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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

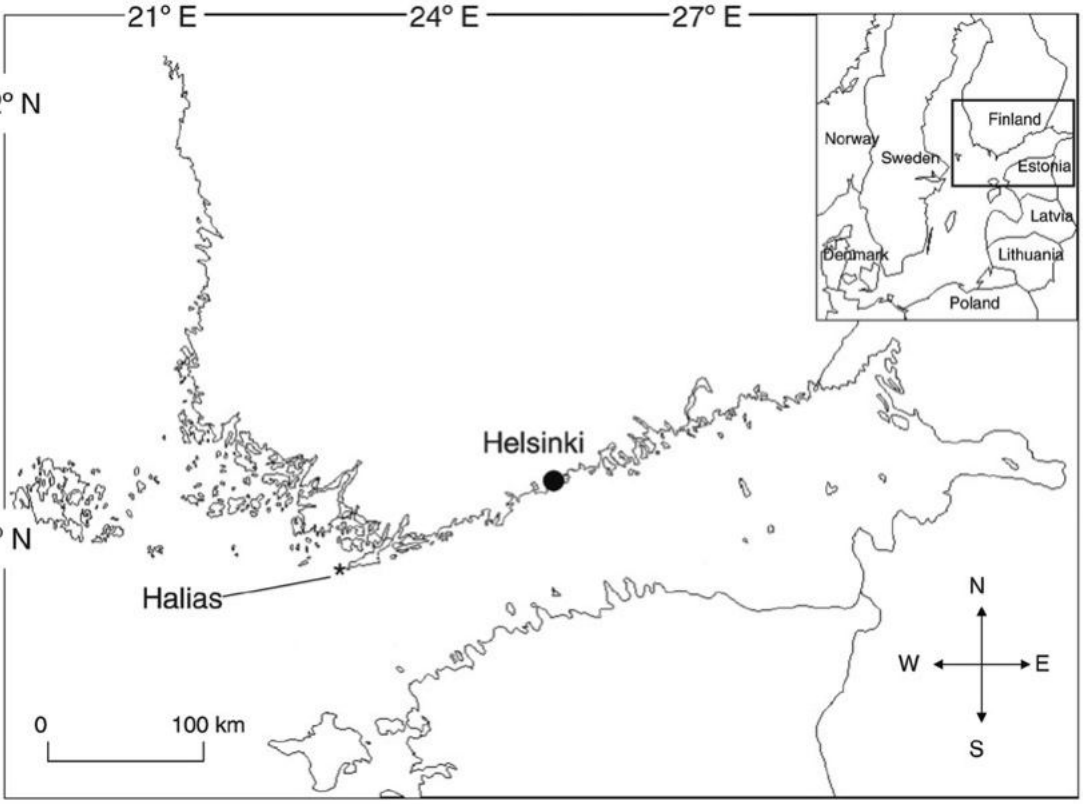

Figure 1. Location of the Hanko Bird Observatory

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

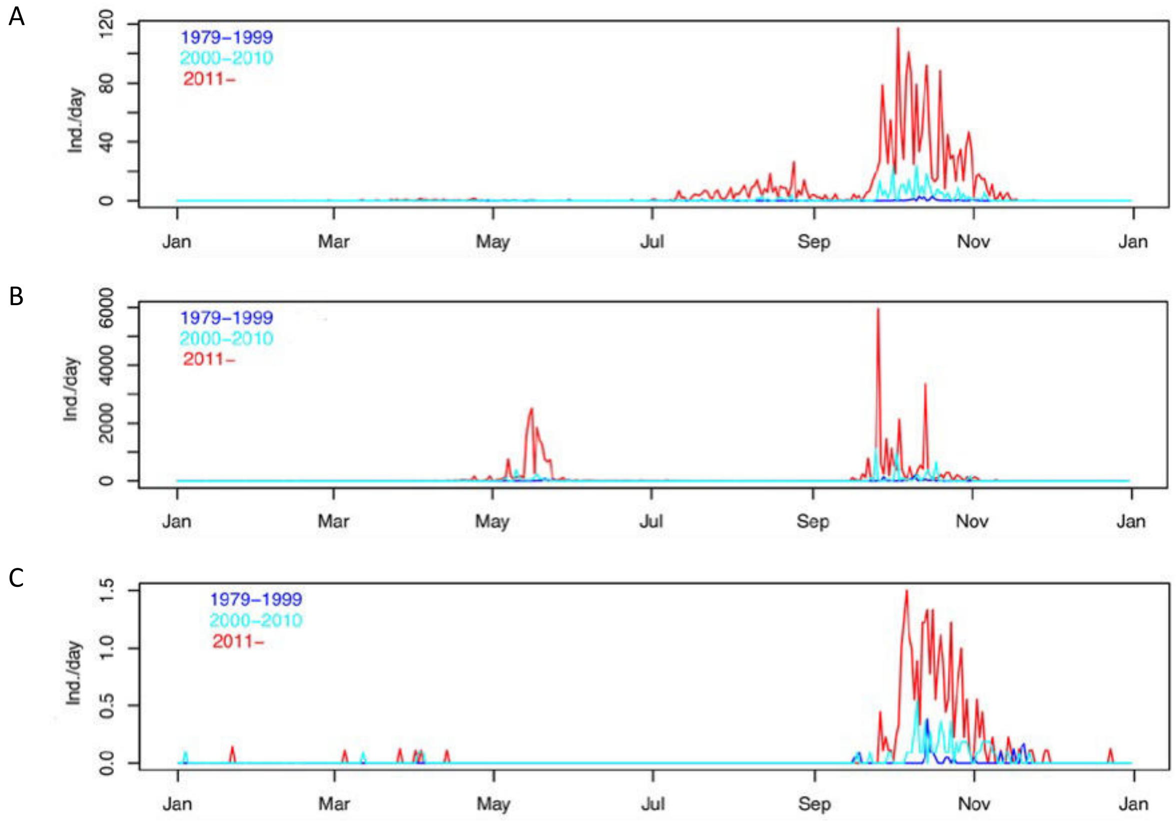

Figure 2. Mean abundances of (A) Tree Sparrow *Passer montanus*, (B) Barnacle Goose *Branta leucopsis*, and (C) White-backed Woodpecker *Dendrocopos leucotos* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red) (see also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

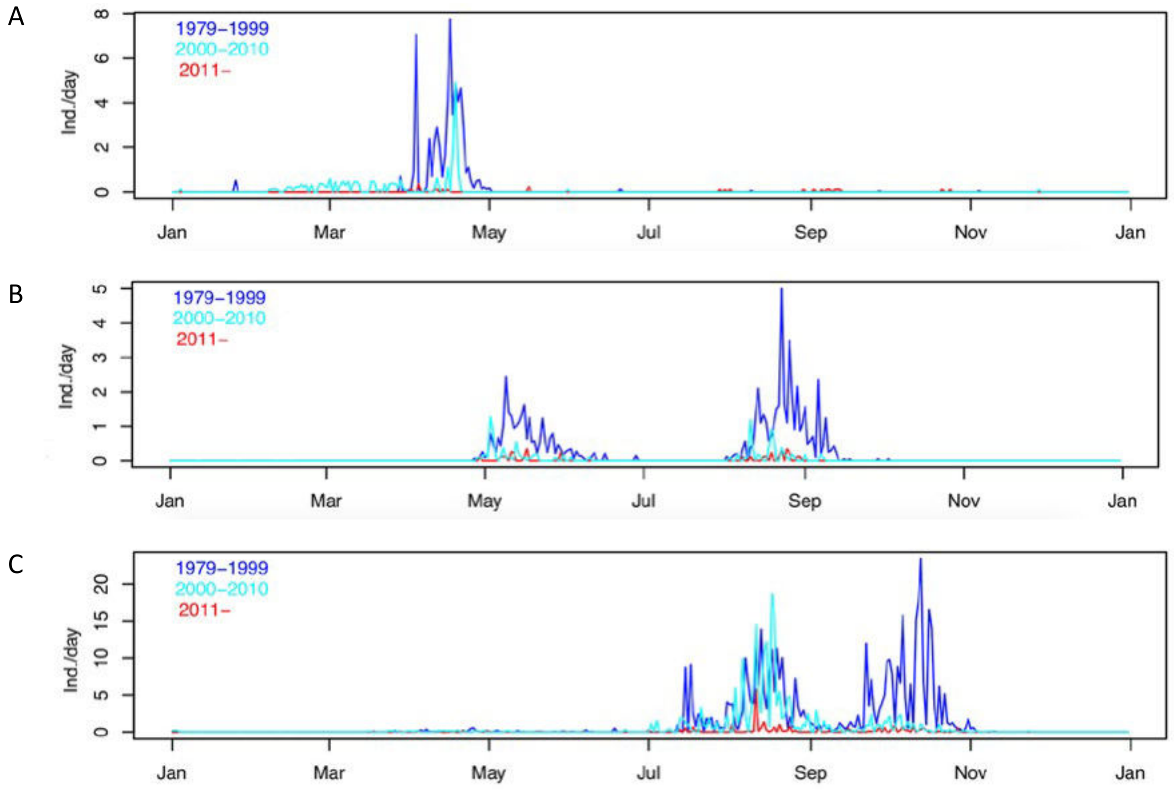

