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Are large fields of autumn wheat at Kvismaren, central Sweden, used as nesting and food search habitats by Skylarks *Alauda arvensis?*

Är stora höstvetefält vid Kvismaren i mellersta Sverige utnyttjade som bo- och födosökshabitat för sånglärka Alauda arvensis*?*

JAN SONDELL

Abstract

The skylark *Alauda arvensis* population has declined in Sweden. The breeding in silage fields fails and the success in autumn crops is disputed. Therefore, I decided to study the skylark utilisation of autumn crop fields in Kvismaren, central Sweden. The largest accessible field was selected (40 ha) to get as tough conditions as possible for foraging. I could conclude that the nests were evenly placed, the youngsters developed normally and the occupancy was about 80 pairs or territories per km^2. The skylarks searched for food as much inside as outside the large breeding field. The flight distances were on average 204 m and up to 550 m. The conclusion was that autumn crops are probably as good as spring crops regarding breeding habitat; potentially even better as the offspring fledged at least 1–2 weeks earlier. One potential positive factor for the breeding was the occurrence of unsown tractor tracks (tramlines, 2.5% of the area) which were frequently utilised by the skylarks. Such tracks are commonly created nowadays in Sweden and may replace otherwise desired skylark plots.

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Introduction

The skylark is the twentieth most common bird species in Sweden. The population on farmland is approximately 680 000 pairs with strongholds in provinces with the largest agricultural plains: Skåne, Halland, Västergötland, Östergötland, and Uppland (Ottosson et al. 2012).

Information mainly from England indicates that autumn or, as it often is called, winter crops are suboptimal breeding habitats for skylarks because of the height and density of the stems at breeding time. Vegetation grows too dense for the larks to move in and to use for foraging. Furthermore, large areas are sown with the same autumn crop and distances between the nest and potential foraging habitats may be too large. The mean foraging distance observed in southern UK was 75 m and only 10% of distances were longer than 150 m and the longest 380 m (Donald 2004).

The Common Birds Census in UK showed an almost "remarkable relationship" between the index for skylark abundance and area of spring crops during the period 1968–1996 (Donald & Vickery 2000). The index went up from 0.6 at 1 million hectares spring crops to 1.3 at 2.5 million hectares. This striking correlation has put focus on negative consequences when autumn crops replace spring crops. A possible method to improve the habitat for skylarks is to leave small unsown areas in the field (so-called skylark plots), normally two per hectare with an area of 16–24 m^2 (RSBP Leaflet: Skylark plots).

Morris et al. (2004) showed that two undrilled plots of 24 m^2 per hectare were not related to the skylarks' nesting success at the beginning of the breeding season: he found 1.27 fledged nestlings without plots vs. 1.31 with plots. Later in the season, when the crop had grown high, the effect of the plots was significantly positive; the number of nestlings was 0.87 per nesting attempt in areas without plots compared to 1.86 in areas with plots.

In Sweden Hiron et al. (2012) found that skylarks utilised autumn crops as breeding habitat as much as spring crops, and Berg & Kvarnbäck (2011) found no difference in population density in organic autumn crops with and without skylark plots.

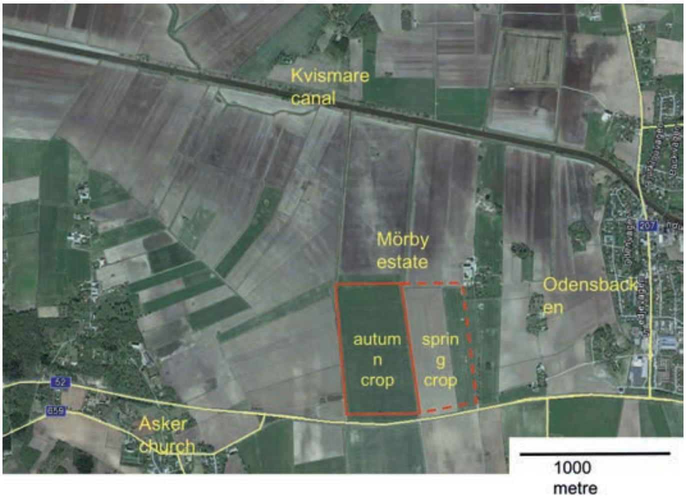

Figure 1. Study area between Asker and Odensbacken, Örebro commune, central Sweden. The main study field is bordered by solid red lines. A spring crop area used for some comparisons next east of the main study area is bordered by dashed red lines.

Studieområdet mellan Asker och Odensbacken i Örebro kommun. Den huvudsakliga studieåkern är markerad med heldragen röd ram. En vårsådd åker, som användes för vissa jämförelser omedelbart öster därom, är markerad med streckad röd ram.

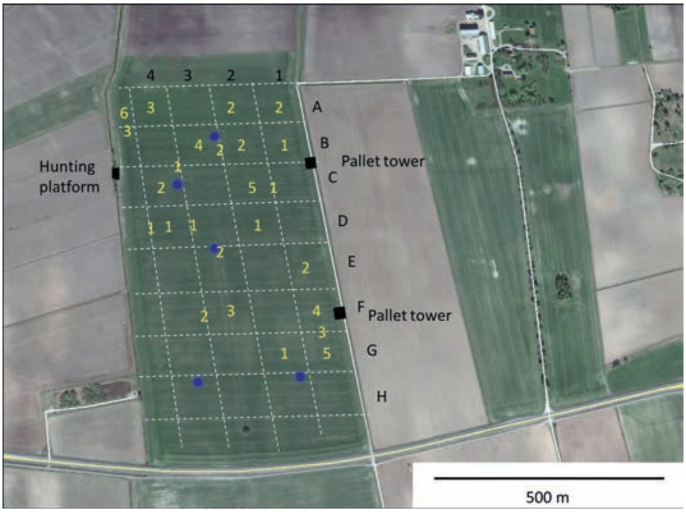

Figure 2. The study field at Mörby estate with observation towers (black squares). Number of observed foraging trips related to nests in different grid cells are indicated by yellow numbers. About 20 nests were estimated to be involved in the study. Blue dots are water regulation wells. Note the pond covered with reed containing a marsh harrier nest south-west of the field (close to square H5).

Studiefältet på Mörby gård med observationsposter (svarta fyrkanter). Antal observerade födosök relaterat till bon i indelade rutor anges med gult. Ca 20 bon bedömdes ingå i studien. Blå fläckar är brunnar för vattenreglering. Ett kärrhökbo låg i en vasstäckt damm alldeles utanför ruta H5.

Odderskær et al. (1977) studied the skylarks' utilization of micro-habitats in spring barley fields and found that unsown small patches and tractor tracks were preferred compared to areas with uniform swards. Schön (2011) is more hesitant to endorse "artificially created" skylark plots and says that there are permanent structures in the fields which may develop spontaneously and exist over long time. These are highly appreciated by the territory-faithful skylarks.

In 2015 we studied the density of skylark territories in 50 ha of silage fields, 110 ha of spring crop and 40 ha of autumn crop in the Kvismaren valley (Sondell et al. 2016). We found about the same density (75–83 pairs per km^2) for the different crops. Important to know in this context is that skylarks are very faithful to the territory held the previous year (Delius 1965, Jenny 1990, Donald 2004). As far as we understood the skylarks nesting in the grain crops developed well but skylark nests in silage fields were destroyed by the harvest. It would be interesting to understand what happens in autumn crops in Sweden. Are there similar problems relating to the dense vegetation as indicated by the studies in England (Morris et al. 2004)? The search for food is probably most difficult in large fields with high uniform vegetation where the borders of the field, i.e. potential foraging areas outside the field, are far away.

The 2016 skylark studies at Kvismaren were aimed to learn about skylark breeding in large homogenous fields of autumn crop: where do the larks place their nests, is the breeding successful (mainly in terms of active feeding behaviours), and how far do they fly to find food to feed the nestlings?

Study field and study conditions

The Kvismaren valley is a wide agricultural plain in central Sweden situated about 15 km SE of Örebro in the province of Närke. To locate a very large homogenous field for the studies in this area *Google earth* maps were used. Three suitable fields with autumn crop were found. We chose a wheat field at Mörby estate between Asker and Odensbacken. The field measured 450×900 m, thus with an area of about 40 ha (Figure 1).

The selected field was one of the largest in the province of Närke 2016 and according to estimations made using *Google earth* it belongs to the largest category in Sweden. Arable fields in Sweden, even in plain areas, are usually divided into smaller cultivation units by farm roads or ditches, clearly visible on an aerial map. The study field is bordered by the county highway 52 in the south (Figure 1 and 2). East of the field is a gravel road and an open ditch. Another similar field next to the east border was sown with spring barley and the field north of our study field with spring wheat. West of the field is a quite large ditch, and on the other side several smaller fields, most of them with spring crop. The autumn crop at the study field was accordingly more or less surrounded by spring crop. We concentrated our observations to the central and northern part of the field, as skylark activity was estimated to be lower in the southern part, possibly due to disturbance from the road. The spring crop field east of the study field was partly used as an area for comparison of crops growth, nest period and stay after breeding.

In the study field there were five water regulation wells clearly visible on the map and in the terrain (Figure 2), which facilitated distance orientation. A 2 m high hunting tower was already located at the field edge, and a further two 1.5–2 m high observation towers were built using pallets (Figure 3). Thus three observers could work simultaneously from different places. We also put up sticks 100 m apart along the gravel road (A–H) and the northern border (1–4) marking endpoints of gridlines across the field (Figure 2) to further facilitate orientation.

Only one solitary big oak was within the study field in the south and a row of 5–8 m high broadleaved trees or bushes were found at the north-western side together with the larger ditch (Figure 2). In the uniform study field there were a few (≤5) small (approx. 10 sq.m.) unsown patches, probably created by some problem with the sowing machine. On some areas the weed couch grass *Elymus repens* was common and covered the ground. However, the total area with this weed was less than one hectare.

Figure 3. Southern pallet tower along the gravel road. Mariana Lapa is searching for nests. Autumn wheat to the left and spring barley to the right.
Södra utsiktsplattformen vid sök av lärkbon. Höstvete till vänster och vårkorn till höger.

In the study field unsown tractor tracks (called tramlines in the UK) were present. The field had been sown with a *Väderstad Combi Rapid* sowing machine. A GPS steering device was used with RTX support (Real-Time eXtended) to keep the tracks straight and make them possible to maintain throughout the season. The equipment produced two unsown tracks every 24 m apart by leaving two unsown rows at 0.125 m distance for each tractor wheel (total theoretical width 0.375 m). The rubber tyres were 0.30 m wide (Figure 4), i.e. there were 0.3 m wide tracks twice every 24 m all over the field resulting in an area share of approximately 2.5%. On each passage the existing tracks were somewhat widened, and the weeds on the ground together with some crop stems were pressed down by the wheels at the track edges, becoming compressed (Figure 4). The field was fertilized four times starting on 20 April and sprayed once each with herbicides (against weeds) on 29 April and with fungicides on 15 June to fight crow rust *Puccinia coronate* and filamentous fungus *Mycosphaerella graminicola*. The last passage was on 15 June. Hence, a tractor passed over the field a total of six times before the end of June. In the spring crop there were also tramlines and several tractor passages.

Figure 4. Unsown tractor track on 16 June after the sixth tractor round 15 June 2016. Note the unsown ground and some compressed straws of wheat from the sides of the row. The smaller image shows the tractor with trailer.
Osått traktorspår 16 juni efter den sjätte traktorpassagen 15 juni 2016. Notera den osådda marken och några från radens sidor nerpressade strån av vete. Lilla bilden visa den aktuella traktorn med vagn.

Methods

Skylark observations

In total, approximately 80 man-hours of observations in the autumn crop were carried out during 17 days between 30 May and 19 June 2016, thus 17 out of 21 available days. This period was chosen to begin when we judged the skylarks to have started intensively feeding the chicks and ended when no more nest feeding activities were going on.

The height of the crop in the wheat field was measured by holding a one metre long stick horizontally at the top of the stems and then measuring the distance to the ground. The measurements were done on 10 days during the period 30 May–30 June, measuring five representative height values and calculating a mean per day.

A main interest was to estimate and record approximate nest locations, the distances between nest locations and foraging sites, and the type of foraging habitat chosen. At first skylark nests in the autumn wheat with active feeding during an observation shift were observed. After about three foraging trips an exact direction (using a spotting scope) and an approximate distance to the nest was recorded. The distance estimate was facilitated by subtle variation in the vegetation along the actual direction. Each foraging trip was characterised as on one of the following:

A complete foraging trip including starting a flight from the nest for search and returning with food in the bill to the nest.

A flight out from the nest ending with a drop to the ground in a foraging area or a skylark just leaving to disappear out of the foraging area (flying out from the same area several times).

A flight back from the foraging area to the nest with or without visible food in the beak. This mostly happened at shorter foraging distances.

That feeding had taken place was demonstrated by a lark landing in the vicinity of the nest with food in the beak and a lift out from the nest position afterwards, very often with a visible dropping in its bill. Many larks landed a small distance away from the nest on small open patches, see Appendix 1. A foraging trip lasted often up to 20–40 minutes on the ground searching for food and birds spent 1–5 minutes at the nest when feeding the young. After about 40 minutes of not seeing any lark we regarded the bird as lost.

We also visited 6 nests, selected at random, to check the nests' condition and offspring development. The selected nests had different distances to the field edges.

To find out where skylarks gathered at the end of the first clutch breeding period we searched both fields (autumn wheat and adjacent spring barley,

Figure 1) by walking the unsown tracks to flush skylarks on 23 June, starting 0800 and ending 1600. Two people (ML & MP) spent a whole day walking 35 km (2×17.5 km) and searched for skylarks. The search started with tracks close to and along the gravel road and continued successively farther away from the road (Figure 2). During this search we also recorded singing skylarks that would indicate territory claiming for starting up a new clutch.

All possible nest predators passing over or close to the study field were recorded during all observations of skylarks.

Ground dwelling invertebrates

At Kvismaren a study of Ortolan Bunting *Emberiza hortulana* has been going on since 2009. With the intention to examine supply of food for that species in agricultural landscapes, a study was carried out in 2012 with collection of ground dwelling invertebrates in different foraging habitats. These invertebrates are also the main food for skylarks.

Presence of ground invertebrates was surveyed using pit fall traps that consisted of plastic cups (height 100 mm, width 70 mm) dug down to the ground surface and filled at the bottom with some water containing detergent. We used 5 traps within some 25 sq. m. each in 5 different habitat types (in total 25 traps): (1) unsown field (set aside), (2) a 2 m unsown strip along spring crop field, (3) at the shoulder of the gravel road, (4) oat field, and (5) potato field. The trap sites were situated in a similar part of the Kvismaren valley about 5 and 6 km from the study field of 2016. There were 3 collection rounds, on 18–22 May, 6–10 June and 24–28 June. The results are briefly presented here as they are relevant for the discussion of the food search of the skylarks.

Tractor tracks in Swedish autumn crop

In order to collect information on the occurrence of pre-prepared tractor tracks in Swedish grain fields, a 500 km car drive was carried out on 1 August 2016 through the provinces of Sörmland, Närke, Västmanland and Uppland. All grain fields bordering the road were checked for presence of tractor tracks of different kinds (pre-prepared or created when fertilising or spraying). The harvest of autumn wheat (and triticale) was just about to start.

Results

Crop height

In the study field the wheat stems grew from 0.45 m on 30 May, 0.75 m on 13 June, 0.80 m on 19 June and to 0.90 m on 30 June. The spring barley next to the main study field was about 0.2 m lower on 30 June.

Distribution of nest in the study field

A compilation of the grid cell nest notations is shown in Figure 2. Judged by this about 20 nests were involved in the study, during one or several days. The figure also shows that the nests appear to be randomly spread in the northern and central part of the field. However, in the south and south-western corner with no observation tower and closer to the highway, few or no nests were observed or searched for. No clear aggregation of nests is apparent, neither along the borders of the field or in the centre.

Visited nests

We visited randomly selected nests, three nests in autumn crop (calculated start of egg laying: 18, 21 and 23 May) and three in the adjacent spring crop (calculated start 13, 17 and 19 June) to check nest condition and development of the young. All nests had been built on flat ground in the crop a small distance away from unsown tractor tracks. Not far away from most nests we often found small patches of open ground (Appendix 1). The mean number of young was 3.66 and the nestlings were 6–9 days old. All clutches appeared to be developing normally. When approaching the nest, the young first hid in the nest cup but when disturbed and handled they were quick to try to escape.

Utilisation of tractor tracks, perches in the field and farm roads

Many of the larks were observed to use the unsown tractor tracks when they were landing in the field, both to forage and to deliver food to the nest (Appendix 2). Early in the season, when the crop was not so high and the tracks therefore were not so distinct it was hard to see if the larks were using the tracks to land. But later in the season when the crop got higher and denser it was obvious that the tracks were utilised (Figure 5). The field was both fertilised and sprayed 15 June by use of a tractor going twice in the tracks. During the passage the tracks were somewhat widened by the wheels through pressing down of some vegetation (Figure 4), which might be of sig-

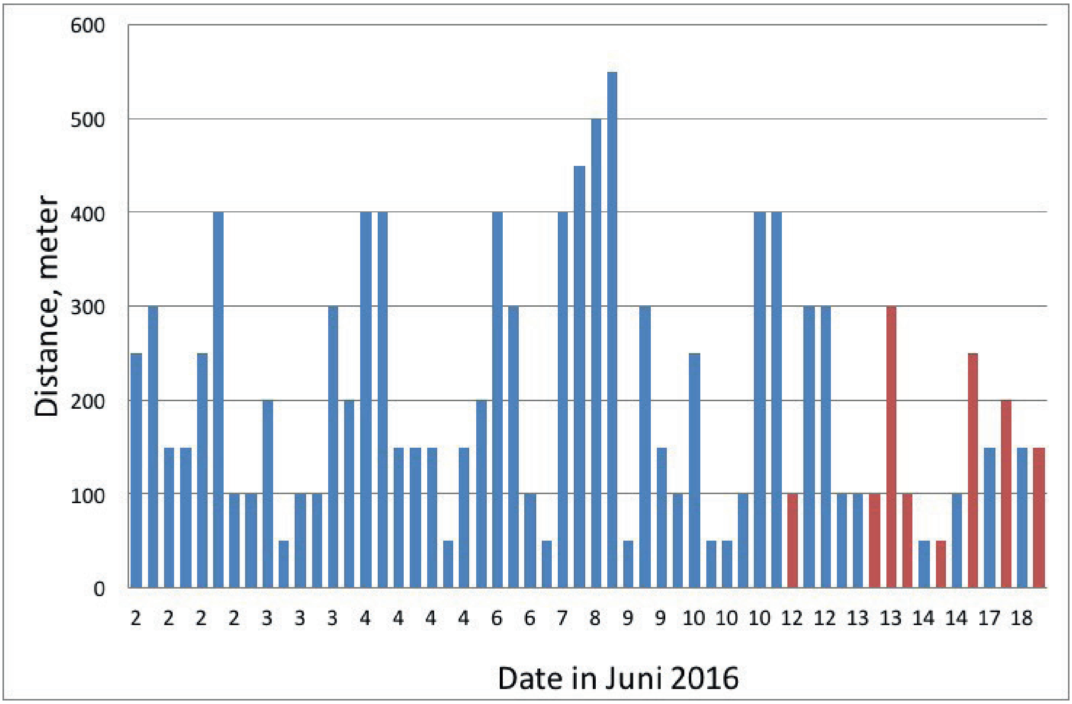

Figure 5. Estimated distances for food search during June 2016. Red bars indicate use of tractor tracks.
Uppskattat avstånd för födosök olika dagar i juni 2016. Röda staplar indikerar utnyttjande av traktorspår.

Table 1. Number and biomass of invertebrates collected in 2012 with pit fall traps (plastic cups) dug down to ground surface in five different farmland habitats (5 pitfall traps in each) in the Kvismaren valley.
Antal och vikt för ryggradslösa djur fångade i Kvismaren 2012 med fallfällor (plastglas) nergrävda till markytan, fem fällor i vardera av fem olika habitat.

Catching round *Fångstomgång*	Unsown field *Osått fält*	Unsown edge *Osådd åkerkant*	Shoulder of gravel road *Vägkant, grusväg*	Spring crop, oats *Vårsäd, havre*	Potatoes *Potatis*	Sum *Summa*
Round 1, 18–22 May *Omgång 1*						
Number of individuals *Antal individer*	163	82	372	121	70	808
Weight in grams *Vikt i gram*	8	8	6	4	11	37
Round 2, 6–10 June *Omgång 2*						
Number of individuals *Antal individer*	61	48	125	81	154	469
Weight in grams *Vikt i gram*	5	6	9	9	13	42
Round 3, *24–28 June* *Omgång 3*						
Number of individuals *Antal individer*	69	61	132	65	70	397
Weight in grams *Vikt i gram*	8	9	8	7	7	39
Sum; individuals *Summa individer*	293	191	629	267	294	1674
Sum; weight in grams *Total vikt i gram*	21	23	23	20	31	118

nificant importance to the larks' activity. Small open patches, due to irregular sowing for example, also occurred near nesting places (Appendix 1). Furthermore, at each water regulation well in the study field a small marker sticks could be found. These sticks were used by the birds for perching and also to sing. Several observations were made of birds using the water regulation well areas to land on the field both to access the nest and to forage for invertebrates.

The gravel road to the east was used as a resting (mainly in the afternoon, see "Flush study") and foraging area, particularly after the young had fledged and breeding was about to cease in the autumn crop field. A grassy farm road bordering the study field in the north was used for foraging, particularly at the end of the breeding period when the spring crop was also quite high.

Foraging behaviour and distance

During the period 30 May–19 June a total of 84 foraging trips were recorded (presented in detail in Appendix 2). For 61 of the foraging trips we could identify specific foraging places. Skylarks searched for food both within and outside the autumn crop to about the same extent (Appendix 2). Of the observed foraging places, 27 (44%) were situated within the wheat field and 22 (36%) in surrounding spring crop, and the remaining 20% outside along the farm roads. Regarding the outside foraging places, two were observed for skylarks finding food on the gravel road and 10 in the grass on a farm road at the northern border of the study field.

The unsown tractor tracks were used in the later part of the nesting season (Figure 5, indicated by red bars). Over the period 30 May–19 June the nest feeding activities in the autumn crop gradually decreased with date. After 13 June when the swords reached 0.75 m in the autumn wheat field a higher share of the larks was observed in that field in and around the tractor tracks (Figure 4). (The spring crop had at that time also grown fairly high.)

The estimated foraging distances in June varied from finding food close to the nest up to 550 m (Figure 5). The mean foraging distance in our study was 203.6 m, SD=70.7 m, N=56. Out of the observed foraging trips, 13 (22%) were estimated to be over 300 m with the longest being 550 m.

Invertebrates

Skylarks feed on small invertebrates found on the ground or in the ground vegetation (Smith et. al 2009). A total of 1 674 individuals of ground dwelling invertebrates, with a total weight of 118 grams, were identified using pit fall traps (Table 1). The abundance and biomass of invertebrates was moderately varying between habitat types and over time (Table 1). The number of individuals decreased from collection round 1 to round 2 and 3, mainly at the roadside habitat. The biomass expressed by weight varied between habitat types from 21 to 31 gram.

Flush study

In total 35 skylarks were observed during the flush study on 23 June (after the first clutch had fledged). In total 5 larks were flushed from the autumn crop and 8 from the spring crops. All larks were flushed from the unsown tracks in both fields with some droppings also being found in these open rows. Between the tracks additional larks may have dwelled, but remained unflushed, as the tracks were specifically used as walking paths during flushing. In addition, 10–13 skylarks were seen actively flying over each field. The activity of the skylarks decreased after midday and many were seen resting by sitting on the gravel road. Six birds were flushed by the car there when leaving the area. As the fields are of equal size (about 40 ha) the figures are comparative. During the flush study on 23 June no skylark song was heard in the area (during 8 hours of field work), indicating that territories for a second (or replacement?) clutch were not defended at that time.

Predators

Only one observation of an attempted predation event was made. It was a marsh harrier *Circus aeruginosus* unsuccessfully tried to catch a skylark. However, several potential predators were seen foraging in the field, such as fox *Vulpes vulpes*, marsh harrier, short-eared owl *Asio flammeus,* hooded crow *Corvus corone cornix*, jackdaw *Corvus monedula*, kestrel *Falco tinnunculus* and hobby *Falco subbuteo.* A pair of marsh harriers were breeding in a pond close to the SW corner of the field (visible in Figure 2), and a hooded crow was seen several times perching in the southern tower. The two latter species were observed on a daily basis. No smaller mammals such as hedgehog, ferret, weasel, mink, cat, etc. were observed in or even in the vicinity of the study field.

