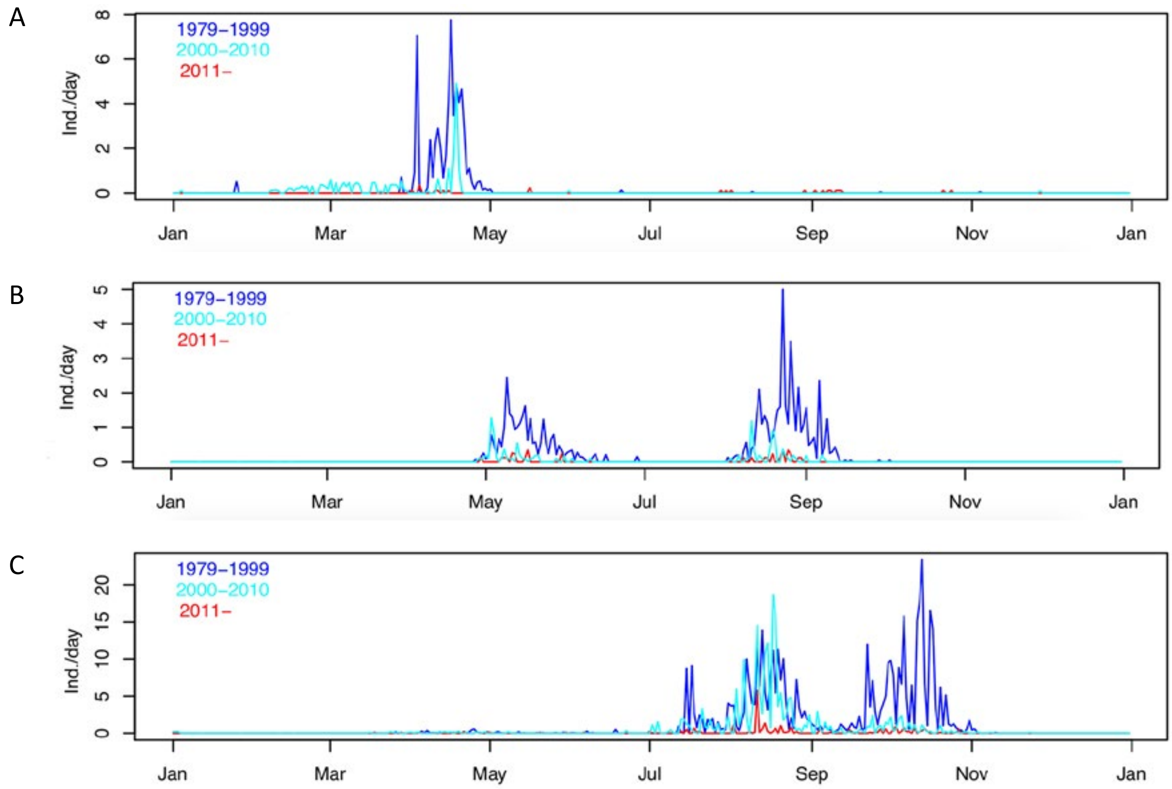

Figure 3. Mean abundances of (A) Common Coot *Fulica atra*, (B) Ortolan Bunting *Emberiza hortulana*, and (C) House Sparrow *Passer domesticus* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red) (see also Table 1).

term values were 64 and 107 for increasing and declining species, respectively. The species with the highest long-term increases were Tree Sparrow *Passer montanus* (+8537%), Barnacle Goose *Branta leucopsis* (+3681) and White-backed Woodpecker *Dendrocopos leucotos* (+1658%) (Fig. 2), whereas the strongest declines were calculated for Common Coot *Fulica atra* (-96%), Ortolan Bunting *Emberiza hortulana* (-95%) and House Sparrow (-94%; reflecting dispersal numbers in this resident species) (Table 1, Fig. 3).

The trend calculations are visualised in the new online tool of the observatory: haahka.halias.fi. The tool represents all species recorded at the observatory. The tool has been built by using shinyapps software, and the code of the tool is freely available in github-link of the web-page.

Discussion

The method to calculate population trends can be applied to data which has observation gaps. Furthermore, large variation in daily counts between days and years are flattened when averages of several years are used. Combining multiple years can increase the possibility of detecting clear trend patterns as it decreases stochasticity in the data. The compared periods do not necessarily need to be 10 years long like here, but shorter periods can also be applied. The methodology can be used for different type of migration count data even if the whole annual cycle is not covered.

The current methodology could be also further developed. For instance the significance of population change estimates could be calculated e.g. using paired t-test between calendar day values of different periods or trend values of several observatories could be combined, which would increase the reliability of the trend estimates. The trend calculations could also be conducted separately for different seasons. For instance Common Goldeneye *Bucephala clangula* numbers have increased especially during winter due to shifts in species wintering ranges and overall migration phenology of autumn migratory waterbirds has delayed (Fig. 4; Lehikoinen & Jaatinen 2012, Lehikoinen et al. 2013). The calendar day curves thus also enables investigation of phenological changes such as advancing spring phenology or shifting autumn phenology (Fig. 4; Lehikoinen & Jaatinen 2012, Lehikoinen et al. 2019).

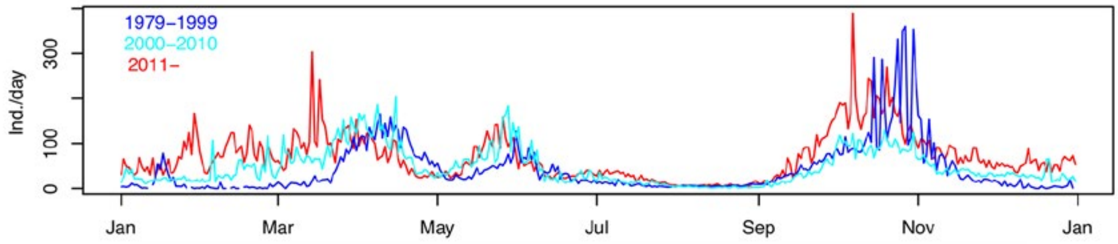

Figure 4. Mean abundances of Common Goldeneye *Bucephala clangula* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red). Note the advanced migration phenology including moult migration of males in late May-early June, and increasing wintering numbers.

Acknowledgements

I wish to thank hundreds of volunteers who have participated the data collection during all these years. Finnish Cultural Foundation have supported the data collection since 1980. Alfred Kordelin Foundation supported lounging of the online tool haahka.halias.fi, which has been coded by Joona Lehtomäki with a help of Mikko Koho.

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Received: 13 February 2020
Accepted: 25 March 2020

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