Figure 3. Mean abundances of (A) Common Coot *Fulica atra*, (B) Ortolan Bunting *Emberiza hortulana*, and (C) House Sparrow *Passer domesticus* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red) (see also Table 1).

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).

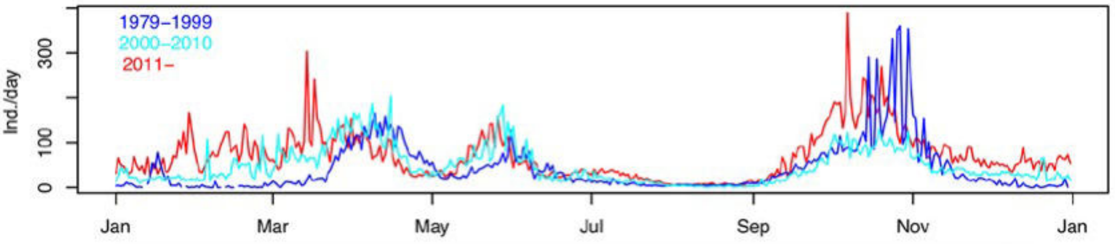

Figure 4. Mean abundances of Common Goldeneye *Bucephala clangula* at the Hanko Bird Observatory during each calendar day during periods 1979–1999 (dark blue), 2000–2010 (light blue) and 2011–2019 (red). Note the advanced migration phenology including moult migration of males in late May-early June,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

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