Tractor tracks in fields of central Sweden

Today the share of sowing machines having the function to leave rows unsown in conventional farming is estimated to be approximately 90% (Lennart Karsson, senior service supervisor at Vaderstad Ltd.). The car survey on 1 August 2016 showed that about 75% of the surveyed grain fields along the highways had tractor tracks. Fields without tracks were mostly organic fields, spring oats and spring barley fields. Almost all wheat fields had tracks, both autumn and spring wheat. In most autumn sown fields, the tracks were unsown and were clearly visible. There were also some spring wheat fields where green grain grew in the tracks indicating that no unsown rows had been prepared in advance.

Discussion

General

The skylark dominates the sky over open agricultural plains. This species is independent of song posts and avoids all forest edges and tree islets (Piha et al. 2003). It is the only common bird species in Sweden dedicated to wide open farmland. The skylark is an excellent flyer. In spring the male claims territory by singing for hours (Donald 2004). No other bird utilises uniform arable land to the same extent. It avoids fields smaller than about 10 ha (ca. 325 times 325 m) and chooses nest places at least 100–200 m from forest edges (Piha et al. 2003).

In 2014 grassland covered 45%, spring crop 23% and autumn crop 17% of the farmland area in Sweden (Jordbruksverket). The skylark is faithful to its breeding site from previous year (e. g. Delius 1965). Independent of the farmer's cultivation intentions of the actual spring the faithfulness is strong. If it is silage the whole reproduction of the year will be spoiled (Jenny 1990, Sondell et al. 2016). Autumn crop is also a crop that has been disputed. Is it good or bad for the larks? Do skylarks have difficulties reproducing in this type of crop that tends to be both high and dense? Results from England clearly indicate that autumn crop is too high, too dense and covers too cohesive an area. Measures there are thus necessary to maintain the population (Donald & Vickery 2000, Morris et al. 2004)!

Distribution of nests, foraging behaviour and distance

We estimated that around 20 skylark nests were active in the northern, central and eastern part of the field (Figure 2). The density of nests was thus of the same magnitude as in the territory studies 2015 (about 80 territories per km^{2,} Sondell et al. 2016). These data indicate that the large uniform area did not at all restrain the larks from breeding (Figure 2).

The study result shows that search for food at distances over 300 m was regular (mean distance at least 204 m) and up to 500 m was not uncommon (Figure 4), and that the larks searched for food both within and outside the autumn crop to about the same extent (Appendix 2). As there are very few fields suitable for autumn crop with areas larger than our study field practically all fields in Sweden are available for nesting by skylarks being able to search for food outside the field. Our study field was, as mentioned, among the largest in the province of Närke, and the situation is almost the same in other provinces according to *Google earth*. As the skylark population was relatively dense in the actual field (about 80 pairs per ha) the reproduction is obviously normal despite long feeding distances.

Tractor tracks

We noticed that when the crop grew higher the unsown tractor tracks played an increasingly important role as resting and food search habitat. In the study field these tracks covered about 2.5% of the total area. Another positive effect is that the tracks hosted a limited amount of weed at the ground, probably because of the shade and the compression from the tractor wheels (Figure 4). Weed may sometimes grew very dense where there is enough sunlight (and water supply which varies over time and years with the precipitation) and could potentially prevent the skylarks from finding invertebrates at the ground.

Negative effects of the tracks may be that they serve as corridors for smaller mammalian predators. Predator pressure was judged to be low in the study area. The visited nests were placed well off the tracks except one lying right between the two wheels. Nests placed in the actual tracks will be destroyed by the wheels early in the season.

Abundance of food

The study conducted with pitfall traps in the Kvismaren valley 2012 shows that there are plenty of invertebrates, independent of type of farming habitat. Therefore, the main question is whether the invertebrates are accessible for the skylarks or not (Menz 2008). The food is easier to catch on open ground or in low grass along roads, on open patches in the fields and along the tractor tracks when the crop stems grow higher. In areas of dense vegetation, the food is more difficult or impossible to extract. Our data indicate that there is food every-where, but critical for foraging success is to find a foraging area where it is possible to extract.

Breeding period and number of clutches

The issue about how many successful clutches the skylarks produce and its relative contribution to the production of young in a specific year is crucial for the long term population development of the species.

A breeding cycle covers about 45 days including (re)start with nest building (Donald 2004, Sondell et al. 2016). After 26 days it is possible to ring the young. The first ringing takes place in central Sweden during the last few days in May when the young are about 6 days old (data from the Swedish Bird Ringing Centre analysed by Sondell et al. 2016). Thus the breeding starts with nest building on average 1 May, egg laying around 5 May. A second clutch is possible and it will start around 15 June and end 30 July. More likely than a true second clutch a first failed clutch is followed by a replacement clutch. See Figure 6 for a sketch on the timing of the breeding cycle. In spring crop the start of breeding is delayed compared to autumn crop until the growing crop hides the nest as no nests are placed on open soil.

The issue about number of clutches can also be elucidated by the 2015 studies at Kvismaren (Sondell et al. 2016). In the large silage field (50 ha housing about 40 pairs) all nests were destroyed on 8 and 10 June by the harvest. An inventory on 7 July showed 0.31 and one on 17 July 0.17 song territories per hectare compared to 0.83 per hectare in May. Although the larks had got the nest destroyed when having only half grown youngsters in the nests their willingness to start a replacement clutch was low. Most probably only part of the 20% (theoretically 8.5 pairs) that were singing again on 17 July fulfilled a replacement clutch.

To understand the timing of breeding it is also essential to know the start and length of the moult period. The period of primary moult for skylarks in England is 60 days (in Lincolnshire; Davies 1981) or 58 days (Ginn & Melville 1983) and starts, as for most passerines, directly after breeding in July and ends in the middle of September. No moult data on skylarks is accessible from Sweden but a common species at Kvismaren living in the same farming areas is the yellowhammer *Emberiza citrinella*. The moult periods are fairly compatible. Its primary moult is of the same length as for skylark, or 58–60 days in England (Ginn & Melville 1983) and in Sweden, a complete wing moult (primaries and secondaries) is carried out in 67 days (611 birds studied 1976–2015, Kvismare Bird Observatory, unpublished data). The yellowhammer moult at Kvismaren starts on average on 18 July and is finished around 25 September. (Later in the year if access to invertebrates for building new feathers is scarce.) According to the accessible data only a minority of the yellowhammers are able to start a true second clutch in the middle of June as it will not be finished until the end of July. The timing agrees with that of the skylark (Figure 6).

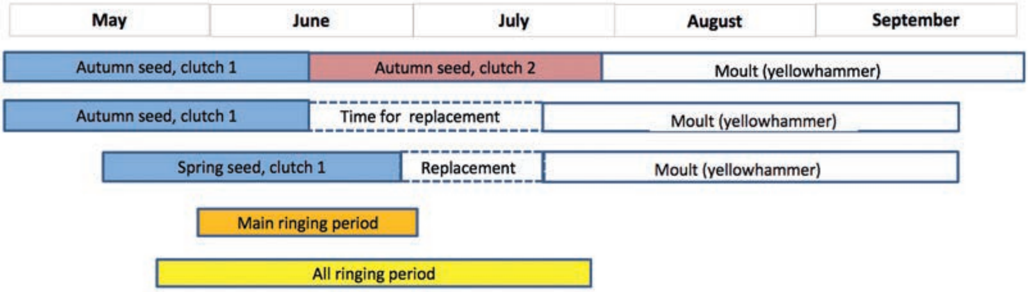

Figure 6. Schematic view of timing of breeding and moult for skylarks in Sweden. Nest building, egg-laying, incubation and feeding young takes about 45 days. The period for moult is assumed to be identical with that of the yellowhammer, which is 67 days. Ringing periods for skylark nestlings according to Swedish Bird Ringing Centre.
Principskiss över tidsåtgången för sånglärkans häckning och ruggning i Sverige. Bobyggnad, äggläggning, ruvning och ungmatning tar ca 45 dagar. Ruggningsperioden som antas vara densamma som hos gulsparv är ungefär 67 dagar. Ringmärkningsperioderna för boungar av sånglärka är härledda från Ringmärkningscentralens data.

Timing of breeding

As discussed above the reproduction of skylarks in Sweden mainly relies on the output from the first clutch as for most other passerines (Sondell & Schilt 1985, Sondell 1987, 1993, 2000, Sondell & Nielsen 2015). A second clutch is, as discussed above, less likely in Sweden. Most passerines have only one clutch. Judged from the moult card archive at Kvismare Bird Observatory (13 000 cards 1973–2016) and so far published data, they have time only for a replacement clutch if necessary (Figure 6). UK reports on skylarks suggest that the skylarks frequently produce several clutches each year, probably because the predation pressure from small mammal predators is high, and replacements are regular (Morris et al. 2008, Buckingham et al. 2015). At Kvismaren the predation risk is probably lower and is mainly caused by birds (harriers, crows etc.) as in the Czech Republic (Praus et al. 2010). Some nests may possibly be damaged by the tractor wheels in unsown tracks.

The skylarks started to breed earlier in autumn crop, compared to the spring crop adjacent to our study field (median ringing date for our three nests in autumn crop was 13 June and for three nests in spring crop 7 July), as the plants there were able to hide a nest earlier in spring. From a temporal point of view, autumn crop is thus preferable as breeding habitat compared to springs crop, as the young may become independent at least 1–2 weeks earlier (Hiron et al. 2012, Sondell et al. 2016). In the summer of birth, the skylark young will carry out a complete moult of body, wing and tail feathers. The earlier such a moult takes place the better, as the feather growth is dependent on nutrients from invertebrates (protein). There are also many studies stating that passerines starting the breeding cycle earlier have higher reproductive success in terms of fledged young, e.g. Perrins (1970).

May unsown tractor tracks replace skylark plots?

The technical function to leave tracks unsown was first marketed by Väderstad AB (Vaderstad Ltd) in 1984–1985, the biggest manufacturer of sawing machines in Sweden with a market share of about 80% (Lennart Karsson, senior service supervisor at Vaderstad Ltd). This function has successively been more and more adapted by the farmers, by getting both new sowing equipment and more sophisticated steering devices (GPS/RTX). Previously the tractor wheels only depressed the stems, and depending of number of passages and the date during the growing season, the plants more or less recovered. The recovery was delayed as the stems in the tracks matured later and were often still green at harvest time. To harvest green grain increases the moisture content of the crop and increases the drying cost. Therefore, unsown tramlines have gained terrain in later years. Today most tracks in autumn crop in central Sweden are unsown.

The solution in the UK to support skylark reproduction was to create skylark plots, recommended by RSPB to cover about 0.5% of the fields to improve the foraging habitat. The skylark plots are promoted by saying that the breeding output doubles, but this is true mainly in the later part of the breeding season. For early clutches the lark plots make little difference (Morris et. al 2004). In Sweden the first clutch is (as argued above) most significant for the reproductive output.

The crop is probably lower and less tight in Sweden compared to England, and autumn crop covers only 10–25% of the total farmland area, varying between regions and years (Jordbruksverket). The unsown tractor tracks in the study field covered an unsown area five times larger than that recommended for lark plots and these tracks were also evenly distributed over the field. Furthermore, lark plots more often get covered with weed because they are exposed to more intense light at ground level, in comparison to the tractor tracks (own observations).

Later in the season when the crop had grown higher, we observed that the tracks were frequently used (Figure 5), probably both for feeding, resting (flush study) and to get easy but hidden access to the nests. The study therefore indicates that skylark plots may not be needed at all on farmland in Sweden where nowadays unsown tracks are present in most fields.

Resources today earmarked for conservation of skylarks are in my view put to best use in efforts to reduce the disastrous loss young of skylarks, and many other farmland bird species, when harvesting silage fields (Sondell et al 2016). More research is needed to find the best methods to do this.

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Sammanfattning

Inledning och syfte

Sånglärkan är Sveriges tjugonde vanligaste art och den största förekomsten finns i de stora slättbygderna. Även om arten är vanlig så visar inventeringar att den minskat under flera decennier. Från England har rapporterats att arten inte trivs i höstsäd eftersom den är för tät för födosök och numera sås över stora sammanhängande arealer. År 2015 genomfördes studier i Kvismaren som visade på en relativt tät lärkstam (ca 80 par per kvadratkilometer) men också på att alla lärkor som häckade i vallodlingar fick sina bon förstörda av den tidiga höskörden. I vårsäden verkade häckningarna förlöpa normalt. Frågan om återstod var hur det gick med häckningarna i höstsäd i Sverige representerade av området runt Kvismaren.

Syftet med lärkstudierna 2016 i Kvismaren var alltså att undersöka hur häckningarna lyckades i höstsäd. Har vi samma problem som i England? Intressant var att se hur långt sånglärkorna tvingades flyga för att finna föda och om det var någon principiell skillnad i höst- och vårsäd. En 2012 genomförd studie av tillgången på ryggradslösa markdjur, som är del av födotillgången för lärkorna redovisas också här.

Studieförutsättningar

Kvismardalen är en sammanhållen slättbygd ca 15 km SO Örebro. Via *Google earth* lokaliserades det största tillgängliga höstvetesfältet i Kvismardalen. Det var beläget på Mörby egendom mellan Asker och Odensbacken (Figur 1). Fältet var på 40 hektar (450×900 m) och valdes för att studera på hur långt håll lärkorna kunde söka föda. Fältet visade sig vara bland de större i landet, vilket framgick vid ett kartsök som genomfördes i övriga slättbygder. Det stora vetefältet i Mörby var omgivet av vårsädesfält och gränsade i söder till länshuvudväg 52. Fältet var homogent och enformigheten bröts bara av ett enda träd och fem rensbrunnar, markerade med käppar (Figur 3).

Fältet hade hösten 2015 sått s med en *Väderstad Combi Rapid* såmaskin, märket är marknadsledande. På fältet gjordes vid sådden två traktorspår på 24 meters avstånd genom att 2+2 rader inte såddes. Traktorn skulle sedan följa dessa spår nästa vår och navigerade då med hjälp av GPS och med RTX-stöd (markkorrektion). På så sätt erhölls raka sårader som traktorn också kunde följa hela växtperioden 2016. Två gånger två sårader stängdes av (teoretiskt 0,375 m per hjul) för att erhålla osådda spår åt traktorn som hade 0,3 m breda däck (Figur 2). Fältet sprutades med biocider två gånger och gödslades med fyra mindre givor för att gödsel inte skulle lakas ut till grundvattnet.

Studiemetodik

För orientering sattes stakkäppar upp längs fältets östra och norra kant. Därtill fanns de fem brunnarna för vattenreglering på olika avstånd (Figur 2). Från tre plattformar skapades bra utsikt över fältet (Figur 3). Totalt 80 mantimmar spenderades på att följa lärkorna. Studien utfördes perioden 30 maj till 19 juni då matning av ungar pågick i stor omfattning. Höjden på sädesstråna mättes tio gånger under juni månad. Sädens stråhöjd ökade från 0,45 m den 30 maj, 0,75 m 13 juni, 0.8 m 19 juni och till nästan 0,9 m den 30 juni. Vid observationerna var det viktigast att bedöma matningsaktiviteten och notera bonas lägen, längden på födosöksrundorna och i vilken typ av vegetation lärkorna sökte föda. Varje observationsdag (17 av 21 tillgängliga dagar, 80 mantimmar) sökte observatörerna slumpvis upp ett eller flera lärkbon med stor aktivitet och noterade var på åkern boet låg (exakt riktning med tub och bedömt avstånd). Efter tre matningar och därpå följande uppflog var detta i regel fastställt. Sedan registrerades födosök om något av följande tre kriterier var uppfyllt:

Komplett fördosöksrunda inkluderande att lärkan lyfte från boet, landade i födosöksområdet och återvände till boet med föda.

Lärkan lyfter från boet och landar i födosöksområdet eller försvinner långt bort. Detta gällde mestadels på långa håll.

Lärkan kommer flygande från födosöksområdet och landar vid boet. Detta hände oftast på kortare avstånd.

Sex bon besöktes för att konstatera häckningsutfallet. Studierna avslutades med ett eftersök av var lärkorna höll till i området den 23 juni, då häckningen bedömdes vara i stort sett avslutad. En promenad längs traktorspåren i båda fälten företogs, totalt ca 35 km (2 observatörer gick vardera 17,5 km).

Redan 2012 gjordes en studie för att studera i vilka habitat det fanns mest ryggradslösa djur som kunde vara lämpliga som föda för bl.a. sånglärka. Fem fällor i form av plastglas grävdes mer i fem biotoper: osått fält (träda), osådd kant längs fält med vårsäd, på kanten av grusväg, i havrefält samt i potatisfält. Tre fångstomgångar genomfördes i varje biotop i maj–juni.

Den 1 augusti gjordes en 500 km lång biltur genom Mellansverige för att undersöka frekvensen traktorspår i åkrarna. Alla åkrar intill vägen kontrollerades. Skörden av höstvete skulle just starta.

Resultat

Antalet observerade födosök redovisas i tabell 1. Totalt har 84 matningar registrerats från 61 platser, 27 inom höstsädesfältet och 22 utanför i vårsäd. Därtill kommer 2 på grusvägen och 10 i gräs på en körväg mellan åkrarna. Alltså var 45 procent av födosöket inom häckningsfältet, 35 utanför och 20 längs vägarna i kanten av studiefältet. Avståndet var i medeltal minst 204 m. 22% bedömdes till längre än 300 m och det längsta till 550 m. Efter den 13 juni då vetestråna nått 0,75 m sågs en ökande andel av lärkorna i vetefältet hålla till i och omkring traktorspåren (Figur 5).

Fördelningen av bon på studiefältet framgår av Figur 2. Troligen var ca 20 bon föremål för våra studier under en eller flera dagar. Bona är utspridda över hela fältet utan tydliga aggregeringar i någon del. Vi kontrollerade 6 bon varav tre låg i höstsäd och tre i vårsäd intill. Utifrån våra stickprov av bobesök bedömde vi att bona utvecklades normalt.

Många lärkor noterades använda traktorspåren för födosök, vila och dold väg till boet. I början av matningsperioden var det svårare att se hur lärkorna rörde sig i fältet i förhållande till spåren. När stråna blev högre blev det lättare och den sista veckan blev spåren allt viktigare. Vid inventeringen den 23 juni stöttes alla lärkor från traktorspår, men eftersom traktorspåren användes för att gå genom fältet, finns det en möjlighet att lärkor kan ha undgått att stötas om de befunnit sig utanför spåren. Studien resulterade i att 5 lärkor flög upp ur höstsäden och 8 ur den närliggande vårsäden. Dessutom sågs 10–13 lärkor i luften över vartdera fältet.

Traktorn gjorde sex överfarter, två för sprutning och fyra för gödsling vilket gjorde att spåren hölls uppkörda (Figur 4). Förutom i spåren hittades små öppna ytor i närheten av bona (Appendix 1).

Fångade ryggradslösa djur redovisas i tabell 1. Där framgår att det fanns ungefär lika stora mängder potentiella bytesdjur oberoende av typ av markunderlag på Kvismarslätten.

Häcknings- och ruggningsperiod redovisas i Figur 6. En häckningscykel täcker ca 45 dagar inklusive bobyggnad. Via ringmärkningsdata går det att ungefärligt härleda lärkornas häckningsstart i mellersta Sverige. Efter 26 dagar är nämligen lärkungarna märkstora (6 dagar). Häckstart sker alltså ca 1 maj. Om en andrakull läggs kan den i medeltal startas tidigast 15 juni och vara klar 30 juli. Troligare är att en ersättningskull läggs om förstakullen misslyckas (Figur 6).

Ruggningen av sånglärkans handpennor tar i England 58–60 dagar och startar direkt efter det att häckningen är avslutad. Från Sverige finns inga ruggningsdata men för gulsparven, som finns i ungefär samma biotop har vi fina data. Gulsparven ruggar lika fort som sånglärkan i England och i Kvismaren tar hela vingruggningen (handpennor och armpennor) 67 dagar i medeltal. Gulsparven startar rugga i medeltal 18 juli och är klar 25 september. Bara en mindre del av gulsparvarna bedöms alltså teoretiskt kunna starta en ren andrakull. Tidsschemat överensstämmer sannolikt med sånglärkans.

Tänkbara predatorer observerades i begränsad omfattning. Vanligast var kråka och brun kärrhök. En kärrhök sågs vid ett tillfälle jaga en sånglärka utan framgång.

Studien från bil längs huvudvägar i mellersta Sverige för att bedöma frekvensen traktorspår i sädesfälten visade att ca tre fjärdedelar hade traktorspår. Det var fält som odlades ekologiskt men också vissa fält av vårsäd av havre och korn som saknade spår.

Diskussion

Sånglärkan dominerar den öppna slätten och avskyr skog. Den är en utmärkt flygare och kan på våren hävda revir sjungande i luften under många timmar varje dag. Vid studier i Kvismaren 2015 visade det sig att häckningar i vallodling förstördes av den tidiga ensilageskörden medan häckningarna i vårsäd utvecklades normalt (fyra bon kontrollerades). Från England har det kommit signaler om att höstsäden utgör ett mindre bra häckningshabitat därför att den är hög och tät och täcker stora sammanhängande åkerarealer. Åtgärder i form av lärkrutor behövs. Frågan är hur förhållandena är i Sverige.

För studien valdes ett mycket stort fält, detta för att studera på hur långt avstånd sånglärkorna kunde hämta föda. Där häckade många par sånglärka, uppskattningsvis ca 30 par. Den stora homogena ytan hindrade inte lärkorna att häcka – tvärtom! Vi noterade att 300 m provianteringsavstånd var normalt och i vissa fall flög lärkorna en halv kilometer. Lärkorna sökte dock föda inom och utom fältet i ungefär samma utsträckning. När säden blev högre koncentrerades födosöket till traktorspåren där marken fortfarande var åtkomlig och relativt öppen (Figur 2). Spåren utgjorde 2,5% av den totala arealen av det studerade fältet.

Vår studie av ryggradslösa smådjur visade att dessa, som potentiell föda, förekom ungefär lika talrikt över hel jordbruksmarken. Frågan är alltså inte främst tillgången till bytesdjur utan om dessa är åtkomliga för lärkorna eller inte. I kortare vegetation som traktorspår och vägkanter är det givetvis lättare att hitta föda.

Tidsåtgången för häckning och ruggning är schemalagd. Eftersom en häckningscykel tar 45 dagar och först kommer igång omkring 1 maj och ruggningen troligen tar ca 67 dagar är det osannolikt att sånglärkan normalt genomför två häckningar inom studieområdet. Däremot hinns troligen ofta en omläggning med om boet prederas (Figur 6). Sånglärkans aktivitet på fälten går också enligt våra observationer snabbt ner i slutet av juni. Vid inventeringen 23 juni sjöng inga revirhävdande sånglärkor. De fåglar som häckar i höstsäd kan genomföra häckningen minst 1–2 veckor tidigare än paren i vårsäd. Att få ungarna tidigt flygga är alltid en stor fördel för mindre tättingar.

Möjligheten att lämna osådda traktorspår har funnit i ca 30 år i Sverige. Sådana osådda traktorspår erbjuder lärkorna fem gånger så stor areal öppen jord (eller låg vegetation) på sädesfälten jämfört med anlagda lärkrutor. Dock finns idag inga publicerade svenska data på häckningsframgång för sånglärkor i höstsäd med lärkrutor jämfört med enbart traktorspår. Jag anser att sånglärkan bäst skulle gynnas genom att försöka minska förlusterna vid tidig skörd av vallodlingarna. Hur detta bör gå till måste studeras vidare.

Appendix 1

Location of two Skylark nests in 2016 at Mörby, Kvismaren valley
This Appendix was written by Lei Stanley Tang

In June 2016 I have found three nests of the Skylark in autumn crop at Mörby. All three nests were well hidden at the root stems of the crop (wheat), surrounded by tall stalks. Very close (0.1–0.5 m) to each nest, I found small patches of openings which were on average at 0.5-1.0 meter in diameter. Droppings from the adults were easily visible at two of the three nests (Figure 7). During the feeding observations we noticed that adult skylarks usually land at locations nearby the nest and lift straight from the nest after feeding the chicks (Donald 2004). Consequently, I suspect that the observed open patches near the nests were used as landing platforms or roosting sites. It is also possible that the larks used the ground patches to prepare (kill) caterpillars or larvae before offering them to the young. In addition, the openings may also be used as navigation landmarks for the adults to find their nests through the homogeneous field.

Figure 7. Photos showing open patches observed near two of the skylark nests. Yellow dots indicate the nest locations and its size and red circles mark the open patches.
Foton som visar öppna fläckar intill två bon av sånglärka. Gula fläckar indikerar bon och röda cirklar öppna fläckar.

Appendix 2

Observations of skylarks feeding nestlings 30 May–19 June 2016, breeding in autumn wheat. Each row (n=61) gives the number of consecutive trips to the same foraging place, location of the nest according to Figure 2, distance between nest and foraging place, and the habitat of the foraging place. *Observationer av ungmatningar 30 maj–19 juni 2016 för sånglärkor som häckade i ett höstvetefält. Varje rad (n=61) anger antal vändor i följd till samma födosöksplats, boets belägenhet enligt Figur 2, avstånd mellan bo och födosöksplats samt födosöksplatsens habitat.*

	Nest in	No. of	Flight	Place for foraging *Födosöksplats*			
Date	square	turns	distance	Autumn	Spring	Farm road	In tracks
Datum	*Bo i ruta*	*Vändor*	*Avstånd*	*Höst*	*Vår*	*Gårdsväg*	*i spår*
30 May	A2	1	?		x		
30 may	A2	1	?		x		
31 May	F4	1	?	x			
2 June	C1	1	250	x			
2 June	C4	1	300		x		
2 June	C4	1	150	x			
2 June	D5	2	150	x			
2 June	E1	1	250			Grass	
2 June	E3	3	400			Grass	
2 June	G1	1	100	x			
3 June	B1	1	?			Grass	
3 June	G1	1	100			Grass	
3 June	G1	1	200		x		
3 June	F1	1	50			Gravel	
3 June	F1	1	100	x			
3 June	F1	1	100		x		
3 June	F1	1	300		x		
4 june	C2	1	?		x		
4 june	C2	1	200	x			
4 june	C2	1	400		x		
4 june	C2	1	400		x		
4 june	C2	1	150	x			
4 june	G1	3	150	x			
4 june	G1	1	150		x		
4 june	F1/G1	1	50	x			
4 june	F1/G1	1	150	x			
4 june	F1/G1	1	200		x		
6 June	C3	2	400		x		
6 June	B3	1	300		x		
6 June	A1	1	100	x			
6 June	A1	3	50			Grass	
7 June	G2	1	400			Grass	
7 june	D3/D4	3	450		x		
8 June	C4	1	500		x		
8 June	C4	1	550		x		
9 June	A1	1	50			Grass	
9 June	A4	1	300		x		
9 June	B2/B3	2	150			Grass	
10 June	A4/B4	1	100	x			
10 June	A5	1	250		x		
10 June	A5	1	50			Grass	
10 June	A5	1	50	x			
10 June	A5	1	100	x			
10 June	A5	1	400		x		
10 June	A4	1	400		x		
12 June	B3	1	100	x			x
12 June	B2	1	300		x		
12 June	B2	1	300		x		
12 June	F3	1	100	x			
13 June	A4	4	100	x			
13 June	F3/F4	2	100	x			x
13 June	F3/F4	2	300	x			x
13 June	A4	1	100	x			x
14 June	A5/B5	2	50			Gravel	
14 June	A5/B5	2	50	x			x
14 June	A5	1	100			Grass	
15 June	D4	3	250	x			x
17 June	F3	2	150	x			
17 June	F3	2	200	x			x
18 June	D3/E3	1	150	x			
19 June	D3/E3	2	150	x			x
Sum *Summa*		84		27	22	12	

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Shift in migration phenology of a wintering population of Dippers *Cinclus cinclus i*n northern Sweden

Förändring i fenologi hos övervintrande strömstarar Cinclus cinclus *i norra Sverige*

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EMIL FÜRSTENBERG-HÄGG

Abstract

Many organisms have been found to respond to global warming by adjusting one or several aspects of their ecology, such as timing of migration events, time at reproduction and size at maturity. We examined changes in arrival and departure times, and age and sex ratios of overwintering White-throated Dippers *Cinclus cinclus* in northern Sweden, by comparing data collected in 1975–1979 to a similar dataset from 2010–2014. Between these periods, the average winter temperature had increased by about 2°C. During the latter period the Dippers arrived in their winter area two weeks earlier and departed three weeks earlier. We found no change in age and sex ratios during the study period.

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Introduction

Among birds, several effects of climate change have been reported. There are good evidence showing an earlier arrival to, and an earlier departure from the breeding grounds, and these changes are associated with a warmer climate (Hüppop & Hüppop 2003, Cotton 2003, Møller et al. 2011). However, these changes are not consistent among species groups. For example, Jenni & Kéry (2003) found that autumn migration had advanced in species overwintering south of the Sahara while those overwintering north of the Sahara had delayed their departure. The result of these studies also suggests that many birds leave from and arrive to their winter areas earlier. Some support for this has been found. For example, Gordo et al. (2005) found that the climate at the wintering grounds had a stronger influence on the arrival date to the breeding area than the climate changes at the breeding areas. However, Thorup et al. (2007) and Van Buskirk et al. 2009 found that autumn migration showed no strong and consistent pattern with regard to departure time from breeding grounds. More data on the arrival and departure time from wintering grounds would therefore be a valuable contribution for a better understanding of the year-around migration phenology. In addition, there are only few studies available that have focused on how migration pattern changes in birds overwintering in areas where winter temperature goes below 0°C for shorter or longer periods. But studies on waterbirds have shown that in these areas ducks have advanced their spring arrival, and winter population densities and species number of waterbirds have increased, since the 1990s (Guilleman et al. 2013, Musilova et al. 2015).

The White-throated Dipper *Cinclus cinclus* is an interesting species for studying the possible effects of global warming at wintering grounds because it overwinters in areas with low temperature and its wintering areas are well known (Fransson & Hall-Karlsson 2008). The Dippers in our study belong to the subspecies *C. c. cinclus* and breed primarily in western Scandinavia. After breeding, the birds of this sub-species usually migrate 400–750 km southwest, south or southeast to their wintering areas (Andersson & Wester 1976, Lehikoinen & Hakala 1988, Vuorinen & Tyrberg 1994, Fransson & Hall-Karlsson 2008). In the wintering areas in northern Sweden, the average winter temperature (December–February) has increased with 2–3°C from 1961–1990 to 1991–2011 (SMHI 2015a). This increase in temperature might have affected arrival and departure date of overwintering Dippers in the area.

Lundberg et al. (1981) studied the winter ecology of White-throated Dippers in the province of Västerbotten in northern Sweden, collecting data from 1975–1979 on the arrival and departure time, and age and sex ratios of overwintering birds. By conducting a similar study, our main objective was to determine if migration phenology of Dippers in northern Sweden has changed during the last 35 years, in parallel to the increase in average winter temperature. In addition, we compared the age and sex ratios during this period. Lundberg et al. (1981) found a tendency for females and juveniles to arrive relatively earlier in the autumn, and it is interesting to examine if this pattern has changed. We predict that birds would both arrive at and leave their wintering areas earlier because this would match the earlier arrival and departure to breeding grounds that have been found in several other species (Cotton 2003, Jonzén et al. 2006). We had no a priori predictions for changes in age and sex ratio.

Methods

Lundberg et al. (1981) studied the winter ecology of Dippers in three streams in the province of Västerbotten: Ängerån (63°34’47”N, 19°50’9”E), Kvarnfors (63°58’13”N, 20°7’8”E), Norsån (64°15’29”N, 20°14’48”E), (Figure 1). For comparison with the results reported in the 1970s, we conducted a similar study in 2010–2014.

Lundberg et al. (1981) visited each location two to three times per month from November to April 1975–1979. During visits, mist nets were used to capture birds, and sex and age were determined according to Andersson & Wester (1972) and Svensson (1975). Wing length was determined with the maximum length method (Svensson 1975), and individuals with a wing length >94 mm were scored as males and those <94 mm as females (Svensson 1975). Each bird was also banded with a metal band. Visits once a week during October and May revealed that no Dip-

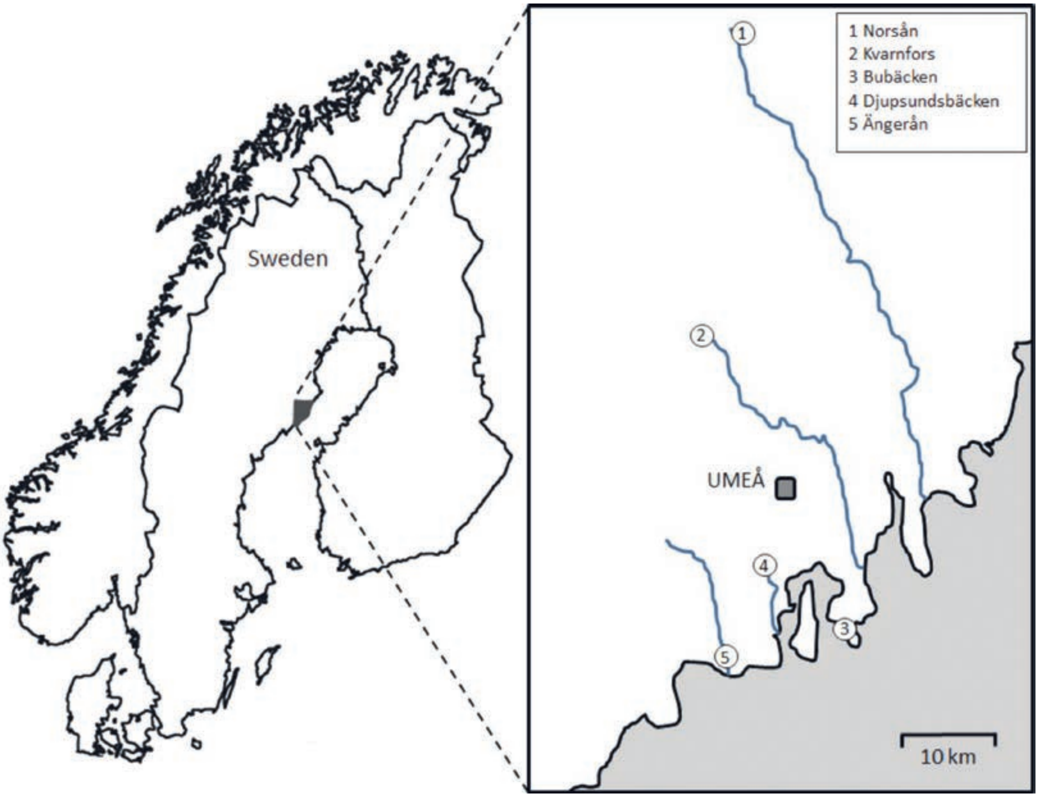

Figure 1. Map showing the study area and localities studied.
Karta över studieområdet som visar undersökningslokalerna.

pers were present in the area during these months. The absence of birds was determined by walking along the streams at a stretch about 400–500 m. All results presented in Lundberg et al. (1981), were based on the number of birds caught and identified through mistnet captures.

In our repeated study in 2010–2014, it was unfortunately not possible to study Dippers at all of the same locations, because of limiting access at the old sites. But one of the sites was the same as in Lundberg et al. (1981). However, all locations are in the same area in northern Sweden and within a radius of 39 km. The locations in our study sites were Djupsundsbäcken (63°41'30"N, 20°23'13"E), Kvarnfors (63°58'13"N, 20°7'8"E), and Bubäcken (63°45'19"N, 20°12'31"E) (Figure 1). All streams are surrounded by boreal forest, have a stream width of about 2–5 meters, and stream bottoms that are dominated by hard substrate consisting of a mixture of sand, gravel, cobble and boulder. Stream order (a measure of stream size and nutrient flow, Strahler 1957) varied between 1 and 2. First order streams (1) are the outermost tributaries, which join together to form a second order stream 2, and so on. The new sites were chosen based on their similarity to the former study sites in environmental variables, and because they had overwintering Dippers. Information on overwintering Dippers were obtained from local birders and the Swedish Species Observation System for bird reports. The Species Observation System is a web-based platform where the public can report sightings of Swedish plants, animals, and fungi (http://www.artportalen.se).

The streams were visited once each week from approximately October 15, which is before the first Dippers arrived, to April 15 which is after the last Dippers had left. The presence or absence of birds was determined by walking along the streams at a stretch of about 400–500 m. If birds were observed during this initial walk, we always put up mistnets and tried to capture the Dippers, independent of whether they were previously banded or not. If no birds were observed during the initial walks, no mistnets were used. This gave us information on arrival and departure of the banded birds. Information from local birders, and records in the Swedish Species Observation System for bird reports, indicated no presence of Dippers outside the period of our visits to the streams, and accordingly, no evidence of breeding, in any of the studied streams during the 1975–1979 and 2010–2014 periods. In the province of Västerbotten there were only five reported records in total of Dippers outside the study period. Indeed, very few indications of suspected breeding (and no confirmed) have been reported within a radius of 50 km of the study area (Olsson & Wiklund 1999, Swedish Species Observation System for bird reports). Depending on the stream and the ice situation, Dippers were only captured along a 100–400 m section of the 400–500 m distance initially walked to confirm presence or absence of birds at each site. Once a bird was captured, the date was noted, and sex and age was determined as in Lundberg et al. (1981). No birds with a wing length of 92–95 mm were caught (males >94 mm and females <94 mm; Svensson 1975). We therefore feel certain that our sex determination is correct. Since neither Lundberg et al. (1981) nor we visited the streams on a daily basis the earliest and last sighting by a bird could differ at a maximum of 7 days from the true arrival and departure day. As in Lundberg et al. (1981) the results are based only on birds caught and identified through mistnet captures.

We also calculated average monthly temperature (December, January, and February) based on data from Umeå airport weather station for 1966–1980 and 2001–2014 (SMHI 2015b). This weather station is situated within the 39 km radius of the study sites. The chosen periods also included 10 years prior to each study period, because we assumed that birds do not adapt instantaneously to changes in winter temperature.

Statistical analysis

Raw data on birds banded in 1975–1979 was available from The Swedish Museum of Natural History. However, that data did not show the recaptures at the local level. Hence, it could not be used for our purpose because it did not show the length of the stay of each individual at a yearly basis. Instead, we examined possible differences between time periods by comparing mean values and 95% confidence intervals provided by Lundberg et al. (1981) with the averages and confidence intervals estimated in our study. If the confidence intervals between the two time periods overlapped for the variables in focus we determined the comparison between the time periods as non-significant. Mean and confidence interval from the variables in Lundberg et al. (1981) were obtained graphically by scanning the figures from their article, and then using the program Image J (Abramoff et al. 2004) to estimate the mean and error bars from each of their figures. The program allows to measure values directly from the figures, since a measurement scale, which is used as a reference scale, can be drawn along the axes in the scanned figures. When error bars were given as standard errors (SE) in Lundberg et al. (1981), we recalculated the SE to 95% confidence intervals by multiplying the SE by 1.96. For the 2010–2014 data sets, we had the raw data and calculated mean values and 95% confidence intervals in Microsoft Excel (Microsoft 2007). We merged data from all three streams before calculating the monthly means per year for the period 2010–2014 (as in Lundberg et al. 1981) for this later period.

Three variables were compared between the two study periods. 1) Numbers of overwintering birds were compared by comparing the percentage of birds each month estimated from the total number of birds for the entire winter. Total number of birds was estimated from the numbers banded. We first calculated the percentage of birds caught each month for each year and then the average and 95% confidence interval for the period using year as replicates. 2) The percent of adult birds per month was estimated by first calculating the percentage for each month and year and thereafter retrieving a mean value and 95% confidence interval for each month averaged over the whole time period. 3) Sex ratio was calculated in the same way using percentage of males as the variable instead of percentage of adults. In summary, we could only compare the periods quantitatively using mean and 95% confidence intervals, and some caution must therefore be taken when interpreting the results. The comparison was done with the actual numbers retrieved or calculated, but we present figures showing mean and 95 % confidence intervals.

Results

Number of overwintering birds and temperature increase

Lundberg et al. (1981) captured and banded 63 Dippers in the three main streams (Ängerån, Kvarnfors, and Norsån) in 1975–1979. In 2010–2014, we captured 43 Dippers in Djupsundsbäcken, Kvarnfors, and Bubäcken. In total 21 of these 43 Dippers were recaptured within the winter season of ringing, on in total 44 occasions. The total number of trapping occasions (new ringing plus recaptures over the five years was 30, but the number of visits to the streams was considerable larger. Site fidelity of the Dippers to a specific stream was high within in the years 2010–2014, with banded Dippers only being recaptured in the stream where they initially where captured and banded. High site fidelity was also reported by Lundberg et al. (1981). The average temperature increase between the two study periods was about 2°C (Table 1).

Table 1. Average monthly temperature (°C) at Umeå airport for 1966–1980 and 2000–2014, and increase in average monthly temperature between the two periods.
Medeltemperatur vid Umeå flygplats för åren 1966–1988 och 2000–2014, samt ökning*en i medeltemperatur mellan dessa tidsperioder.*

Years/month	December	January	February
1966–1980	-5.7	-9.1	-9.7
2000–2014	-3.9	-6.5	-7.2
Temperature increase	1.8	2.6	2.5

In 2010–2014, a significantly greater proportion of birds had already arrived in October and November as compared to 1975–1979 (Figure 2; no overlap of 95% confidence intervals). No birds were present in the area during October 1975–1979, but four birds were present in October 2010–2014. For the period from December to March, the 95% confidence intervals overlap, suggesting no difference between the two periods in proportion of birds present each month. No Dippers were in their wintering areas in April during 2010–2014, but ~8% of the birds were still in wintering areas in April 1975–1979 (Figure 2). The earliest arrivals and latest departures were 3 November and 23 April, in 1975–1979, and 19 October and 28 March in 2010–2014. These data suggest that, since 1979, Dippers have started arriving in wintering areas two weeks earlier and leaving more than three weeks earlier. Since we visited the streams once a week the exact advance of arrival and departure date might differ by a maximum of 7 days. Even with these 7 days of uncertainty included there is still a shift of 1–2 weeks in arrival and departure time.

Percent adult birds and sex ratio

Juvenile birds seem to arrive to the overwintering area before the adults, and this was evident under both study periods (Figure 3). Confidence intervals of percent adult birds overlapped considerably between the two time periods and no significant difference was evident for any of the months (Figure 3). The 95% confidence intervals for sex ratios for each month during the two time periods overlapped considerably, and hence no significant difference was evident for any of the months (Figure 4).

Discussion

We found support for the predicted shift in the migratory behaviour of Dippers in the areas studied. On average in 2010–2014, the first individual Dippers arrived two weeks earlier and left three weeks earlier

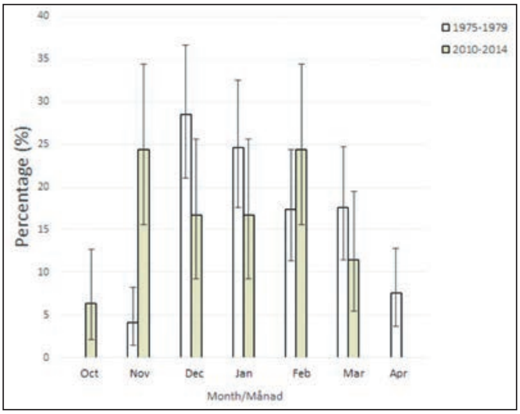

Figure 2. Percent White-throated Dippers in each month relative to total number of birds for each year for the time periods 1975–1979 and from 2010–2014. Error bars denote 95% confidence intervals.

Procent strömstarar för varje undersökningsmånad relativt det totala antalet strömstarar för tidsperioderna 1975–1979 och 2010–2014. Felstaplar motsvarar 95 % konfidensintervall.

compared to 1975–1979. Similarly, in 2010–2014, a larger proportion of the Dippers arrived in the area already in October–November and fewer were present in April, compared to 1975–1979. Since we, as in Lundberg et al. (1981), did not analyse how long each individual bird stayed during the winter, our data show only when the first birds arrived and the last ones departed. It does not show how long each individual bird stayed. Shifts in migration behaviour of birds have been suggested to be an effect of global warming and have been commonly observed for spring migration. For example, an earlier spring arrival time of short distance migrating birds that migrate to Scandinavia from continental Europe has been observed (Hüppop & Hüppop 2003). This earlier arrival is correlated with global warming factors such as spring temperature and North Atlantic Oscillation index (Hüppop & Hüppop 2003). Similarly, Cotton (2003) found that arrival and departure times for long distance migrants in the United Kingdom had advanced eight days and these changes were associated with higher winter temperatures in sub-Saharan Africa and higher summer temperature in the United Kingdom. Few studies are available that show changes in arrival and departure time at overwintering grounds. Nevertheless, in a review on waterbirds, Guillemain et al. (2013) showed an advancement of departure time over the last decades from their wintering grounds. Our study shows that arrival date and departure date at wintering areas of one passerine species that overwinter in a seasonal climate zone has shifted in phenology over a 40-year period in an area were temperature has increased about 2°C during the overwintering period.

What Lundberg et al. (1981) found suggested a change in overall sex and age ratio over season with more adults and males later on during the overwintering season. We found no differences in age or sex ratio between the two study periods, since the 95% confidence intervals overlapped between study periods for each month, suggesting that the within-season pattern was the same in the two study periods. In many bird species, sex ratio differences at geographically different overwintering grounds have been explained by dominance status, where in most cases assumed dominant males overwinter closer to the breeding ground and thereby cause differences in sex ratio at overwintering ground (Prescott & Middleton 1990, Marra 2000). We feel that our data set is too small to allow discussion about sex ratio at our study site, but see Lundberg et al. (1981). However, using a much larger data set Andersson & Wester (1973) found a significantly higher proportion of overwintering females and juveniles at a study site in southern Sweden. Lundberg et al. (1981) speculated that the differences in sex and age ratio between studies could be due to dominance status where dominant individuals (males and adults, Bryant & Newton 1996) over winter closer to the breeding grounds which in our case is northwestern Norway (Cramp 1988, Fransson & Hall-Karlsson 2008). In general, differences in age ratio at autumn arrival seems to depend on whether the birds moult at their breeding or overwintering sites. If adults moult at their overwintering grounds they usually leave the breeding grounds before the juveniles (Newton 2011). The Dipper moults at their breeding grounds (Svensson 1975), and hence we expect juveniles to arrive first to the wintering grounds, which seems to be the case in both study periods.

Using the earliest day of arrival for the 2010–2014 period and comparing that with the earliest arrival of the period 1975–1979 generates a mean shift of 0.42 days earlier arrival per year. This figure is somewhat higher compared to other migration shift observed over similar time periods. Tøttrup et al. (2006) found an earlier arrival in spring averaging 0.26 days/year in Scandinavian passerines over a 20-year period, and Cotton (2003) found a mean of 0.27 days earlier spring arrival per year for migratory birds over a 30-years period in the United Kingdom. Unfortunately, the departure dates in autumn have not been studied to the same extent. Nevertheless, Jenni & Kéry (2003) found that short distance migrants had delayed their autumn migration by 0.11 days/year while long distance migrants had advanced their au-

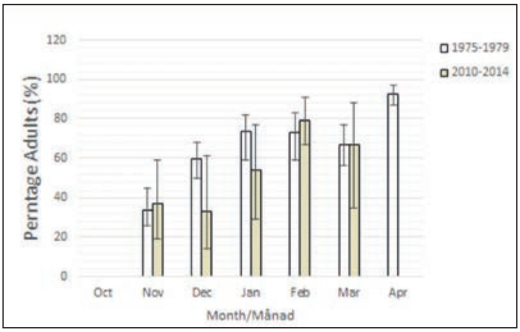

Figure 3. Percent of adult White-throated Dippers in the overwintering streams relative to total number of juveniles and adults present. Error bars denote 95% confidence intervals. *Procent adulta strömstarar relativt det totala antalet som övervintrar i de studerade vattendragen. Felstaplar motsvarar 95 % konfidensintervall.*

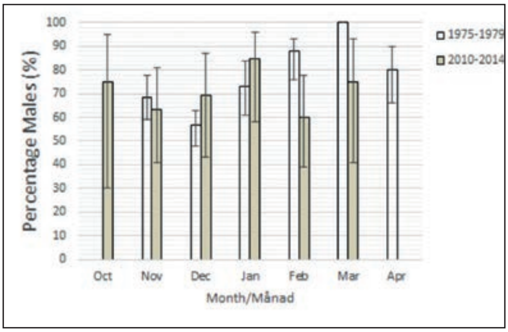

Figure 4. Percent of male White-throated Dippers in the overwintering streams relative to total number of males and females present. Error bars denote 95% confidence intervals. *Procent hanar av strömstarar relativt det totala antalet hanar som övervintrar i de studerade vattendragen. Felstaplar motsvarar 95 % konfidensintervall.*

tumn migration by 0.08 days/year during a 30-years period. Dippers are short distance migrants according to the definition of migration distances studied in Jenni & Kéry (2003), but the change in autumn migration we found in our study is opposite to that found in Jenni & Kéry (2003) for short distance migrants. Jenni & Kéry (2003) studied autumn passage dates rather that arrival at wintering grounds, which may explain the difference. Alternatively, Dippers have not reacted to climate warming in the same way as most other short-distance migrants.

Being short-distance migrants, Dippers may be efficient at tracking temperature variation among years and therefore there has been a fast change to the alteration in temperature. In fact, Hegelbach (2001) found that the onset of breeding by Dippers was correlated with air temperature in Switzerland and hence arrival and departure time at overwintering might consequently also be correlated with temperature at breeding grounds. A similar pattern has been found in other passerines with regard to wintering area temperature and spring arrival (Gordo et al. 2005). The Dippers in our study area probably breed west/northwest of their wintering area, i.e. in the Swedish and Norwegian mountains, because Dippers in northern Europe have east/south east migration routes to their winter grounds (Cramp 1988, Fransson & Hall-Karlsson 2008). It would therefore be interesting to study temperature changes at the breeding grounds for the birds that overwinter in our study area.

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Sammanfattning

Under de senaste 100 åren har jordens temperatur ökat med ca 0.7 grader. Förändringar av temperaturen påverkar växters och djurs ekologi. Till exempel så har fåglars flyttningsvanor förändrats. Många arter anländer och lämnar sina häckningsområden på norra halvklotet tidigare än för några decennier sedan. I denna studie undersökte vi fenologin hos strömstarar som övervintrar i Västerbotten. Vi jämför ankomst- och avfärdsdatum samt åders- och könskvot under åren 2010–2014 med data från en studie som gjordes 1975–1979. Data för båda perioderna samlades in med hjälp av slöjnätsfångst (fångst/återfångst) i fem stycken mindre vattendrag. En jämförelse av medeltemperaturen mellan de två studieperioder visade att medeltemperaturen ökat med ca 2°C i studieområdet. Under perioden 1975–1979 kom de första strömstararna till övervintringsområdet i november och de sista strömstararna lämnade området under april månad. Under perioden 2010–2014 däremot, kom de första strömstararna till övervintringsområdet i oktober och inga strömstarar fanns kvar i april. Våra resultat visar att strömstararna anlände till övervintringsområdet i medeltal två veckor tidigare och lämnade området tre veckor tidigare under 2010–2014 jämfört med för 35 år sedan (1975–1979). Juvenila fåglar anlände före adulta fåglar under båda tidsperioderna. Vi hittade inga skillnader i ålder- och könskvot mellan de både studieperioderna.

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Population trends and status of four seabird species *(Uria aalge, Alca torda, Larus fuscus, Larus argentatus)* at Stora Karlsö in the Baltic Sea

Populationstrender och status hos fyra havsfågelarter (sillgrissla, tordmule, silltrut, gråtrut) på Stora Karlsö i Östersjön

OLOF OLSSON & JONAS HENTATI-SUNDBERG

Abstract

The island of Stora Karlsö hosts the largest colonies of fish-eating seabirds in the Baltic Sea. However, recent and reliable estimates of the number of breeding pairs of the main species have been missing. Based on a complete census in 2014, we estimated the number of Common Guillemots *Uria aalge* to 15 700 pairs, more than half (up to 70%) of the Baltic Sea population. The number has almost tripled since the early 1970s and the increase has been particularly strong the last 11 years, with an annual increase of 5.1%. We counted 24 600 individual adult Razorbills *Alca torda* and estimated it to correspond to a maximum of 12 300 pairs in 2015–2016 (census over two seasons). The colony has grown strongly; on average by 5.6% annually since the early 1970s, and Stora Karlsö now hosts up to 30% of the Baltic Sea population. Stora Karlsö also hosts colonies with about 300 pairs each of Lesser Black-backed Gull *Larus fuscus* and Herring Gull *Larus argentatus*. The gulls' trends are negative, with an average annual decline the last 10-year period by 5.0% and 6.2%, respectively.

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Introduction

Seabirds are charismatic top predators and have a high conservation value, but can also be valuable indicators of marine ecosystem changes (Cairns 1987, Furness & Camphuysen 1997, Parsons et al. 2008). The international conventions HELCOM and OSPAR have developed indicators to ensure good conservation status of birds in the Baltic Sea and North Sea regions (ICES 2013, Herrmann et al. 2013). These indicators link to those under development within the European Marine Framework Directive (MSFD), which aims at obtaining Good Environmental Status (GES) in European seas by 2020 (EC 2008). Key to assess these indicators is that relevant seabird populations are identified and monitored with sufficient detail to identify changes in numbers.

The Baltic Sea is one of the best studied marine ecosystems in the world, with many long-term data-series of different ecological and environmental parameters. Sweden has the longest coast of all countries around the Baltic Sea and has national monitoring programs for many aspects of the marine ecosystems, which since 2015 also include coastal and marine birds. The Swedish island of Stora Karlsö (57°17′1N, 17°58′2E, Figure 1), is a key breeding site for seabirds in the Baltic Sea, and this paper will contribute with important and updated information to national and international monitoring.

We provide new information on colony size and trends for four pelagic fish-eating seabird species that breed at Stora Karlsö: Common Guillemot *Uria aalge*, Razorbill *Alca torda*, Lesser Black-backed Gull *Larus fuscus fuscus* (i.e. the nominate subspecies that mainly breeds in the Baltic Sea, northern Norway and western Kola Peninsula) and Herring Gull *Larus argentatus*. The two auk species have been identified by HELCOM as key species for evaluating the indicator “Abundance of Waterbirds in the breeding season” as one of the core indicators for biodiversity in the Baltic Sea (Herrmann et al. 2013). The two gull species are nationally red listed in Sweden, with Herring Gull having a higher listing than Lesser Black-backed gull (VU and NT respectively) (ArtDatabanken 2015). We discuss the conservation value of the Stora Karlsö colonies in the Baltic Sea context.

Methods

Common Guillemot – census

We executed a mainly land-based count of the Common Guillemot colony at Stora Karlsö in 20–23 May 2014. All breeding sites around the island were identified and photographed with an iPad camera (iPad by Apple, Model A1416). We hereafter use the term “ledge” for all breeding sites or spots that we have counted separately and that have a continuous, small or large, group of breeding birds, usually within a natural demarcation. Every single breeding ledge was directly marked on the photo on the iPad screen in the field, and the birds were counted in the field from land with binoculars. Appendix 1 and 2 include photographs of all breeding ledges, geo-coordinates for the counting spots, and raw data on numbers of breeding birds on each ledge. Digital versions of Appendix 1 and 2 (including the photographs) are also stored for the future at Svensk Nationell Datatjänst (SND). They are available at the following online address https://doi.org/10.5878/002919.

We only counted birds that we judged were breeding (seen with, or strong behavioural indication for, egg or chick). This documentation makes it possible to repeat the total count of Common Guillemots in the future, by revisiting sub-colonies and both register change in numbers on each ledge and compare if new ledges have been occupied, or if ledges have been abandoned. Some ledges were not possible to observe from land and for those we instead counted birds on detailed, high quality photographs, that were taken from a small boat on 20 May, 2014 and covering the whole island. The largest sub-colony, Västerberget (area H-K, Figure 1), includes several caves with large numbers of breeding Common Guillemots, where a direct count of birds, from land or from sea, is difficult or impossible. This problem was partly solved by photographs taken with a camera mounted on a pole and held outside the entrance of some of the cave, or other concealed areas. However, for some of the

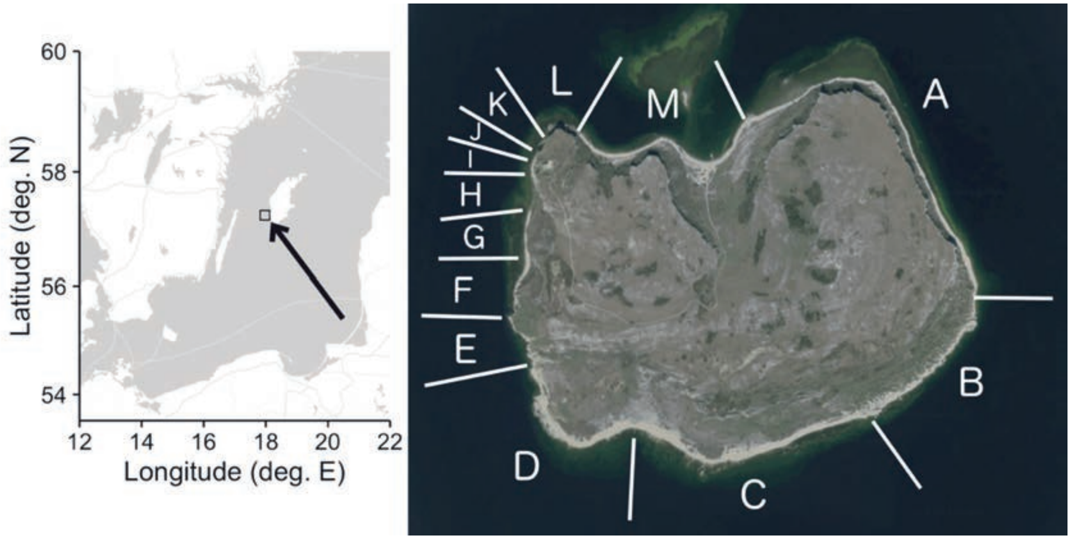
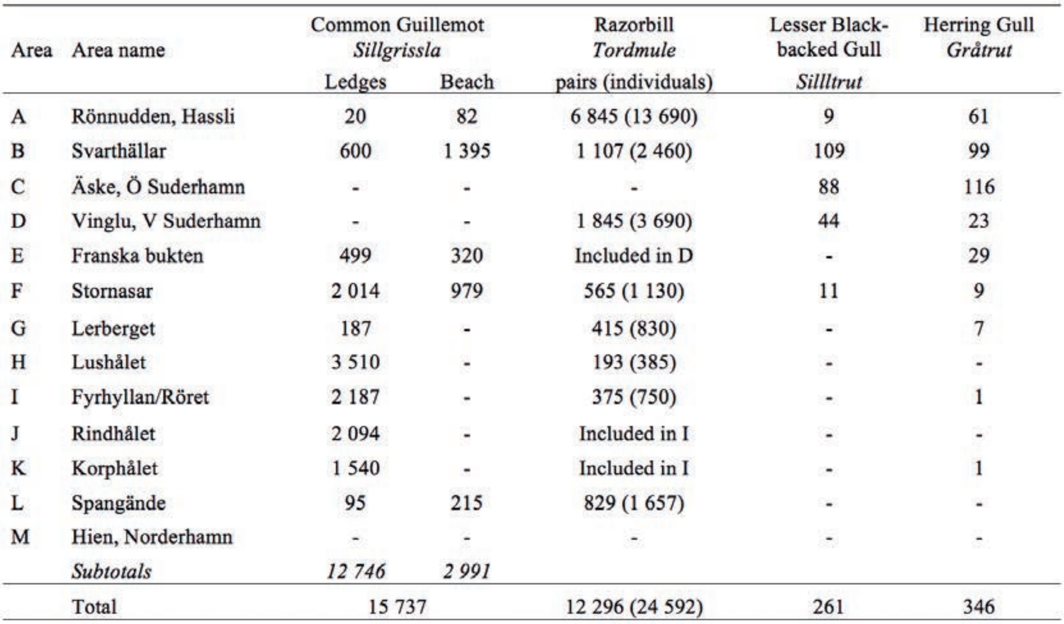


Figure 1. Map showing the location of the island of Stora Karlsö in the central Baltic Sea and the sub-areas of the island, indicated by letters, where we counted birds. For counting numbers, see Table 1. Area names: A – Hassli; B – Svarthällar; C – Eastern Suderslätt; D – Brygge; E – Franska Bukten; F – Stornasar; G – Lerberget; H – Lushålet; I – Fyrhyllan/Röret; J – Rindhålet; K – Korphålet; L – Spangände; M – Hien.
Karta som visar var stora Stora Karlsö är beläget i centrala Östersjön samt räkningsområden på ön, angivna som bokstäver. Siffrorna för de olika områdena och arterna anges i Tabell 1. Se texten ovan för områdenas namn.

caves, especially Lushålet and Röret (areas H and I, Figure 1), this method was not feasible.

Tocomplement these counts, we used an alternative, indirect method: estimation of sub-colony size by counting fledging chicks. Common Guillemot chicks fledge when they are about three weeks old when they jump from their breeding ledges, at the up to 40 m high cliffs (Hedgren 1975). At the Västerberget sub-colony, almost all chicks land on a beach below the cliffs before they reach the sea. At this beach, it is possible to catch the chicks, and ringing of fledging chicks has taken place here during a century. Starting already in 1913, and including the 2016 season, 79 705 chicks has been ringed at this beach (unpublished data, Bird Ringing Centre, Swedish Museum of Natural History). In 2015, we managed to catch and ring the vast majority (n = 4 947) of all the chicks landing on the beach. Based on our estimates of breeding success (2015: 70.0%, n = 162, of the pairs managed to raise a chick up to the age of 15 days, method described in Kadin et al. (2012)) and an estimate of catchability for each area, we could use the ringing numbers to back-estimate the number of breeding pairs. The catchability estimate is needed due to the fact that we were unable to catch all the jumping chicks. Chicks are missed due to the following reasons: (i) Some chicks jump before and after the ringing season and during very windy days when ringing was not conducted; (ii) chicks that land directly in water are not possible to catch; (iii) some chicks land on the beach but manage to escape the ringing assistants. Due to the difference between the areas both in terms of how easy it is to catch the chicks on the beach and how many that land in the water, we estimated the catchability to 75%, 80%, 90% and 90% for the four areas K, J, I and H, respectively (see Figure 1). Our estimate is thus close to the estimate of 85%, for the same parameter for all four areas together, used by Hedgren (1975) in

Table 1. Seabird breeding numbers at the island of Stora Karlsö. The figure for Common Guillemot is an estimate based on 2014, the figure for the areas H and I that was counted in 2015 is adjusted to show 2014 numbers (see Methods). The figure for Razorbill is based on a combined assessment for the field seasons 2015–2016. Note that the number of pairs of Razorbills simply is the number of counted individuals, divided by two. It is therefore the maximum number of pairs (see Methods). The numbers for the two gull species are based on the nest counts in 2016.
Antal häckande havsfåglar på Stora Karlsö i olika delområden. Siffran som anges för sillgrissla gäller år 2014, se Metoddelen). Antalet tordmular gäller säsongerna 2015–2016. Observera att antalet par av tordmule utgörs antalet observerade individer, delat med två. Detta ger det maximala antalet häckade par (se vidare i Metoddelen). Antalet av de två trutarterna är baserat på boräkningar år 2016.



Area	Area name	Common Guillemot *Sillgrissla* Ledges	Beach	Razorbill *Tordmule* pairs (individuals)	Lesser Black-backed Gull *Sillltrut*	Herring Gull *Gråtrut*
A	Rönnudden, Hassli	20	82	6 845 (13 690)	9	61
B	Svarthällar	600	1 395	1 107 (2 460)	109	99
C	Äske, Ö Suderhamn	-	-	-	88	116
D	Vinglu, V Suderhamn	-	-	1 845 (3 690)	44	23
E	Franska bukten	499	320	Included in D	-	29
F	Stornasar	2 014	979	565 (1 130)	11	9
G	Lerberget	187	-	415 (830)	-	7
H	Lushålet	3 510	-	193 (385)	-	-
I	Fyrhyllan/Röret	2 187	-	375 (750)	-	1
J	Rindhålet	2 094	-	Included in I	-	-
K	Korphålet	1 540	-	Included in I	-	1
L	Spangände	95	215	829 (1 657)	-	-
M	Hien, Norderhamn	-	-	-	-	-
	Subtotals	*12 746*	*2 991*			
	Total	15 737		12 296 (24 592)	261	346

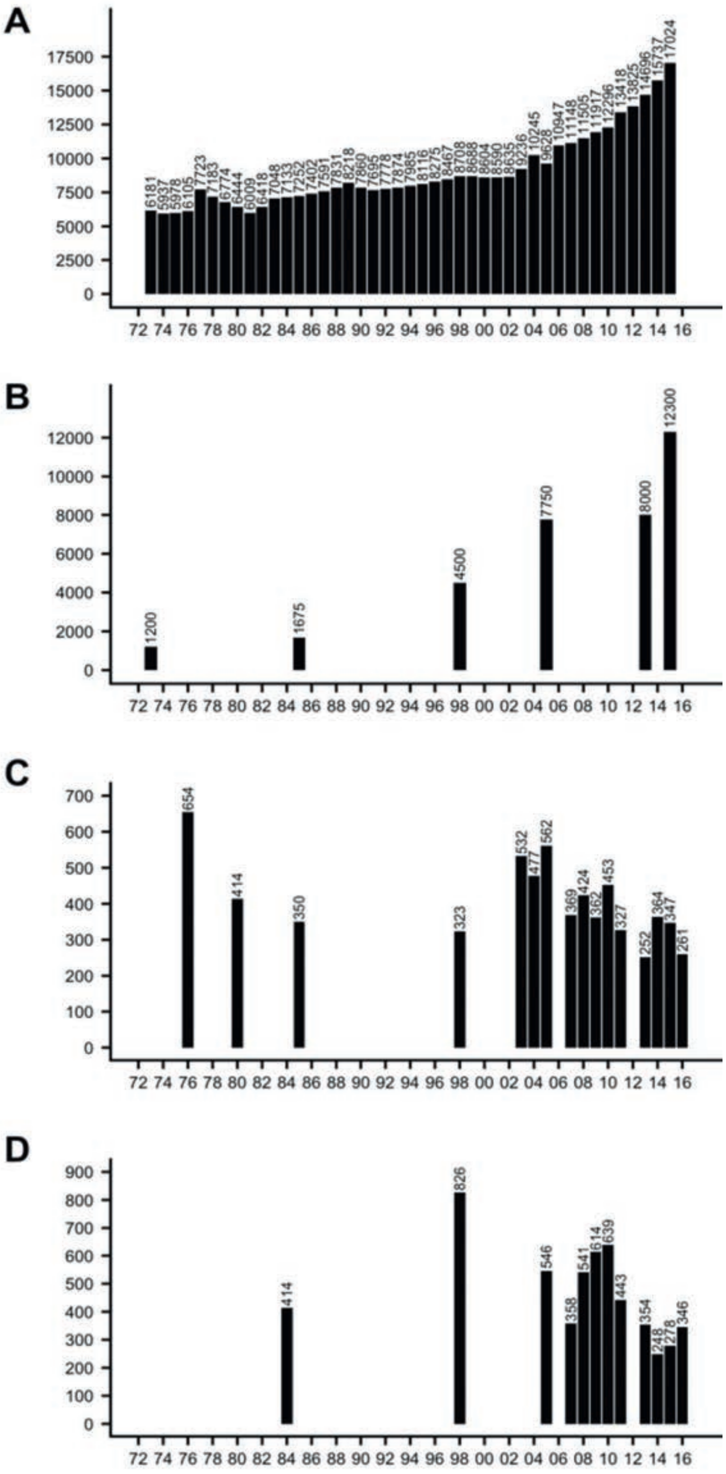


Figure 2a–d. Trends in numbers of pairs of seabirds breeding at Stora Karlsö. (A) Common Guillemot, (B) Razorbill, (C) Lesser Black-backed Gull, (D) Herring Gull. The Common Guillemot trend estimates were based on a stratified sampling scheme, described in Methods. The Razorbill trend is based on already published data except for new data in 2015–2016. The gull trends are based on complete annual nests counts.

Tidstrender för antalet häckande par av havsfåglar på Stora Karlsö. (A) Sillgrissla, (B) Tordmule, (C) Silltrut, (D) Gråtrut. För sillgrisslorna visar grafen förändringen över tid baserat på fotografier av kolonin. För tordmule redovisas tidigare räkningar, i huvudsak utförda av Länsstyrelsen på Gotland. För trutarna redovisas totalräkningar av bon.

the early 1970s. As the final total figure for each sub-area, we used either the figure from the direct count or the indirect ringing method, as determined by which method that yielded the highest number. We did so because we consider both methods conservative in estimating the total number of breeding pairs. The indirect ringing-based method gave the numbers for areas H and I; for the rest of the areas, the census-based method was used. Note that the indirect method used for areas H and I, was performed in 2015, whereas the total census was done in 2014. This is compensated for in Table 1 and Figure 2, the numbers in Table 1 refer to year 2014 and is adjusted for areas H and I.

Common Guillemot – colony development

Since the 1970s, there have been four attempts to estimate the number of breeding Common Guillemots at Stora Karlsö – in 1974, 1985, 2005 and 2013. In 1974, the census was based on the same method as in this study, i.e. a combination of counting jumping chicks at Västerberget and counting birds on the ledges in field and/or from photographs in the other sub-colonies (Hedgren 1975). The three more recent censuses were based on a different method; counting birds at sea in the spring before breeding (Hedgren 1985, Hedgren & Kolehmainen 2006, Hermansson & Wizén 2014). We regard these results, especially from 2005 and 2013, as unrealistic given the obvious colony growth presented recently in Hentati-Sundberg & Olsson (2016) and also given the result of this study (see further in Results and Discussion).

In 2006, we set up a monitoring scheme based on photographing breeding ledges of Common Guillemots at the Stornasar sub-colony (area F, Figure 1). This area covers about 20% of the entire Stora Karlsö colony. Bases on these photographs, we were able to determine the annual change in numbers. A complicating factor in obtaining a trend estimate that is representative for the entire colony, is that each ledge essentially has its own history of the establishment of breeding pairs. We handled this by dividing the ledges from the 2014 census into three strata: (i) old ledges in the cliffs (those where Common Guillemots have bred at least since the 1970s), (ii) new ledges in the cliffs and (iii) new ledges on the beach. The two latter categories represent fairly recently occupied breeding sites. For each of these strata, we calculated trends based on our photographic surveys (details described in Hentati-Sundberg & Olsson 2016). We then combined the annual trend estimates with the 2014 census numbers to obtain total annual figures. For the birds breeding on the beach, we had no photographic documentation prior to 2006, instead we extrapolated the trend from 2006–2015 backwards in time (beach-breeders were very few before 2006). In this paper, we only report estimates of colony development from 1974 until 2015. The 1974 census by Hedgren (1975), using the same methods as in this study, was used as a further validation of both the trend and the estimate of colony size.

Razorbill – census and colony development

Because Razorbills, like Common Guillemots, lay their single egg directly on the ground, and most of them breed concealed in-between and under stones, boulders and rocks, direct counts of nest site are not possible. Neither are the indirect methods that we use for Common Guillemots possible to use for estimating Razorbill numbers. Instead we used an alternative indirect method, which previously has been used by the County Administrative Board of Gotland (Länsstyrelsen), namely to count individuals resting at the sea outside the sub-colonies in the spring, about two weeks before the onset of egg-laying. We did such total counts in two consecutive years, on 3 May 2015 and on 1 May 2016. Birds observed sitting ashore in the colonies were added to the total numbers. We chose days with no or very little wind, when no or very few Razorbills were seen ashore, and consequently with large numbers of birds resting on the water around the island. The birds were typically concentrated in large, continuous rafts, that could start at the shoreline and continue several hundred (up to 700–800) meters ashore. The weather (calm and sunny conditions), but not the time of the day, seemed to be an important factor for the build-up of rafts. In 2015, we were able to count the birds outside all sub-colonies during a single day, whereas in 2016, the right conditions, with no or few birds ashore, were only met for parts of the island. Here we present the largest number of birds counted for each sub-colony in any of the years, as we assume that this is the best estimate of the true number of individuals belonging to the colony. In Table 1, we present both number of observed individuals and the maximum number of pairs (i.e. number of individual divided by two). Although this may be an over-estimate of the true number of pairs, it is the only figure that is comparable with previous censuses. We observed very few Razorbills flying away from, or towards, the island on the days of the counts, and thus we assume minimal absence due to foraging.

Before our censuses in 2015–2016, there have been five attempts since the 1970s to estimate the number of breeding Razorbills at Stora Karlsö; in 1973, 1985, 1998, 2005 and 2013, respectively (Hedgren 1976, Hedgren 1985, Hedgren & Kolehmainen 2000, Hedgren & Kolehmainen 2006, Hermansson & Wizén 2014). On all these occasions, the same method as in this study was used – counting birds resting at sea outside the sub-colonies. We do recognize that this method entails larger uncertainties, compared to the one that we used for Common Guillemots. But given the time and resources available, this method was the only option, and we discuss colony development based on these data.

Lesser Black-backed Gull and Herring Gull – census and colony development

All active nests of Lesser Black-backed Gull and Herring Gull were counted annually from 2005 to 2016 (expect in 2006 and 2012), in the end of the incubation period, i.e. between 18–28 May for Herring Gull and 29 May–7 June for Lesser Black-backed Gull. The counts took between 1–2 days for an experienced field crew, ranging between 3 and 6 persons. The number of nests reported includes those with eggs or chicks and also empty nests that we considered as being used during season (either egg not laid yet, clutch predated, or chicks left the nest), following the methodology of Lif et al. (2005).

Results and discussion

Common Guillemot – census

The number of breeding pairs of Common Guillemots at Stora Karlsö in 2014 was 15 737 (Table 1). The largest sub-colony was Västerberget (area H–K, Figure 1), located at the north-western corner of the island, with 59% (9 351) of the pairs. The second largest sub-colony was Stornasar-Franska bukten (area E–F, Figure 1), situated at the south-western corner of the island, with 24% (3 812) of the pairs. The third largest sub-colony was Svarthällar (area B, Figure 1), situated at the south-east part of the island, with 13% (1 995) of the pairs. Photographs of all breeding sites are presented in Appendix 2.

Common Guillemot – colony development

The Stora Karlsö Common Guillemot colony has increased from about 6 000 pairs in 1975 to the estimated 15 737 pairs in 2014 (Figure 2a). The colony increased further in 2015 to approximately 17 000 pairs. During the 30-year period from 1975 to 2005, the increase was steady but relatively slow, with an annual growth rate of 1.3% and with a total increase of 58%; from about 6 000 to about 10 000 pairs (Figure 2a). After that, during the 11-year period from 2005 to 2015, the colony has increased about three times faster, with an average annual growth rate of 5.1% and with a total increase of 77%; from about 10 000 to 17 000 pairs. With a continued increase at this rate, we prognosticate the total number of breeding pairs of Common Guillemots at Stora Karlsö to reach 20 000 in the year of 2018.

The increase of breeding Common Guillemots at Stora Karlsö has taken place both at newly occupied and at old breeding sites. Since long occupied, and seemingly already crowded, ledges have been even more densely populated, new ledges surrounding old ones have been occupied, but also entirely new breeding areas have been colonized at the island. A particularly striking phenomenon during the recent increase, is that birds have started to use beaches for breeding, especially in areas rich in big boulders. In 2014, about 20% of the pairs were breeding on beaches, with the largest number, 1 395 pairs, at Svarthällar (area B, Figure 1, Table 1. The photograph SNE3 in Appendix 2 illustrates this. Very recently occupied beaches are in areas with boulders at Hassli and Spangände (area A and L, Figure 1), where we foresee further increase in the number of breeding pairs. At Stornasar (area F), the number of beach-breeding pairs has gone from under 100 in 2006 to about 1000 in 2014, and they constituted about 1/3 of the breeding pairs in that sub-colony (Table 1, photograph SNE3 in Appendix 2). So far, only a small fraction of the total area of beaches with boulders are occupied by Common Guillemots, implying that the island's potential breeding space for the species is far from saturated. However, the boulder areas are the main breeding sites for Razorbills and competition for breeding sites between the species may develop in some areas. In fact, at the Stornasar sub-colony (area F), the recent expansion of beach-breeding Common Guillemots, has taken place in areas previously occupied by Razorbills. But because Common Guillemots breed much denser than Razorbills, comparatively few Razorbills are affected by a relatively large expansion of Common Guillemots.

As a complementary and independent method to evaluate the long-term colony change, we compared estimates of the total number of breeding pairs at the Västerberget sub-colony (area H–K, Figure 1) between 2014 and the data that Hedgren

(1975) reported for 1974. In 1974, the total number was estimated based on counts of 3 674 jumping chicks throughout the whole season (3 109 were ringed). This corresponds to 4 663 ± 478 breeding pairs, given a breeding success of 0.79 (Hedgren 1975). Our result in 2014 was 9 351 pairs for the same sub-colony, which was based partly on the same methodology (see above; note that we used a lower figure on breeding success, 0.70, in 2014). This indicates an increase with 101% (4 688 pairs) at Västerberget over these 40 years. This increase is, however, lower that the estimated increase for the whole island. We suggest that the reason for this is that Västerberget is the core area for the Common Guillemots on the island and that the most suitable breeding ledges were occupied already in 1974 (see e.g. photograph VBL1 in Appendix 2). The potential for increase has therefore been smaller here than at other sub-colonies around the island.

Common Guillemot – earlier analyses of colony development

In a review of the historical population development until the mid 1970s of the Common Guillemots in the Baltic Sea, with special attention on Stora Karlsö, Hedgren (1975) indicated that the population decreased during the 19th century and that only about 20 pairs remained on the island in the 1880s. In 1880, the Common Guillemots of Stora Karlsö became protected through a private initiative, and the population started to recover. Hence, Stora Karlsö is likely the main source colony for the entire Baltic Sea population of today.

In 1974, Hedgren (1975) made a total census based on the same methodology as our census in 2014, and found 6 400 pairs of Common Guillemots at Stora Karlsö. This is very similar to the 6 000 pairs in 1975 that we estimate here, based on the photographs in the Stornasar sub-colony (Figure 2a). We regard the difference as negligible and conclude that both these independent estimates show that the size of colony was 6 000–6 500 pairs in the mid 1970s. After that, three censuses have been made, in 1985, 2005 and 2013, using a different method: counting birds at sea outside the sub-colonies before breeding onset (Hedgren 1985, Hedgren & Kolehmainen 2006, Hermansson & Wizén 2014). The results from these censuses, 7 500, 6 000–6 500 and 7 000 pairs respectively, suggest a more or less stable colony size in 1985–2013. Our estimates for these three years, based on the calculation from photographs in the Stornasar sub-colony, were 7 250, 9 600 and 14 700 pair, respectively (Figure 2a). Hence, the two methods yield close to similar result for the 1985 colony size, whereas the continued increase of the colony size, shown in our data, is not reflected in the censuses from 2005 and 2013. This suggests that counting birds at sea is a less reliable method for Common Guillemot censuses. Reasons for this are that it is impossible to know if the birds counted on the water are breeders or non-breeders, and whether all breeders are present at a given time. We conclude that the method used by Hedgren (1975) and in this study, is preferable. Moreover, it is important to note that our trend estimate is based on a sub-sample of breeding sites. We have tried to choose a representative sub-sample, but there might still be a bias in the whole island figure in either direction. However, it is obvious that the colony size has increased substantially over time. A reliable estimate of the colony size in the future needs to combine both regular detailed counts of representative sub-areas, with occasional (perhaps every 10 years) complete censuses of the island. The census method, in combination with the 2014 baseline estimate, presented in this paper (see Appendix 1 and 2), provide a good base for this.

In a review of population trends, Ottvall et al. (2009) report an increase in the Swedish population of Common Guillemots during 30 year (1975–2006) and a stable population during the last 10 years of that period (1995–2006). Our study confirms the long-term increase, but rather show a moderate but steady increase also the last ten years of that period (Figure 2a).

Razorbill – census

In the seasons 2015–2016, we counted about 24 600 individuals of Razorbill, mainly at sea (but also some ashore) outside to the different sub-colonies at Stora Karlsö (Table 1). Assuming an equal sex ratio and that all were breeding birds, this corresponds to a maximum of 12 300 pairs. Because it is impossible to know if all the counted individuals are breeding birds (some might for example be young, 1–3 year, non-breeding individuals), we suggest that the number of breeding pairs at Stora Karlsö were in the range of 10 000–12 300. The sub-colonies at the southern part of the island (Svarthällar, Suderhamn and Franska bukten; areas B–D), were estimated to a maximum of 3 075 pairs (25% of the entire colony), and showed very similar numbers in the two census years. The sub-colonies at the eastern part of the island (Rönnudden-Hassli; area A) were estimated to maximum 6 845 pairs

(56% of the entire colony), and showed large differences between the two years. The sub-colonies at the western part of the island (Stornasar, Lerberget, Västerberget and Spangände; areas F–L) were estimated to maximum 2 375 pairs (19% of the entire colony), and were only possible to count in 2015. The proportion of estimated breeding birds in these three areas fits well with our general impression of the distribution of birds and occupied breeding habitats around the island. The estimates imply that the main concentrations of Razorbills are on the eastern side of the island, whereas most Common Guillemots breed on the western side, something that corresponds well with earlier studies (Hedgren & Kolehmainen 2006).

Razorbill – colony development

We present no new data on colony development for Razorbill in this paper. However, in Figure 2b we report our estimate from this study, in relation to previous censuses at Stora Karlsö. These indicate that the colony has grown from roughly 1 000 to maximum 12 300 pairs in 40 years. Given the numbers reported in Figure 2b, the increase over the period has been on average 5.6% annually. Above we concluded that the method of counting Common Guillemots at sea is not reliable. Unfortunately, for Razorbills at Stora Karlsö, there exists no data derived from other methods. We suggest that ideally a similar method that we used for the total census of Common Guillemots in 2014, should be used also for the Razorbills; i.e. mapping all breeding sites (sub-colonies) and count, or estimate, the number of pairs (or density) in all sub-colonies. Still, the general impression of the colony development of Razorbills at Stora Karlsö, with steadily more birds in already established areas and also with colonization of new areas, fits very well with the trend from these censuses (Figure 2b). However, our census in 2015–2016, (maximum 12 300 pairs) differs substantially from the census in 2013 by Hermansson & Wizén (2014) (8 000 pairs) (Figure 2b), indicating weaknesses in this method for Razorbills too. Nevertheless, we conclude that the results from the censuses, except the one made in 2013, fits well

Table 2. The number of pairs, and comparisons of proportions, of four seabird species censuses at Stora Karlsö (in 2014, 2015 or 2016; this study) in relation to the number of pairs for the Swedish part of Baltic Sea and the entire Baltic Sea. We have defined the Baltic Sea to include all waters south and east of a line between the north-western border of Skåne in Sweden and Grenå in Denmark. For the total numbers in the Swedish counties (län), we have used the figures given in Ottoson et al. (2012). Note that this may include pairs of the two gull species that are breeding inland in these counties. The number of pairs in the entire Baltic Sea of the two auk species are retrieved from reviews in Herrman et al. (2013). Note also that the census data from Stora Karlsö are from later dates than for the other areas, see text for details.

Antal häckande par sillgrissla, tordmule, silltrut och gråtrut på Stora Karlsö i relation till resten av den svenska Östersjökusten och hela Östersjön. Vi har definierat Östersjön att inkludera allt vatten söder och öster om en linje mellan det nordvästra hörnet av Skåne och Grenå i Danmark. Den totala siffran för Sverige är baserad på Ottosson m.fl. (2012). Notera att siffran för kustlänen också innehåller en del inlandshäckande trutar. Antalet alkor i hela Östersjön är baseras på en sammanfattning av Herrman m.fl. (2013). Notera att totalräkningarna från Stora Karlsö är från senare datum än de övriga områdena, se texten för detaljer.

	Common Guillemot *Sillgrissla*	Razorbill *Tordmule*	Herring Gull *Gråtrut*	Lesser Black-backed Gull *Silltrut*
Number of pairs *Antal par*				
Stora Karlsö	15 700	12 300	350	260
Sweden (Baltic Sea part)	20 640	29 905	38 200	8 848
Baltic Sea	23 540	39 115	-	-
Proportion of breeding pairs at Stora Karlsö in relation to the total for: *Andel häckande par på Stora Karlsö i förhållande till totalsumman för:*				
Sweden (Baltic Sea part)	78%	41%	1%	3%
Entire Baltic Sea *Hela Östersjön*	68%	31%	-	-

with the general impression of an overall strong increase of the colony. It also reflects a similar colony development as for the Common Guillemots (Figure 2a and 2b.)

In the review of population trends, Ottvall et al. (2009) reported a significant increase in the Swedish population of Razorbills both during a 30-year period (1975–2006) and in the last 10 years of that period (1995–2006). Our result from Stora Karlsö seems to reflect the same overall colony development (Figure 2b).

Lesser Black-backed Gull and Herring Gull – censuses and colony developments

The number of breeding pairs of Lesser Black-backed Gulls has varied between 562 and 261 in the period 2005–2016 of this study (Figure 2c). We have also added previously reported annual counts, back to 1976; numbers prior to 2005 reprinted from Fredriksson (1992) and Lif et al. (2005). The data since 2005 show a significant decrease, averaging 5.0% per year. The two years (2013 and 2016) with the lowest numbers of breeding pairs occurred within the lasts four years (Figure 2c).

The annual total number of breeding pair of Herring Gulls has varied between 639 and 248 in 2005–2016 (Figure 2d). We have also added two previously reported annual counts, 1984 and 1998 (Hedgren 1985, Hedgren and Kolehmainen 2000). Also, Herring Gulls have been decreasing since 2005 with an average rate of 6.2% per year. The two years (2014 and 2015) with the lowest numbers of breeding pairs occurred within the lasts three years (Figure 2d).

The inter-annual variation in the gull nest numbers is considerable, which can be both a result of the difficulty of detecting nests, which partly is related to the thickness of the undergrowth (see Lif et al. 2005), but maybe also due to the fact that not all adult gulls breed each year. In any case, we consider the observed trend estimate robust to such inter-annual variation.

In their review, Ottvall et al. (2009) reported that the Swedish Lesser Black-backed Gull population (sub-species Larus fuscus fuscus, that breeds in the Baltic Sea) had been stable in a ten-year period, 1995–2006, and that the Herring Gull population had decreased. Data presented in Figure 2c indicate a stable colony size, or even an increase in the Stora Karlsö colony of Lesser Black-backed Gull, in the late 1990s and early 2000s. This is in line with the trend for the Baltic Sea reported by Ottvall et al. (2009). However, the last ten years of this study show a decrease in Lesser Black-backed Gulls. Although we have few data on Herring Gulls for the period 1995–2006, this study confirms the decrease (Figure 2d), reported by Ottvall et al. (2009).

The counting of gull nests entails some disturbance. Our impression is that this has not influenced the gulls' breeding success at Stora Karlsö. But because both gull species are red-listed, the populations are decreasing, and the fact that we cannot totally exclude that the censuses have had a negative impact, we recommend that the gull censuses are done less frequently in the future, perhaps at an interval of three to five years unless there are specific scientific questions motivating a higher interval, and that all other types of non-necessary disturbances are minimized.

Significance of the Stora Karlsö seabird colonies

Because neither the auk nor the gull populations are stable and different sub-populations or colonies may have different trends over time, and because data on colony and population sizes derive from different years (between this study and published data from other colonies), it is not possible to make precise estimates of how large proportion the Stora Karlsö colonies constitute of the Swedish or the entire Baltic Sea populations. Nevertheless, to get a rough idea of the proportions, in Table 2 we compare the most recent results from this study with the most recent published numbers of breeding pairs of the four species for the total populations in the Swedish part of the Baltic Sea and for the entire Baltic Sea. This comparison indicates that the Stora Karlsö colony is a very important locality for the two auk species. For Common Guillemots, Stora Karlsö hosts at least half, and perhaps up to 70%, of the entire Baltic Sea population and up to 80% of the Swedish population. The corresponding numbers for Razorbills is up to 30% of the entire Baltic Sea population and up to 40% of the Swedish population. A problem with these comparisons are that the data on colony size from Stora Karlsö are from later dates than all other data. Hence, if there is a general positive trend for a species in the whole region, including Stora Karlsö, this means that the figures on colony size from Stora Karlsö could be larger than those from other areas that have be counted earlier, and vice versa. We may therefore over-estimate the proportion of auks and under-estimate the proportion of gulls at Stora Karlsö. However, for Common Guillemots, there may have been a decrease, or a less strong increase, in the number of breeding pairs in some areas, at least along the Swedish coast, due to predation or disturbance from an increasing population White-tailed Eagles *Haliaeetus albicilla* (U. Lötberg, pers. com.).

Reasons for population change

In this study, we do not present data on any environmental parameter that might influence the seabird populations. Neither is the ambition to provide an extensive review of possible such parameters. However, we still want to give some hints on possible explanations to the results, that might be interesting to explore more in depth in the future.

A striking result from this study is that we have shown long-term trends for four seabird species that to a large extent is dependent on the same food resource (small pelagic schooling fish – European Sprat *Sprattus sprattus* and Herring *Clupea harengus*) (Lyngs, 2001, Lyngs & Durinck 1998, Kadin et al. 2016, Schönberg Alm 2007, unpublished data). Two of them, the auks, are increasing in numbers whereas the two others, the gulls, are decreasing.

Generally, the abundance of Sprat and Herring seem to have been good, although with some variation, throughout the last 40 years covered in this study. Good food availability is a prerequisite for seabird population growth, which especially the two auk species seem to have benefited from. The increase of Common Guillemots shows a clear acceleration the last ten, or so, years (Figure 2a). Our results indicate the same pattern also for Razorbills, although the data are less reliable (Figure 2b). The reason for this acceleration is probably not that the food has become even more abundant, but rather lower mortality rates for young and adult birds. It coincides with the ban on driftnet fishing (Hentati-Sundberg et al. 2015) and, thus, one explanation might be lower bycatch rates in fishing gear (see also Österblom et al. 2002). During the last 40–50 years, also the ban of hunting of the auks, fewer oil spills and lower concentrations of some key environmental pollutants, such as DDT and PCB, potentially have had positive effects on the auk populations (Olsson et al. 2000, Bignert & Helander 2015).

The figures of annual increase of both auk species at Stora Karlsö, about 5 %, are similar to those reported from Skomer Island, at the Welsh coast, and which are suggested to be at the population's intrinsic rate of increase (Meade et al. 2013).

Historically, the gulls have benefited from discards from fishing vessels and this recourse has likely decreased dramatically in the last decades due to a contraction of the cod stock and diminished cod fisheries, in the area close to Stora Karlsö (Casini et al. 2012). The decrease in this food resource may have influenced the gulls' numbers in the early part on this study, but probably less so during the last 20 years. The change in land-fill management in northern Europe may have had a negative effect on winter survival of Herring Gulls. The fuscus-subspecies of Lesser Black-backed Gull migrates to northern and central Africa and changed conditions at migration routes, or in winter quarters, may have contributed negatively to survival rates. We have also observed poor breeding success at Stora Karlsö, especially for Lesser Black-backed Gulls, but the reason for this is unknown (Lif et al. 2005).

Conclusions

- Stora Karlsö is a key colony with over half, perhaps up to 70%, of the Common Guillemots and up to 30 % of the Razorbills in the Baltic Sea. Monitoring the colony developments of these species at Stora Karlsö is critical for evaluating the HELCOM breeding seabird indicator for the Baltic Sea region.
- Conservation measures that enhance adult survival, such as driftnet ban, appear to have had a strong positive effect on the auk populations.
- The colonies of Lesser Black-backed Gull and Herring Gull are decreasing steadily at Stora Karlsö. We see no obvious explanation for this ongoing decrease.
- Integrating seabirds with other ecosystem components, such as forage fish populations, bycatches, discards, environmental contaminants and oil spills, is important to assess future sustainability of the populations.

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Sammanfattning

Stora Karlsö har de enskilt största havsfågelkolonierna i Östersjön. Det har dock saknats uppdaterade siffror på antalet häckande fåglar och trender över tid. Under häckningssäsongen 2014 genomförde vi en heltäckande kartläggning av sillgrisslorna på Stora Karlsö och uppskattar antalet häckande par detta år till 15 700. Vi har kartlagt samtliga häckningsplatser på ön och räknat, direkt eller indirekt, alla häckande par. Dokumentationen av denna räkning kan tjäna som underlag för detaljerade jämförelser i framtiden. En jämförelse med tidigare studier samt fotografisk dokumentation av kolonin visar att antalet sillgrisslor nästan har tredubblats sedan 1970-talet, och att ökningen eskalerat under de senaste 11 åren, då ökningen i genomsnitt har varit 5,1% per år. Sillgrisslornas expansion har delvis skett genom att häckningsbestånden på befintliga hyllor har förtätats, dels genom en expansion till nya områden, inte minst i blockterräng på stränder. År 2014 häckade omkring 20% av beståndet på stränder. Vår uppskattning av antalet sillgrisslor på Stora Karlsö tyder på att ön idag hyser väl över hälften, kanske upp till 70%, av alla Östersjöns sillgrisslor. Vi räknade under säsongerna 2015–2016 till 24 600 individer av vuxna tordmular och uppskattar därför antalet häckande par till maximalt 12 300. Siffran bygger på räkning av samtliga tordmular som låg på vattnet, cirka två veckor före äggläggningen, utanför de olika delkolonierna runt Stora Karlsö. Ökningen av tordmular har varit ännu kraftigare än för sillgrisslor, i genomsnitt 5,6% årligen för hela perioden från 1973 fram till 2015. Vi uppskattar därmed att Stora Karlsö hyser upp till 30% av Östersjöns tordmulebestånd. Vi rapporterar också antal och trender för silltrut och gråtrut på Stora Karlsö. Båda arterna har minskat i antal de senaste tolv åren (2005–2016); 5,0% årligen för silltrut och 6,2% för gråtrut. Dessa arter är mer utspridda på olika lokaler i Östersjön och Stora Karlsö hyser endast några procent av den svenska Östersjöpopulationen. Sammanfattningsvis är Stora Karlsö en betydande häckningslokal i Östersjön för de båda alkarterna, och ön bör därför utgöra en viktig del i den nationella och internationella havsfågelövervakningen.

Appendix 1. Supplementary data to Olsson, O. & Hentati-Sundberg, J. 2017. Population trends and status of four seabird species (*Uria aalge, Alca torda, Larus fuscus, Larus argentatus*) at Stora Karlsö in the Baltic Sea. *Ornis Svecica* 27(3–4).

This Appendix includes the raw data for the counting of Common Guillemots *Uria aalge* at the Stora Karlsö colony in 2014, including geo-coordinates for the counting spots and the number of breeding pairs in each ledge. The spatial references are in three hierarchical levels. The highest level is the "counting spots", which are listed with their spatial coordinates in Table S1. There were in total 35 counting spots, not including the areas that were invisible from land and thus counted from the sea. For each counting spot, we took one or more photographs. The photo ID, each linked to a counting spot, are also listed in table S1. Appendix 2 shows all the photos with the ledges indicated, in total 70 photographs. On each photograph, there was one or more breeding ledges, in total 184 in the entire colony. Because some of the breeding sites were consealed in caves, theses were not possible to count but instead estimated with an indirect method (see manuscript).

This appendix is also available on line at https//doi.org/10.5878/002919.

Table S1. All breeding ledges with indications on their respective photo ID and counting spot (including coordinates), and the number of breeding birds. For ledges indicated and counted on sea-photos, no coordinates are given but the location of the breeding ledges should be possible to identify in the field in the future anyway. Note also that some ledges are depicted on additional photos than the one indicated in the table. The pair values given in this table for 19 ledges at Västberget (marked with "Chicks" in the Comment column) were not used in the final estimatimation; instead we used counts of fledging chicks.

Date	MainArea	SubArea	Counting Spot	Lat	Long	PhotoID	Ledge ID	Ledge Type	Estimate pairs	Comment
2014-05-22	Hassli	Hassli strand	HS A	57.2924	17.9786	HS A1	HS1	Beach	20	
2014-05-22	Hassli	Hassli strand	HS A	57.2924	17.9786	HS A1	HS2	Beach	5	
2014-05-22	Hassli	Hassli strand	HS A	57.2924	17.9786	HS A1	HS3	Beach	0	
2014-05-22	Hassli	Hassli strand	HS B	57.2925	17.9801	HS A1	HS4	Beach	10	
2014-05-22	Hassli	Hassli strand	HS C	57.2921	17.9827	HS C1	HS5	Beach	10	
2014-05-22	Hassli	Hassli strand	HS C	57.2921	17.9827	HS C1	HS6	Beach	7	
2014-05-22	Hassli	Hassli hyllor	HS D	57.292	17.9828	HS D1	HS7	Ledge	10	
2014-05-22	Hassli	Hassli strand	HS E	57.2909	17.9837	HS E1	HS8	Beach	20	
2014-05-22	Hassli	Hassli strand	HS G	57.2896	17.9848	HS G1	HS9	Beach	10	
2014-05-22	Hassli	Hassli hyllor	HS H	57.2893	17.9855	HS H1	HS10	Ledge	10	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN1	Ledge	25	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN2	Ledge	32	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN3	Ledge	0	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN4	Ledge	30	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN5	Ledge	30	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN6	Ledge	50	
2014-05-20	Stornasar	Lerberget hyllor	SN A	57.2859	17.9575	SN A1	SN7	Ledge	20	
2014-05-20	Stornasar	Stornasar strand	SN B	57.2846	17.9568	SN B1	SN13	Beach	15	
2014-05-20	Stornasar	Stornasar strand	SN D	57.2847	17.957	SN D1	SN8	Beach	25	
2014-05-20	Stornasar	Stornasar strand	SN D	57.2847	17.957	SN D1	SN9	Beach	105	
2014-05-20	Stornasar	Stornasar strand	SN D	57.2847	17.957	SN D1	SN10	Beach	12	
2014-05-20	Stornasar	Stornasar strand	SN D	57.2847	17.957	SN D1	SN11	Beach	30	
2014-05-20	Stornasar	Stornasar strand	SN D	57.2847	17.957	SN D1	SN12	Beach	82	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN15	Ledge	150	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN16	Ledge	195	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN17	Ledge	140	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN18	Ledge	140	
2014-05-20	Svarthallar	Svarthallar	SH H	57.2813	17.9857	SH H1	SH15	Beach	35	
2014-05-20	Svarthallar	Svarthallar	SH I	57.2817	17.9862	SH I1	SH16	Beach	240	
2014-05-20	Svarthallar	Svarthallar	SH J	57.2817	17.9865	SH J1	SH17	Beach	100	

Date	MainArea	SubArea	Counting Spot	Lat	Long	PhotoID	Ledge ID	Ledge Type	Estimate pairs	Comment
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN19	Ledge	90	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN20	Ledge	210	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN21	Ledge	250	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN22	Ledge	175	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN23	Ledge	70	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN24	Ledge	50	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN25	Ledge	42	
2014-05-20	Stornasar	Stornasar hyllor	SN E	57.2846	17.9569	SN E1	SN26	Ledge	52	
2014-05-20	Stornasar	Stornasar strand	SN E	57.2846	17.9569	SN E2	SN29	Beach	120	
2014-05-20	Stornasar	Stornasar strand	SN E	57.2846	17.9569	SN E2	SN30	Beach	70	
2014-05-21	Stornasar	Stornasar strand	SN E	57.2846	17.9569	SN E3	SN31	Beach	100	
2014-05-21	Stornasar	Stornasar hyllor	SN F	57.2841	17.9568	SN F1	SN14	Ledge	25	
2014-05-21	Stornasar	Stornasar hyllor	SN F	57.2841	17.9568	SN F2	SN32	Ledge	15	
2014-05-21	Stornasar	Stornasar hyllor	SN F	57.2841	17.9568	SN F3	SN33	Ledge	90	
2014-05-21	Stornasar	Stornasar hyllor	SN F	57.2841	17.9568	SN F3	SN34	Ledge	20	
2014-05-21	Stornasar	Stornasar hyllor	SN G	57.284	17.9566	SN G1	SN27	Ledge	55	
2014-05-21	Stornasar	Stornasar hyllor	SN H	57.2838	17.9565	SN H1	SN35	Ledge	40	
2014-05-21	Stornasar	Stornasar hyllor	SN H	57.2838	17.9565	SN H1	SN36	Ledge	20	
2014-05-21	Stornasar	Stornasar hyllor	SN H	57.2838	17.9565	SN H2	SN37	Ledge	80	
2014-05-21	Stornasar	Stornasar hyllor	SN H	57.2838	17.9565	SN H3	SN38	Ledge	13	
2014-05-21	Stornasar	Stornasar strand	SN H	57.2838	17.9565	SN H4	SN28	Beach	250	
2014-05-21	Stornasar	Stornasar strand	SN H	57.2838	17.9565	SN H4	SN39	Beach	100	
2014-05-21	Stornasar	Stornasar strand	SN H	57.2838	17.9565	SN H4	SN40	Beach	70	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I1	SN41	Ledge	10	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I1	SN42	Ledge	7	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I1	SN43	Ledge	10	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I3	SN46	Ledge	15	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I4	SN47	Ledge	30	
2014-05-21	Franska bukten	Franska bukten hyllor	SN I	57.2831	17.9573	SN I4	SN48	Ledge	80	
2014-06-30	Franska bukten	Franska bukten strand	SN L	57.2835	17.9564	SN L1	SN55	Beach	270	
2014-05-20	Stornasar	Stornasar hyllor	SN Vatten1			SN Vatten1	SN56	Ledge	20	
2014-05-20	Stornasar	Stornasar hyllor	SN Vatten1			SN Vatten1	SN57	Ledge	27	
2014-05-20	Stornasar	Stornasar hyllor	SN Vatten1			SN Vatten1	SN58	Ledge	45	
2014-05-21	Franska bukten	Franska bukten hyllor	SN Vatten2			SN Vatten2	SN44	Ledge	1	
2014-05-21	Franska bukten	Franska bukten hyllor	SN Vatten2			SN Vatten2	SN45	Ledge	32	
2014-05-21	Franska bukten	Franska bukten hyllor	SN Vatten2			SN Vatten2	SN49	Ledge	17	
2014-05-21	Franska bukten	Franska bukten hyllor	SN Vatten2			SN Vatten2	SN50	Ledge	50	
2014-05-20	Franska bukten	Franska bukten hyllor	SN Vatten2			SN Vatten2	SN51	Ledge	200	
2014-05-20	Franska bukten	Franska bukten hyllor	SN Vatten3			SN Vatten3	SN52	Ledge	47	
2014-05-20	Franska bukten	Franska bukten strand	SN Vatten3			SN Vatten3	SN53	Beach	35	
2014-05-20	Franska bukten	Franska bukten strand	SN Vatten3			SN Vatten3	SN54	Beach	15	
2014-05-20	Svarthallar	Svarthallar	SH A	57.2801	17.9829	SH A1	SH1	Beach	80	
2014-05-20	Svarthallar	Svarthallar	SH A	57.2801	17.9829	SH A2	SH2	Beach	25	
2014-05-20	Svarthallar	Svarthallar	SH A	57.2801	17.9829	SH A3	SH3	Beach	350	
2014-05-20	Svarthallar	Svarthallar	SH A	57.2801	17.9829	SH A3	SH4	Beach	310	
2014-05-20	Svarthallar	Svarthallar	SH B	57.2805	17.9828	SH B1	SH5	Beach	60	
2014-05-20	Svarthallar	Svarthallar	SH E	57.2809	17.9846	SH E1	SH6	Beach	25	
2014-05-20	Svarthallar	Svarthallar	SH E	57.2809	17.9846	SH E1	SH7	Beach	15	
2014-05-20	Svarthallar	Svarthallar	SH E	57.2809	17.9846	SH E1	SH8	Beach	20	
2014-05-20	Svarthallar	Svarthallar	SH E	57.2809	17.9846	SH E2	SH9	Beach	5	
2014-05-20	Svarthallar	Svarthallar	SH E	57.2809	17.9846	SH E3	SH10	Beach	30	
2014-05-20	Svarthallar	Svarthallar	SH F	57.2811	17.985	SH F1	SH11	Beach	15	
2014-05-20	Svarthallar	Svarthallar	SH F	57.2811	17.985	SH F1	SH12	Beach	40	
2014-05-20	Svarthallar	Svarthallar	SH F	57.2811	17.985	SH F1	SH13	Beach	20	
2014-05-20	Svarthallar	Svarthallar	SH G	57.2812	17.9854	SH G1	SH14	Beach	90	

Date	MainArea	SubArea	Counting Spot	Lat	Long	PhotoID	Ledge ID	Ledge Type	Estimate pairs	Comment
2014-05-20	Svarthallar	Svarthallar	SH J	57.2817	17.9865	SH J2	SH18	Beach	40	
2014-05-20	Svarthallar	Svarthallar	SH J	57.2817	17.9865	SH J2	SH19	Beach	10	
2014-05-20	Svarthallar	Svarthallar	SH J	57.2817	17.9865	SH J2	SH20	Beach	60	
2014-05-20	Svarthallar	Svarthallar	SH K	57.2821	17.9869	SH K2	SH21	Beach	70	
2014-05-20	Svarthallar	Svarthallar	SH K	57.2821	17.9869	SH K2	SH22	Beach	70	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L1	SH23	Beach	55	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L2	SH24	Beach	80	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L3	SH25	Beach	5	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L3	SH26	Beach	5	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L4	SH27	Beach	15	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L4	SH28	Beach	40	
2014-05-20	Svarthallar	Svarthallar	SH L	57.2821	17.9875	SH L5	SH29	Beach	10	
2014-05-20	Svarthallar	Svarthallar	SH M	57.2827	17.9883	SH M1	SH30	Beach	35	
2014-05-20	Svarthallar	Svarthallar	SH M	57.2827	17.9883	SH M1	SH31	Beach	15	
2014-05-20	Svarthallar	Svarthallar	SH N	57.2833	17.9892	SH N1	SH32	Beach	25	
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V1	Ledge	16	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V2	Ledge	160	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V3	Ledge	5	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V4	Ledge	28	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V5	Ledge	65	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB B	57.289	17.958	VB B1	V6	Ledge	40	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB C	57.2894	17.9579	VB C1	V7	Ledge	54	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB C	57.2894	17.9579	VB C1	V8	Ledge	26	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB C	57.2894	17.9579	VB C1	V9	Ledge	22	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB C	57.2894	17.9579	VB C2	V10	Ledge	30	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB D	57.2896	17.9579	VB D1	V12	Ledge	30	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB D	57.2896	17.9579	VB D1	V13	Ledge	39	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB D	57.2896	17.9579	VB D1	V14	Ledge	17	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V15	Ledge	275	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V16	Ledge	195	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V17	Ledge	60	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V18	Ledge	54	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V19	Ledge	180	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB E	57.2898	17.9581	VB E1	V20	Ledge	95	Chicks
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB F	57.2902	17.9583	VB F1	V21	Ledge	267	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB F	57.2902	17.9583	VB F1	V22	Ledge	217	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB F	57.2902	17.9583	VB F1	V24	Ledge	350	
2014-06-11	Vasterberget	Vasterberget hyllor Korphålet	VB H	57.2906	17.9588	VB H1	V62	Ledge	40	
2014-06-11	Vasterberget	Vasterberget hyllor Korphålet	VB H	57.2906	17.9588	VB H1	V63	Ledge	590	
2014-06-11	Vasterberget	Vasterberget hyllor Korphålet	VB H	57.2906	17.9588	VB H1	V64	Ledge	230	
2014-06-11	Vasterberget	Vasterberget hyllor Korphålet	VB H	57.2906	17.9588	VB H1	V65	Ledge	145	
2014-06-11	Vasterberget	Vasterberget hyllor Korphålet	VB H	57.2906	17.9588	VB H1	V66	Ledge	180	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V67	Ledge	180	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V68	Ledge	320	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V69	Ledge	210	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V70	Ledge	110	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V71	Ledge	110	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V72	Ledge	140	
2014-06-11	Vasterberget	Vasterberget hyllor Rindhålet	VB I	57.2902	17.9585	VB I1	V73	Ledge	25	

Date	MainArea	SubArea	Counting Spot	Lat	Long	PhotoID	Ledge ID	Ledge Type	Estimate pairs	Comment
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten1			VB Vatten1	V46	Ledge	25	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten1			VB Vatten1	V47	Ledge	10	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten1			VB Vatten1	V48	Ledge	0	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten1			VB Vatten1	V49	Ledge	5	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten2			VB Vatten2	V42	Ledge	50	
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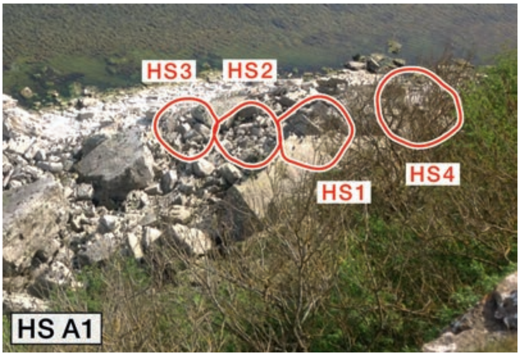
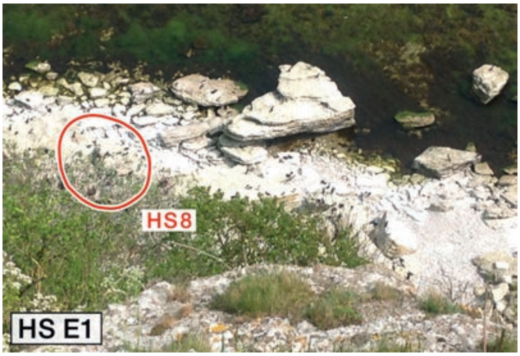
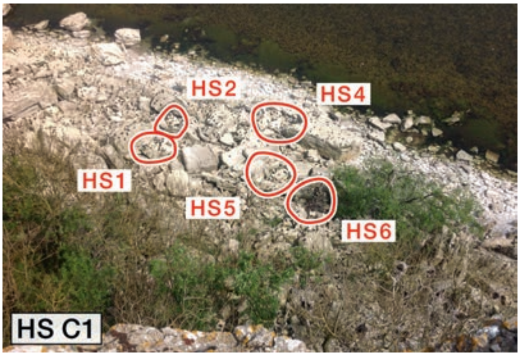
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten2			VB Vatten2	V45	Ledge	80	
2014-05-22	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V11	Ledge	7	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V36	Ledge	80	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V37	Ledge	200	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V38	Ledge	150	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V39	Ledge	125	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V40	Ledge	425	
2014-05-20	Vasterberget	Vasterberget hyllor Lushålet	VB Vatten3			VB Vatten3	V41	Ledge	45	
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V31	Ledge	87	
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V32	Ledge	75	
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V33	Ledge	125	
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V34	Ledge	75	
2014-05-22	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V35	Ledge	20	
2014-05-20	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V50	Ledge	65	
2014-05-20	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V51	Ledge	300	
2014-05-20	Vasterberget	Vasterberget hyllor Röret	VB Vatten4			VB Vatten4	V52	Ledge	20	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V27	Ledge	40	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V28	Ledge	40	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V29	Ledge	4	
2014-05-22	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V30	Ledge	6	
2014-05-20	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V53	Ledge	25	
2014-05-20	Vasterberget	Vasterberget hyllor Rindhålet	VB Vatten5			VB Vatten5	V54	Ledge	50	
2014-05-20	Vasterberget	Vasterberget hyllor Korphålet	VB Vatten5			VB Vatten5	V57	Ledge	160	
2014-05-20	Vasterberget	Vasterberget hyllor Korphålet	VB Vatten6			VB Vatten6	V58	Ledge	180	
2014-05-20	Vasterberget	Vasterberget hyllor Korphålet	VB Vatten6			VB Vatten6	V59	Ledge	15	
2014-05-22	Vasterberget	Vasterberget hyllor Spangande	VB Vatten7			VB Vatten7	V25	Ledge	10	
2014-05-22	Vasterberget	Vasterberget hyllor Spangande	VB Vatten7			VB Vatten7	V26	Ledge	35	
2014-05-20	Vasterberget	Vasterberget hyllor Spangande	VB Vatten7			VB Vatten7	V60	Ledge	30	
2014-05-20	Vasterberget	Vasterberget hyllor Spangande	VB Vatten7			VB Vatten7	V61	Ledge	20	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand1	57.2908	17.9591	VB Strand1	VS1	Beach	10	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand1	57.2908	17.9591	VB Strand1	VS2	Beach	10	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand1	57.2908	17.9591	VB Strand1	VS3	Beach	5	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand1	57.2908	17.9591	VB Strand1	VS4	Beach	20	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand1	57.291	17.9594	VB Strand1	VS5	Beach	15	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand2	57.2912	17.9597	VB Strand2	VS6	Beach	5	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand2	57.2912	17.9597	VB Strand2	VS7	Beach	5	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand3	57.2911	17.9603	VB Strand3	VS8	Beach	50	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand4	57.2911	17.9603	VB Strand4	VS9	Beach	30	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand5	57.2911	17.9603	VB Strand5	VS10	Beach	5	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand6	57.2911	17.9603	VB Strand6	VS11	Beach	30	
2014-05-23	Vasterberget	Vasterberget strand	VB Strand7	57.291	17.9607	VB Strand7	VS12	Beach	30	

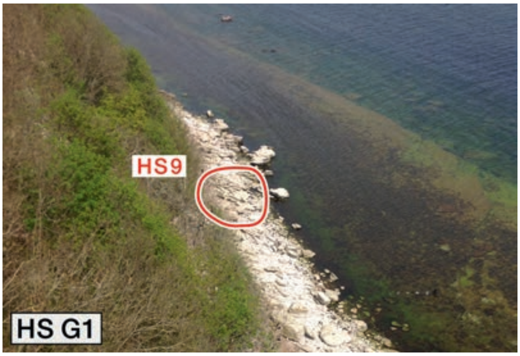
Appendix 2. Supplementary data to Olsson, O. & Hentati-Sundberg, J. 2017. Population trends and status of four seabird species (*Uria aalge, Alca torda, Larus fuscus, Larus argentatus*) at Stora Karlsö in the Baltic Sea. *Ornis Svecica* 27(2–4).

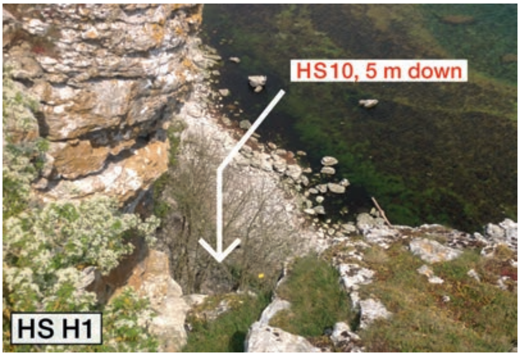
This Appendix is also available on line at https://doi.org/10.5878/002919.
The following 70 photographs show all breeding ledges of Common Guillemots *Uria aalge* at the Stora Karlsö colony in 2014. The photographs and the counting spots, including all ledges and the number of breeding pairs, are listed in Appendix 1, Table S1. Geo-coordinates are also given in Appendix 1, Table S1.



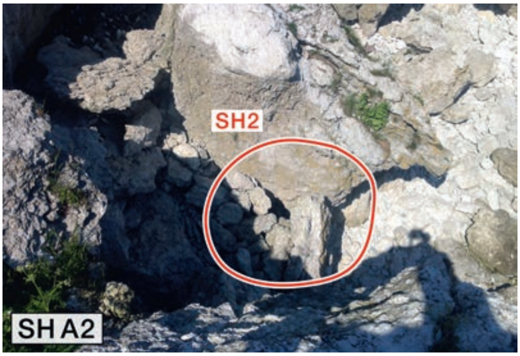









SH1
SH A1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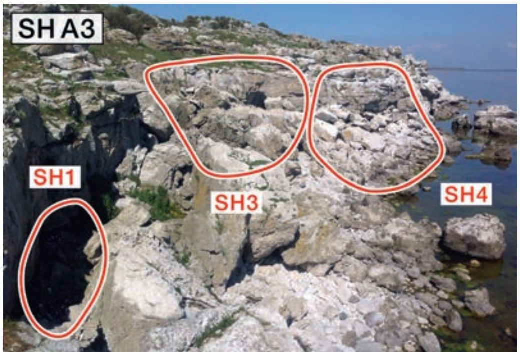
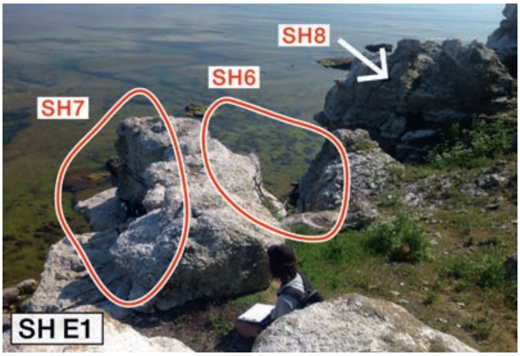
SH A2


SH A3
SH1
SH3
SH4


SH5
SH B1


SH8
SH6
SH7
SH E1


SH9
SH E2


SH10
SH E3


SN14
SN F1


SH14
SH G1


SH15
SH H1

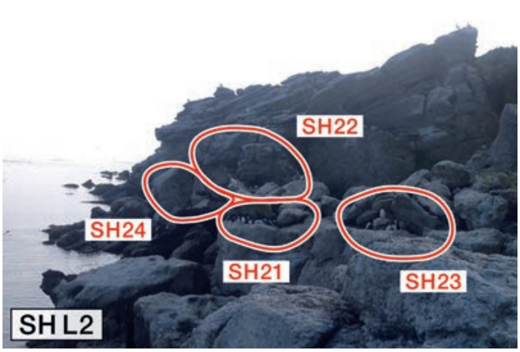

SH16
SH I1


SH18
SH19
SH20
SH J2


SH17
SH J1


SH22
SH21
SH K2


SH23
SH L1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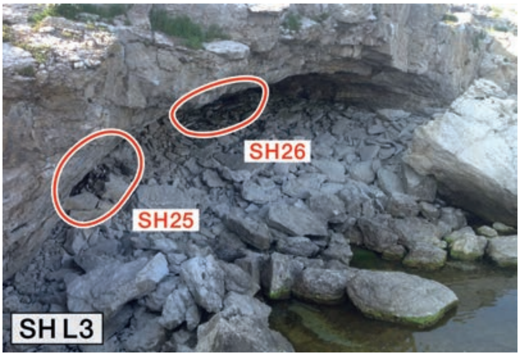
SH L2


SH29
SH L5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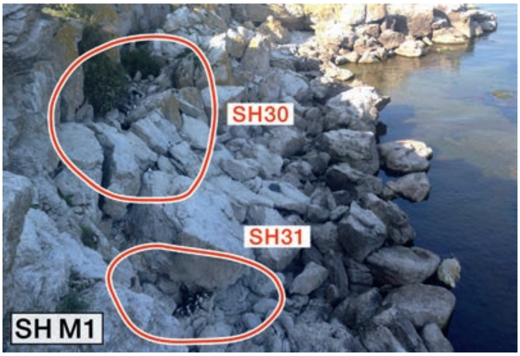
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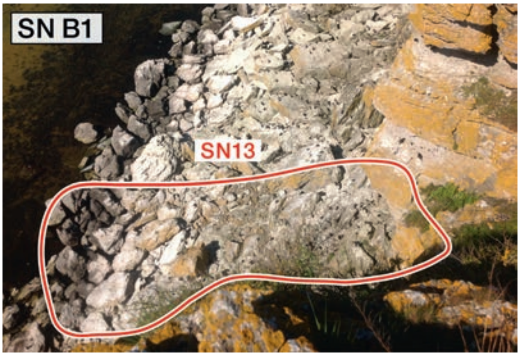
SH31
SH M1


SH28
SH27
SH L4


SH32
SH N1


SN A1
SN1
SN2
SN3
SN4
SN5
SN6
SN7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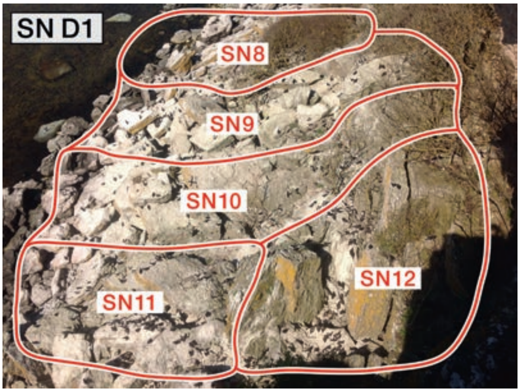
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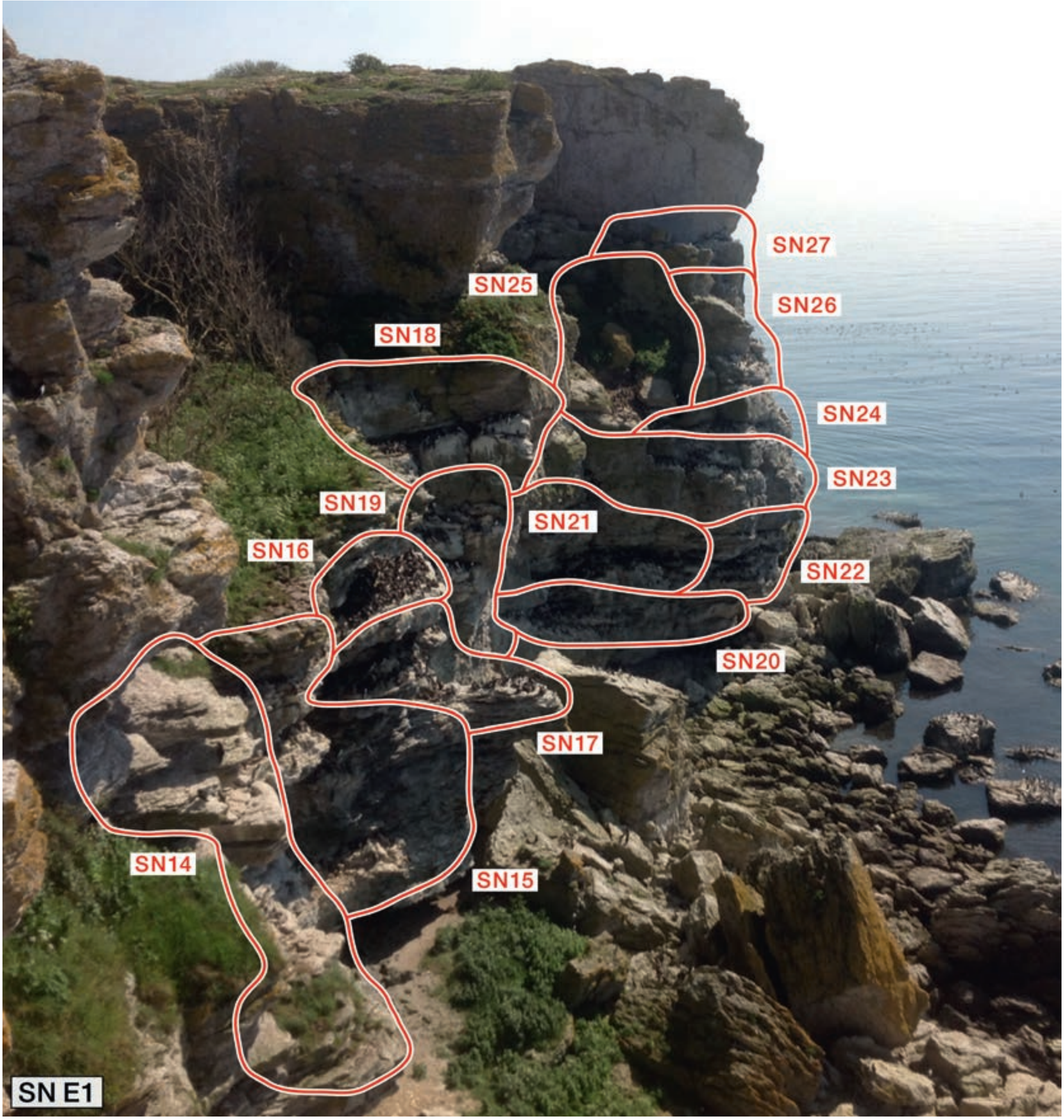

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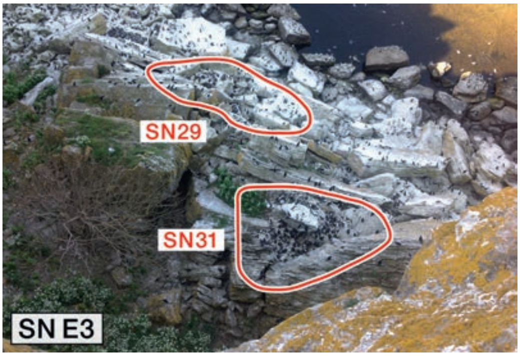

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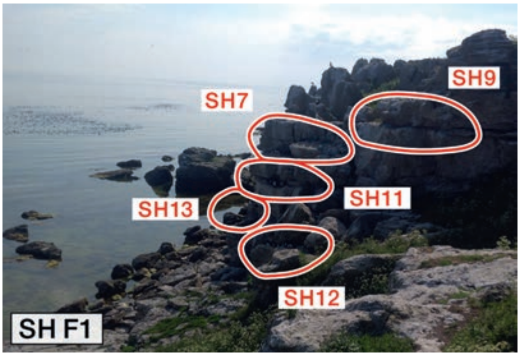
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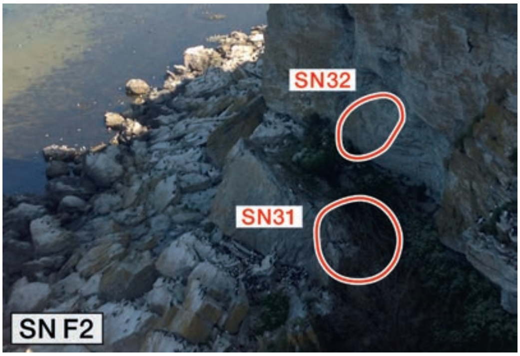
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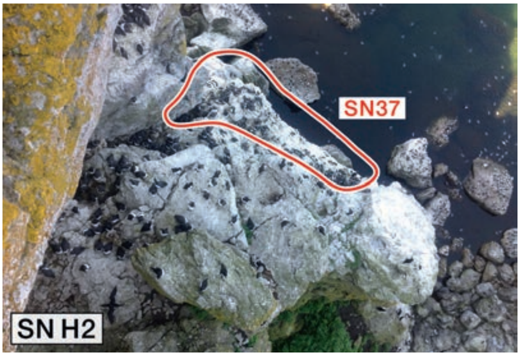
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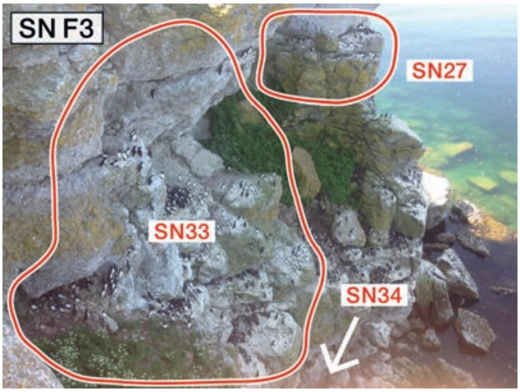
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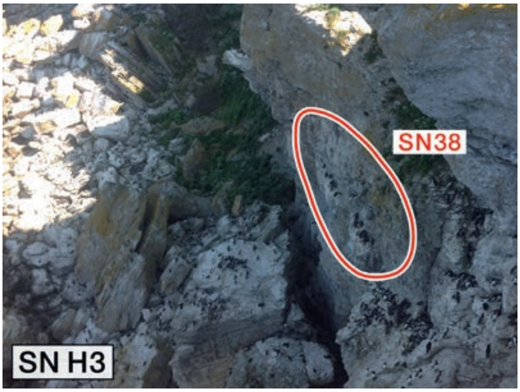
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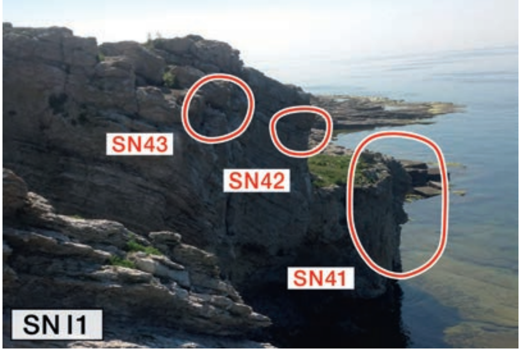
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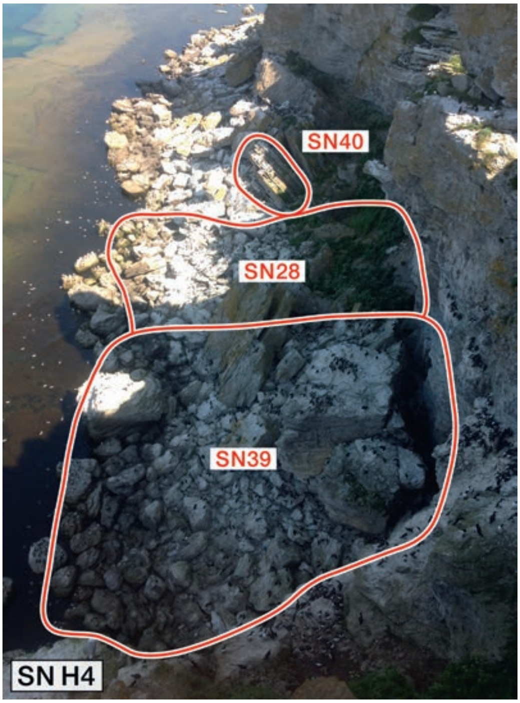
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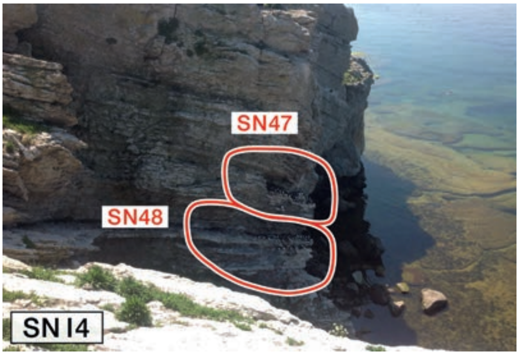
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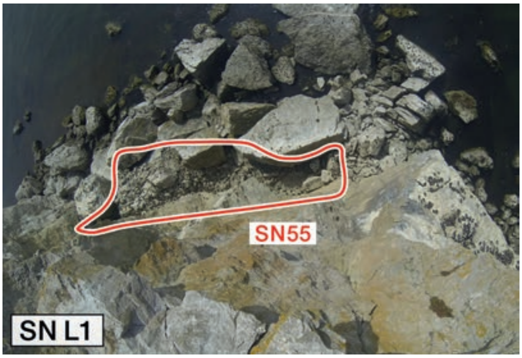
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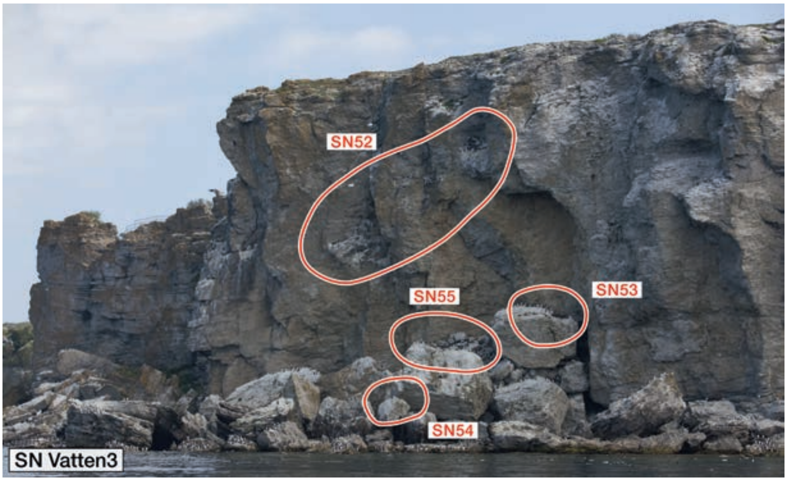
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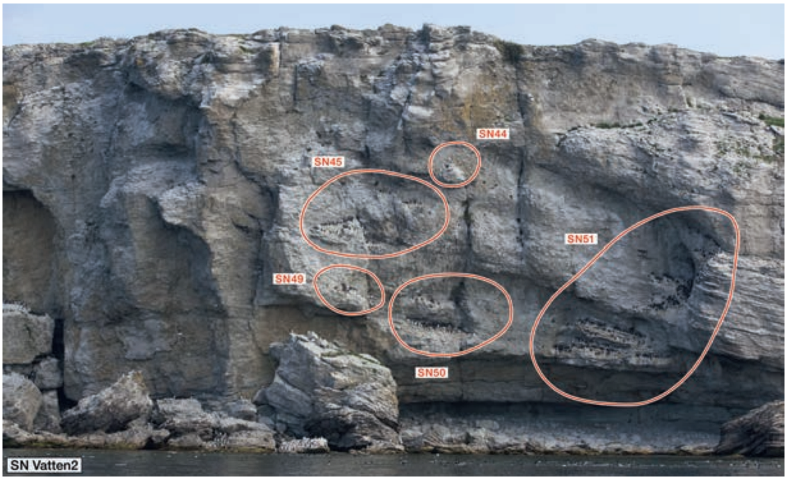
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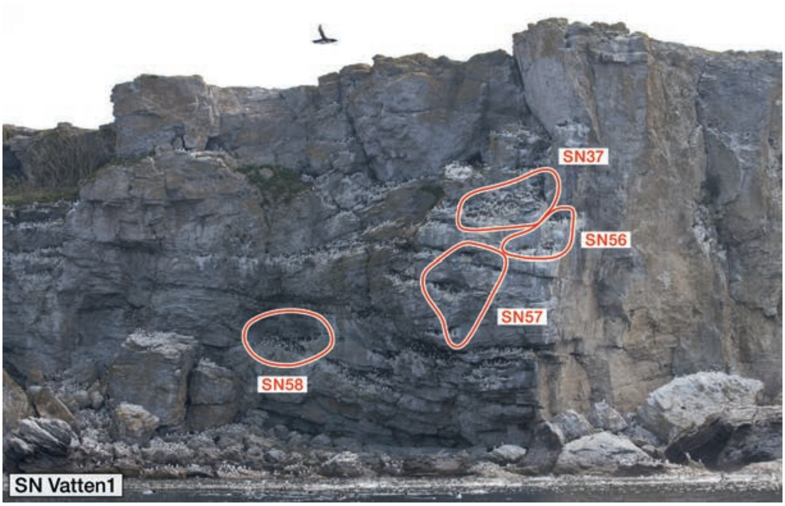
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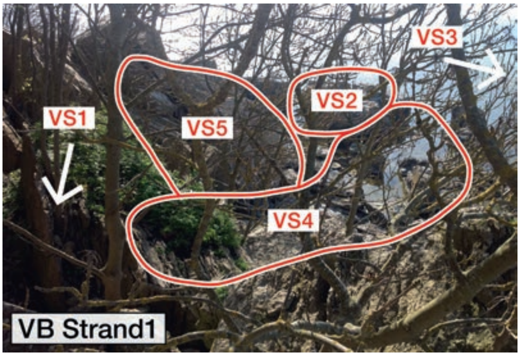
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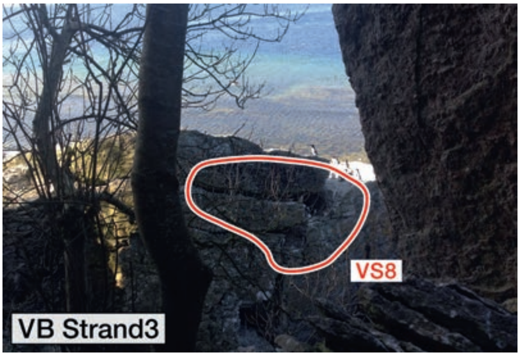
VS5
VS4
VB Strand1


VS6
VS7
VB Strand2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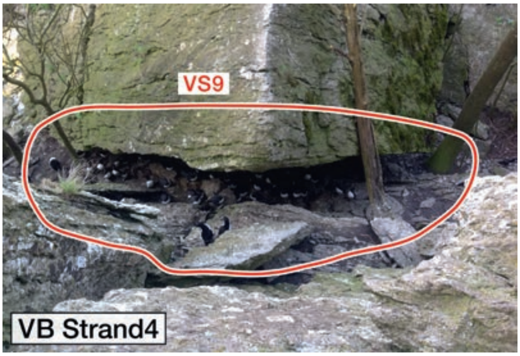
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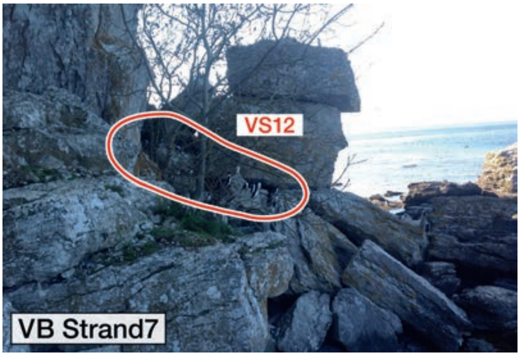
VB Strand4


VS10
VB Strand5


VB Strand6
VS11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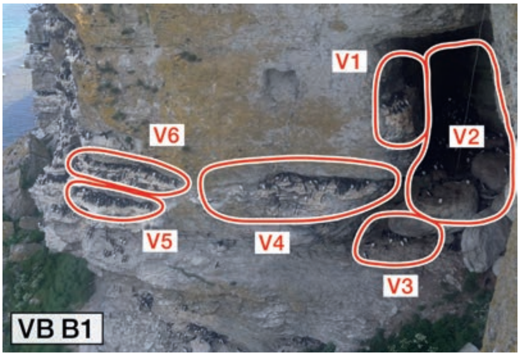
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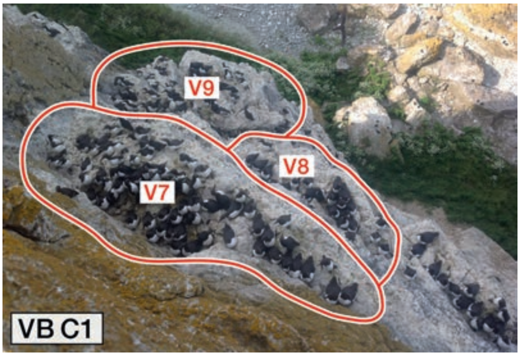
V5
V3
VB B1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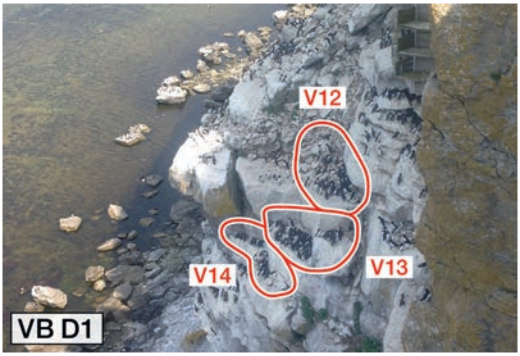
V10
VB C2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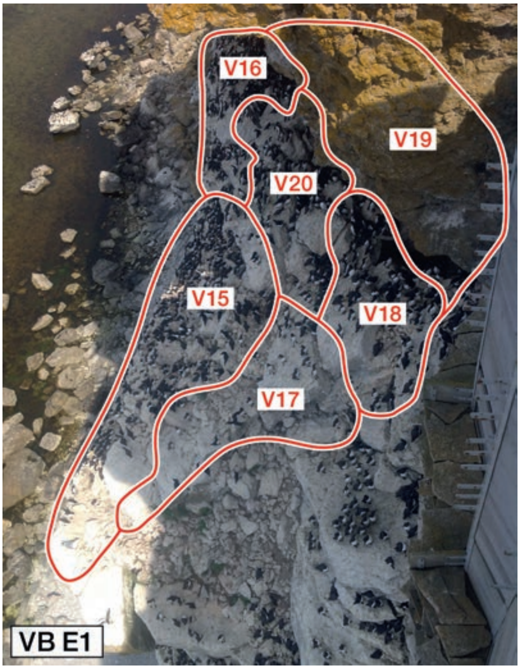
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V17
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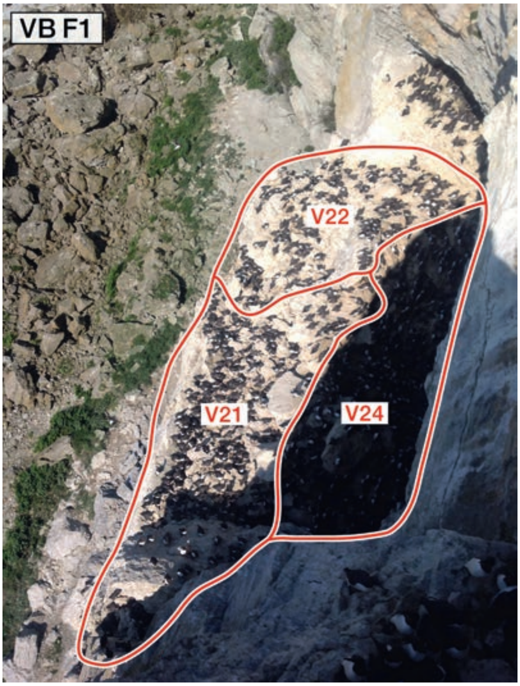
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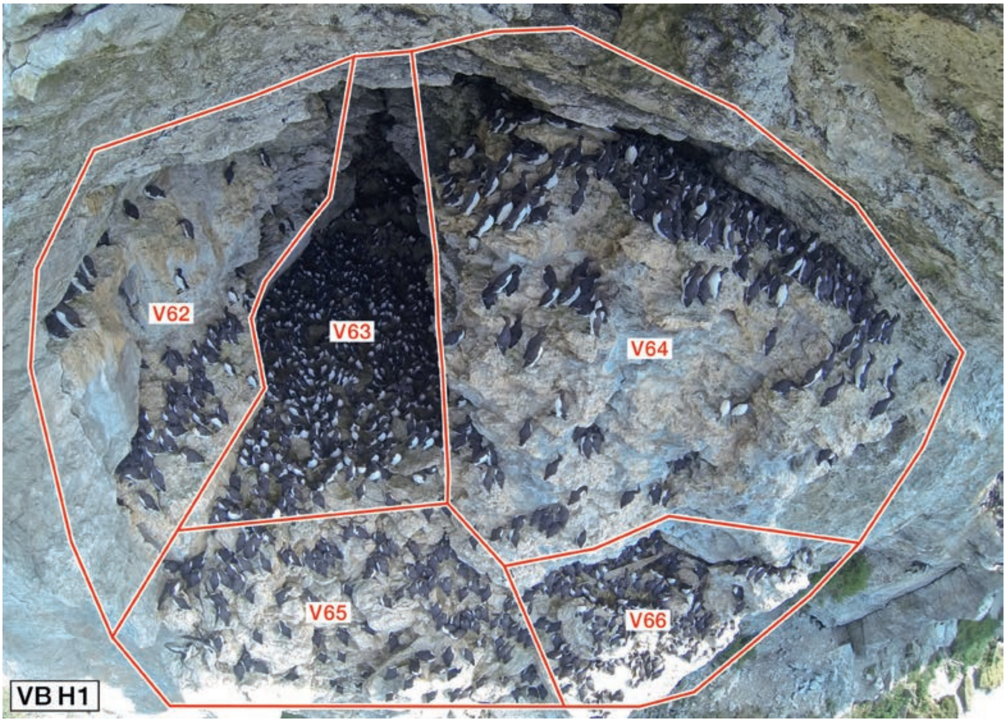
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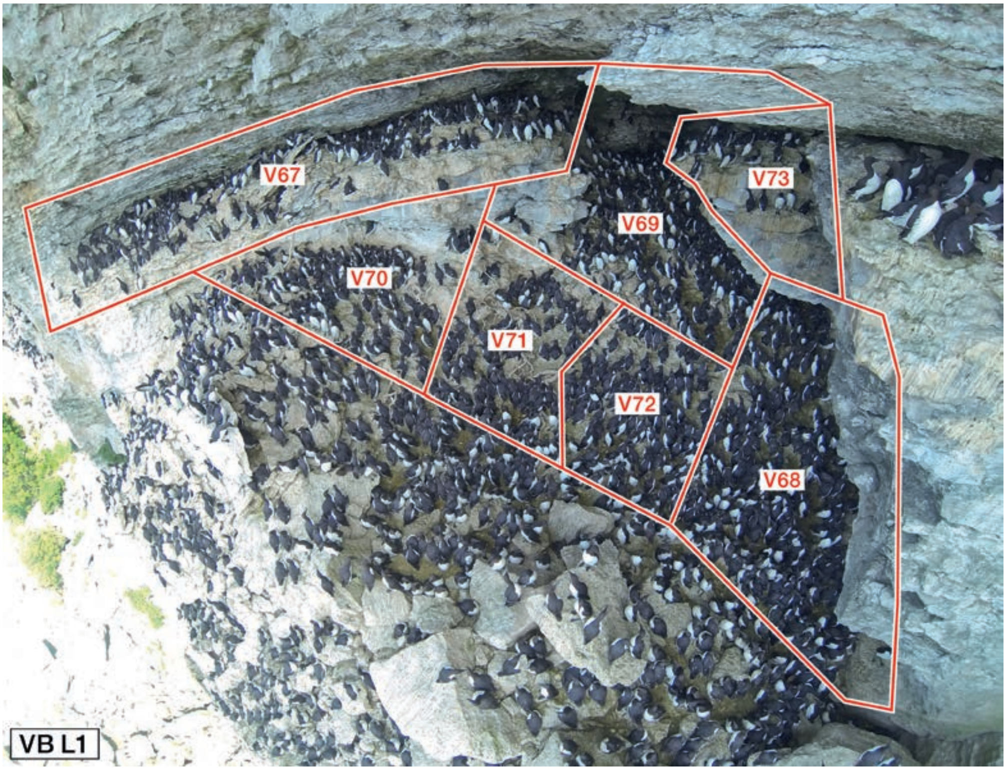
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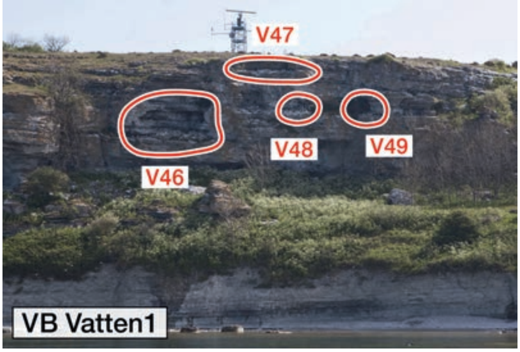
V47
V46
V48
V49
VB Vatten1


V44
V42
V43
V45
VB Vatten2


V11
V38
V37
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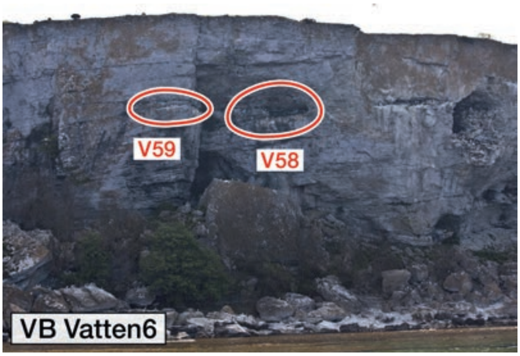
V39
V40
V41
VB Vatten3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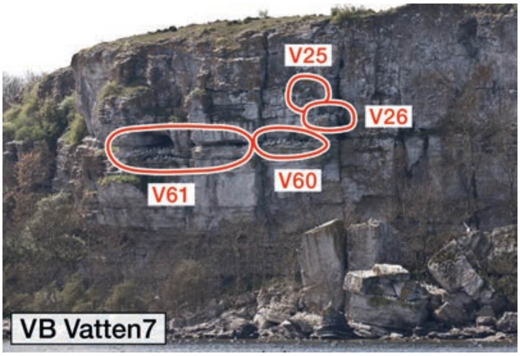
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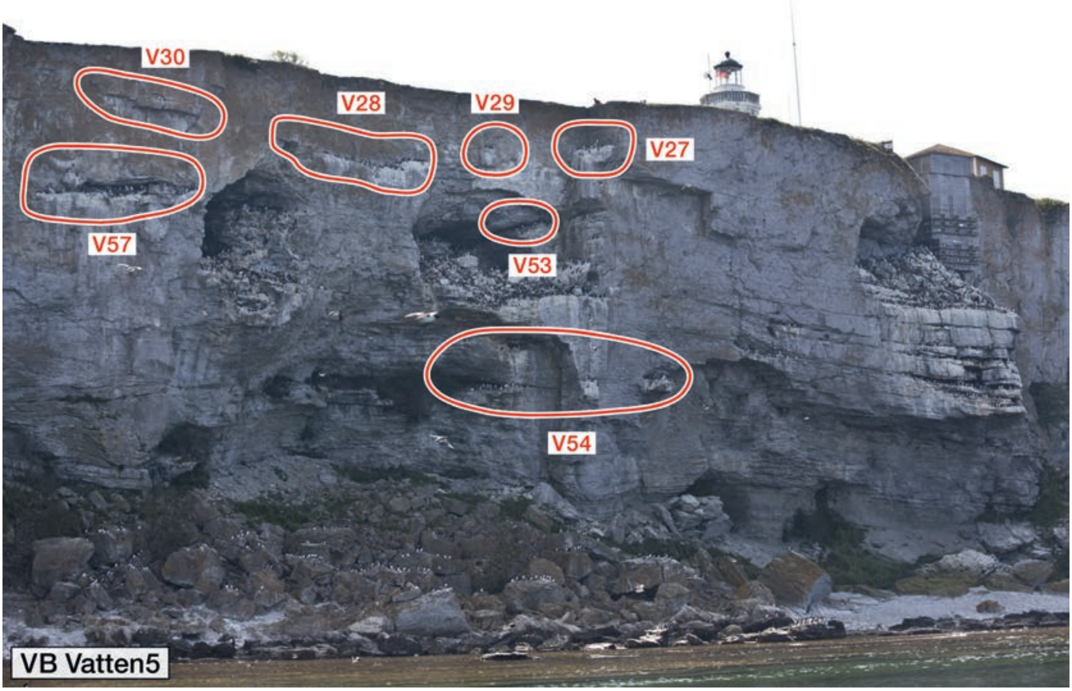
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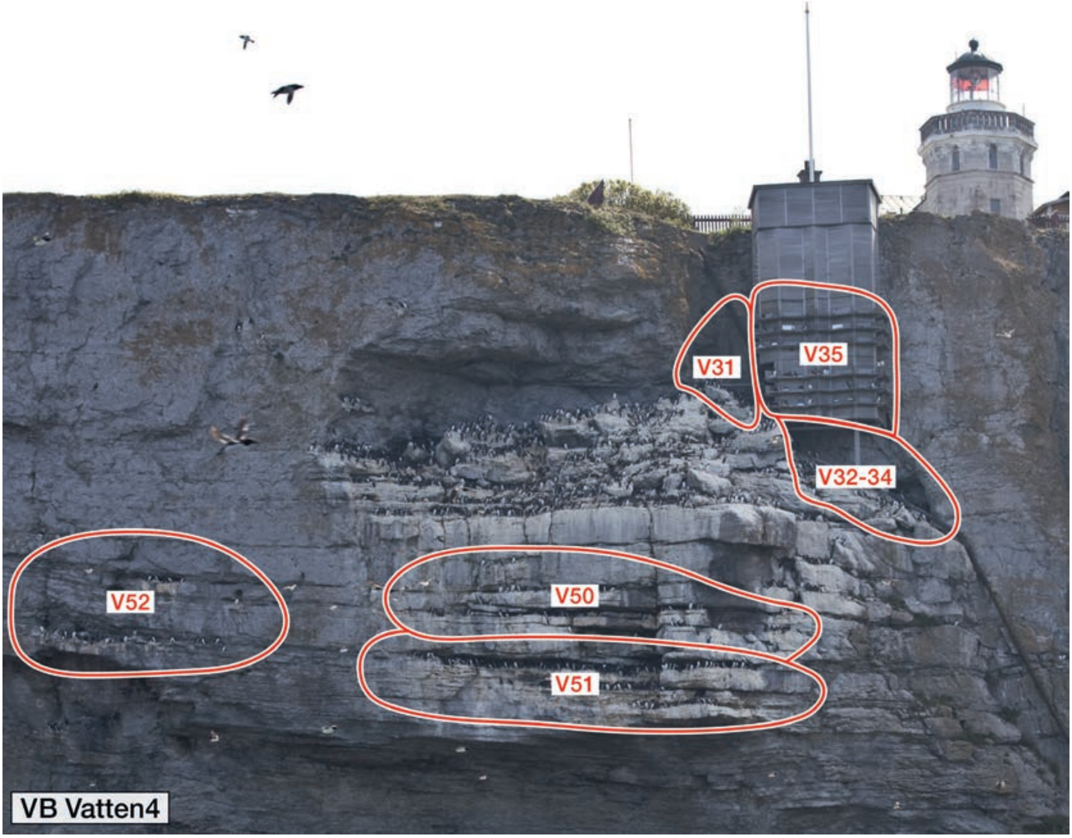
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V35
V32-34
V52
V50
V51
VB Vatten4

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Aggressiva talgoxar *Parus major*: utsvultna fåglar eller tillhörande en annan population?

Aggressive Great Tits Parus major*: starved birds or belonging to a different population?*

HANS RYTTMAN

Abstract

During autumn 2016, bird ringing stations in east Sweden observed Great Tits *Parus major* with extremely aggressive behaviour. They attacked smaller birds such as Goldcrests *Regulus regulus*, killed them and ate the brain or the content of the belly. I examine with data from Ottenby Bird Observatory two explanations: the birds were exhausted after migration and very hungry or they were birds from an eastern population where aggressive behaviour has been suggested to be more common. Fat index and body mass did not indicate low energy stores and the weather was stable with wind from the east so the first explanation was not supported. Unfortunately, wing length cannot be used to differentiate between Swedish and more eastern populations so also the second explanation could not be supported. However, Great Tits from eastern parts of north Europe moult their alula earlier than birds from Sweden. The next time aggressive Great Tits are observed, bird ringers should check the moulting stage of the alula in order to determine their origin.

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Under hösten 2016 kom ett stort inflöde av talgoxar *Parus major* till fågelstationer på den svenska ostkusten. Många av dessa talgoxar uppvisade ett mycket aggressivt beteende. Vissa talgoxar dödade andra fåglar, som oftast var mindre än dem själva, genom att hacka på den mindre fågelns hjässa så att de kom åt hjärnan. Ringmärkare observerade också talgoxar som angrep mindre fåglar utanför näten och dödade dem genom att just hacka sönder hjässan. Fåglar som hängde i näten nära talgoxarna kunde också få sina bukar upphackade varefter talgoxen åt av innehållet (Douhan 2016). En möjlig orsak till detta beteende är att många av de inkomna talgoxarna var uthungrade och snabbt behövde fylla på sina energidepåer.

Larsson (2015) har beskrivit hur magra talgoxar visat aggressivt beteende under två dagars ringmärkning (13–14 oktober 2014) på Utklippan i Blekinge. De fångade talgoxarna, både hanar och honor, vägde signifikant mindre i jämförelse med fångade talgoxar de sju föregående åren. Larsson fann också döda talgoxar i näten och även på marken, vilket indikerar att många talgoxar varit helt utmattade. Larsson (2015) föreslog att det troligen berodde på att talgoxarna som kom till Utklippan den 13–14 oktober hade flugit i regn och i motvind så att flygtiden från Baltikum tagit 15 upptill 20 timmar, vilket kunde förklara de låga vikterna på fåglarna.

Förhållandena var helt annorlunda 2016 då vädret under hela oktober oftast var klart och att fåglarna som troligen kom öster ifrån, hade en stadig medvind så gott som hela månaden (SMHI 2016). Några utmattade talgoxar i näten eller för övrigt sågs varken på Svenska Högarna eller vid Ottenby (Bill Douhan, muntligen, Magnus Hellström, i e-brev). Trots det gynnsamma vädret kunde naturligtvis talgoxarna ändå vara uthungrade på grund av födobrist där fåglarna kom ifrån. En och annan av de fåglar som talgoxarna lyckades döda utanför näten kan naturligtvis ha varit utmattade, likt den brunsångare *Phyllocopus fuscatus* som dödades av en talgoxe på Öland (Christian Cederroth, muntligen).

Detta aggressiva beteende hos talgoxar observeras relativt sällan i Sverige. Douhan (2016), med 40 års erfarenhet av ringmärkning på Svenska Högarna, minns att talgoxarna som ringmärktes 1976 och 1977 hade samma aggressiva beteende att hacka ihjäl mindre fåglar. Däremot såg han aldrig att talgoxarna flög efter eller dödade fåglar utanför nätet som några talgoxar gjorde under hösten 2016 (Douhan 2016).

En annan möjlighet är att talgoxarna kom från en annan population där det aggressiva beteendet är vanligare. Cramp (1989) nämner att ryska talgoxar visat ett aggressivt beteende men orsaken till beteendet nämns eller diskuteras inte. Estok et al. (2010) har beskrivit hur talgoxar i Ungern angripit dvärgfladdermöss och på liknande sätt dödat dessa genom att hacka sönder hjässan.

En möjlighet att studera om det rör sig om utsvultna fåglar eller fåglar från en annan population med andra vanor, som kan vara mest trolig, är att jämföra talgoxar från två år (med och utan den beskrivna aggressiviteten) vad gäller fettstatus, vikt och vinglängd, där det senare måttet kan vara kopplat till populationstillhörighet.

Vid Ottenby fågelstation insamlades data på fett, vinge och vikt på alla talgoxar märkta höstarna 2015 och 2016. Inget aggressivt beteende observerades 2015 men det var vanligt förekommande 2016. Antalet talgoxar skiljde sig mellan åren. Under 2015 var antalet 82 och under 2016 hela 1170. Mängden synligt fett klassades enligt en skala från 0 till 6 (Pettersson & Hasselquist 1985). Fåglarna fångades mellan den 3 och 31 oktober båda åren, förutom en respektive två fåglar som fångades i september.

Proportion juvenila (10) och äldre (2+) fåglar mellan de två åren skilde sig inte signifikant åt (homogenitets-test, Chi^2 = 1,99, NS). I analyserna har jag därför inte slagit ihop åldersklasserna. Eftersom det är en tydlig storleksskillnad mellan honor och hanar vad gäller både vikt (0,5–1,0 g) och vinglängd (2,5 mm) har dock jämförelserna mellan de två åren gjorts separat för respektive kön. Skillnader mellan åren testades med t-test.

Två signifikanta skillnader fanns mellan åren (Tabell 1). Honorna 2016 hade signifikant mindre fett än honorna 2015, även om värdena som sådana under 2016 inte var speciellt låga (2,5 på en skala från 0 till 6). Omvänt så vägde hanarna under 2016 mer än hanarna 2015.

Sammantaget tyder alltså inget i data från Ottenby på att 2016 års talgoxar var speciellt magra, inte heller i jämförelse med 2015. Hypotesen om att talgoxarnas angrepp och dödande av andra fåglar för att komma åt deras hjärna och maginnehåll för att snabbt få mer energi tycks alltså inte stämma.

De medelvikter som Larsson (2015) anger för Utklippans fångade talgoxar för åren 2007–2013 är lägre än de hos både 2015 och 2016 års talgoxar på Ottenby. Även de talgoxar som hade 0 i fettindex vid Ottenby 2016 (n = 23, ca 2%) vägde mer än de på Utklippan hösten 2014 (Larsson 2015). Hanarna med fett 0 vid Ottenby under hösten 2016 vägde 16,4 g (n=7) i jämförelse med 15,8 g (n=73) hos samtliga hanar på Utklippan. För honorna var motsvarande värden 15,2 g (n=16) och 14,7 (n=85). Även detta tyder på att talgoxarna vid Ottenby 2016 inte var speciellt magra eller utsvultna.

Den eventuella stress som födobrist i ursprungsområdet och/eller ansträngande flygningar skulle kunnat orsaka, kunde alltså inte verifieras för talgoxarna vid Ottenby, vilket är i kontrast till talgoxarna vid Utklippan 2014 (Larsson 2015). Att beteendet orsakats av stress då många individer finns på samma plats kan inte uteslutas, men är mindre trolig då antalet fångade talgoxar endast var dubbelt så många som fångats flera tidigare år (Ringmärkningscentralen i e-brev). Emellertid fångade Ottenby över 1000 talgoxar 1976. Ur Ottenbys dagbok (utdrag skickat i e-brev av Magnus Hellström) kan man läsa "Under oktober har sammanlagt närmare 1700 talgoxar ringmärkts. För så gott som samtliga av dessa har vingmått samt uppgifter om ruggning av handtäckare insamlats (JPN). ... Fåglarnas ostliga ursprung verifierades av en polskmärkt talgoxe. Liksom under fjolårets höstinvasion av mesar uppträd-

	År *Year*	Medel *Mean* ± se	n	t	P
Honor *Females*					
Vikt *Mass* (g)	2015	16,7 ± 0,22	44		
	2016	16,5 ± 0,05	695	0,19	0,29
Fett *Fat score*	2015	3,02 ± 0,20	44		
	2016	2,52 ± 0,06	695	2,17	0,03
Vinge *Wing* (mm)	2015	75,3 ± 0,22	44		
	2016	75,3 ± 0,05	695	0,19	0,85
Hanar *Males*					
Vikt *Mass* (g)	2015	17,2 ± 0,19	38		
	2016	17,6 ± 0,08	472	1,99	0,047
Fett *Fat score*	2015	2,55 ± 0,17	38		
	2016	2,63 ± 0,06	475	0,32	0,75
Vinge *Wing* (mm)	2015	77,9 ± 0,24	38		
	2016	78,2 ± 0,07	474	0,44	0,66

Tabell 1. Jämförelse mellan genomsnittlig (± se) vikt, fettindex och vinglängd hos honor respektive hanar av talgoxe fångade vid Ottenby fågelstation år 2015 och 2016.
A comparison between female and male Great Tits average (± se) body mass, fat index and wing length at Ottenby Bird Observatory in southeast Sweden in 2015 and 2016.

de dessa ryska mesar som rena dödsskvadronerna, och talgoxarna sågs bl a attackera rödhake, gärdsmyg och kärrsnäppa(!)"

Vinglängdsskillnader kan ibland användas för att särskilja olika populationer men det fanns inga skillnader i vinglängd mellan åren vid Ottenby (Tabell 1). Pettersson (1981) har studerat tre populationers vinglängd. En östlig, som han särskilde genom att alulan ruggas tidigare i öster än i Sverige, en från Ottenby och en på en svensk inlandslokal på vintern (Tybble, Närke). Mellan dessa tre populationer fanns dock ingen vinglängdsskillnad. Avsaknaden av skillnad i vinglängd mellan de två åren på Ottenby är alltså i sig inte ett bevis för att inte olika populationer varit involverade.

Cramp (1989) skriver att ryska talgoxar kan uppvisa aggressiva beteenden vilket är intressant med tanke på att östliga populationer oftare flyttar öster om Östersjön. Detta visades av Pettersson (1981) då han fann att fler unga talgoxar hade bytt alula på en polsk fågelstation än på Ottenby. Estoks et al. (2010) iakttagelse av talgoxar som dödar fladdermöss i dvala kan också tänkas ha ett östligt ursprung. Om aggressiva talgoxar skulle dyka upp kommande år vore det lämpligt att studera alula-ruggningen för att bättre bedöma talgoxarnas populationstillhörighet. Inte minst vore det intressant att jämföra ruggningen hos individer med dokumenterat aggressivt beteende med förmodat icke-aggressiva individer.

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Tack

Ett stort tack till Magnus Hellström, Ottenby fågelstation, som tillhandahöll de talgoxdata som möjliggjorde studien. Tack också till Bill Douhan för värdefull information från Svenska Högarna samt tips om litteratur. Synpunkter från två anonyma granskare har varit värdefulla och förbättrat artikeln. Detta är meddelande nummer 304 från Ottenby Fågelstation.

Summary

During autumn 2016, several bird ringing stations in east Sweden, including Ottenby Bird Observatory, observed Great Tits *Parus major* with a rather extreme aggressive behaviour. The tits attacked smaller birds such as Goldcrests *Regulus regulus*, especially in the mistnets, by picking on the smaller birds head or on the belly. The Great Tits killed the birds and, if possible, ate the brain or the content of the belly.

This behaviour may indicate that the Great Tits were energetically exhausted and very hungry, which could be analysed by comparing body mass and fat scores of Great Tits from years with no observed killings to those of birds from 2016. An alternative explanation to the aggressive behaviour may be that the Great Tits in 2016 belonged to a different population, where this behaviour is more common.

Great Tits caught at Ottenby in 2015 (n=82) and 2016 (n=1170) were compared regarding fat index, body mass and wing length (Table 1). The females from 2016 were leaner than those in 2016, although the birds from 2016 were not very lean as such (2.5 on a scale between 0 and 6). On the other hand, males in 2016 were heavier than in 2015. Thus, there were no strong indications that the aggressive behaviour from the Great Tits 2016 were due to low energy stores.

This is in contrast to the findings of Larsson (2015) who observed a similar aggressive behaviour of Great Tits in 2014 when the tits were strongly emaciated, probably caused by head-wind and rainy weather during their movement to Utklippan, another bird ringing station in southeast Sweden. The weather in autumn 2016 was quite different with mainly stable weather and wind from the east.

Alternatively, the birds in 2015 and 2016 could have belonged to different populations. Unfortunately, wing length (which did not differ between the two years) cannot be used to differentiate between Swedish and more eastern populations. However, Pettersson (1981) found that Great Tits from eastern parts of north Europe moult their alula earlier than birds from Sweden. The next time aggressive Great Tits are observed, bird ringers should check the moulting stage of the alula in order to have a hint of from which area the Great Tits come from.

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Förändringar av häckfåglar på en sydsmåländsk gård från 1970- till 2010-talet

Changes of the breeding birds on a forest-dominated farm in southern Sweden from the 1970s to the 2010s

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Abstract

I compare the number of breeding birds of a 70 ha farm in a forest region of southern Sweden between the 1970s and the 2010s. The most important habitat change was replacement of 25 hectares 100 years old mixed forest by spruce plantation. Stands dominated by deciduous trees only grew older, and pastures were grazed by cattle both periods. More species decreased than increased, especially residents and tropical migrants decreased. For short distance migrants, the number of decreasing species were balanced by a similar number of increasing species. The density change of most species could be attributed to the replacement of the old mixed forest by the spruce plantation. Species preferring deciduous forest had much higher densities in the study plot than the regional averages. Two deciduous forest species, Pied Flycatcher *Ficedula hypoleuca* and Marsh Tit *Poecile palustris* declined strongly, the latter possibly due to competition from the increasing Blue Tit *Cyanistes caeruleus*. The Starling *Sturnus vulgaris* and the Tree Pipit *Anthus trivialis* stands out as drastically decreasing much more than local habitat changes can explain.

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Antalsförändringar för Sveriges vanligare skogs- och åkerlevande fåglar följs noga sedan 1975, men vad som hänt innan dess vet vi mycket mindre om (Ottvall m.fl. 2008, Green m.fl. 2016). Orsaker till uppmätta förändringar av fågelpopulationer spekuleras det ofta om, men först när man kan relatera lokala förändringar till vad som där hänt med olika arters habitat och föda kan man få säkrare svar. Denna undersökning av häckande fåglar på en gård i södra Småland har gjorts samtidigt som biotopförändringar också följts noga under 60 år. Gården Djäknabygd ägs sedan århundraden av Växjö stift, men ungefär hälften är sedan 2009 naturreservat. Det gäller hagmarkerna, slåtterängar och den äldre lövträdsdominerade skogen.

Djäknabygd var ett traditionellt småbruk med fem till sex mjölkkor, en till två suggor med smågrisar, tjugo till fyrtio höns och en till två hästar fram till 1960, då staten betalade mina föräldrar för att sluta med mjölkproduktion. Jag tillbringade mina första nitton år på denna gård och utförde barnarbete där i lantbruket tillsammans med min storebror Ingvar. Vi samlade också kärlväxter och pressade dem från när jag var tio år 1957. Från detta och följande år har jag också anteckningsböcker med noteringar om fåglar. Det var också här på hemgården som jag under 1950- och 1960-talet lärde mig alla lokala fåglars läten, habitat m.m. Samtidigt blev kunskapen om alla naturförhållanden på gården mycket detaljerad, t.ex. om var det fanns ihåliga träd.

Syftena med denna uppsats är att noga dokumentera fågellivet på en gård i södra Sveriges skogsbygd under två tidsperioder samt diskutera orsakerna till de förändringar som jag funnit. Detaljerade inventeringar av häckande och revirhållande fåglar gjordes 1972–1980 och 2008–2016.

Undersökningsområde

Det inventerade området är 70 hektar, främst på gården Djäknabygd, Stenbrohults socken. Gårdens gränser framgår av karta i Nilsson (2006). De delar av gården som inte ingår är den nordligaste ändan som ligger mer än 100 m norr om den gamla kyrkvägen mellan Råshult och kyrkan. Dessutom ingår hagmarken på Prästgården som ligger intill Djäknabygd och öster om den grävda kanalen mellan

Biersjön och sjön Möckeln; detta hagmarksområde kallat Prästängen är ca 4 hektar stort.

På 1970-talet dominerades den tidigare utmarken på Djäknabygd av grandominerad blandskog, där barrträden var omkring 100 år gamla men de äldsta var omkring 150 år (Nilsson 2006). Denna skogsmarks struktur och trädslagssammansättning under 1970-talet framgår av Nilsson (1979a), delområdena S1 och S2. I dessa gamla skogar utgjorde granen 70–80%, tallen 15–20% och lövträd främst björk 5–15%. Dessutom fanns ganska mycket ung ek och bok i den barrträdsdominerade skogen, se tätheter av dessa trädslag i Nilsson (1985); ”spruce-dominated forest” är från den gamla skogen i Djäknabygd. Några hektar av dessa äldre skogar avverkades 1974, och nästan all övrig äldre barrskog slutavverkades 1981 och 1984. På hyggena lämnades spridda äldre tallar, men de avverkade områdena planterades sedan med gran. Denna plantageskog av gran som hade lövröjts var alltså 30–35 år gammal under inventeringsperioden 2008–2016, men även några hektar äldre olikåldrig grandominerad blandskog fanns ännu kvar. Dessutom har det under båda undersökningsperioderna funnits en tallhögmosse, ursprungligen på ca 6 hektar, varav 2/3 hittills lämnats orörd. Däremot dikades laggarna med kärrvegetation omkring tallmossen ut efter att hygget omkring tagits upp 1984. Rikligt med självföryngrad gran har därefter etablerats längs dikena.

På den tidigare inägomarken kring gårdscentrum dominerar lövträden, främst bok, ek och björk men där fanns även ca 15% gran på 1970-talet. Dessutom växer hassel, asp, skogslind, klibbal, avenbok, skogslönn, apel, rönn och skogsalm spritt i de tidigare inägorna. Södra stambanan går genom gårdens östra del av inägomarken. Den 17 hektar stora delen öster om järnvägen utgör område H i Nilsson (1979a), där mer exakt information finns om delområdets träd och buskar. De äldsta träden där finns i bokbackar på totalt ungefär ett hektar och träden har åldersbestämt till 200–290 år (Mats Niklasson, muntl.). De flesta av dessa ca 50 gamla bokar är ihåliga. Ekarna i området har inte åldersbestämda men de flesta är inte så gamla, utan flertalet sannolikt 80–100 år. Efter en markbrand i maj 1974 avverkade markägaren Växjö stift ca 0,5 hektar med gammal ädellövskog öster om järnvägen och granplanterade detta område som tidigare innehöll många ihåliga ädellövträd. Efter att området öster om järnvägen utnämnts till ”kyrkoreservat” avverkades dock den planterade granen 2001. Betet upphörde därefter under några år öster om järnvägen, då björk föryngrade sig rikligt. Mycket av denna ungbjörk har avverkats åren 2014 och 2016, eftersom detta nu är en hagmark i naturreservatet Stenbrohult.

Hela området öster om järnvägen har betats av nötkreatur och vissa år av en eller två hästar under båda undersökningsperioderna. Under 1970-talet gick rekryteringskvigor från Prästgården här, medan det under senare år betats av dikor av rasen rödkulla. Hälften av ängsmarken öster om järnvägen fårbetades intensivt 2005–2008, men detta område betades av fem ponnyhästar fr.o.m. maj under 2009. Hela området öster om järnvägen betades av nötkreatur och hästar under augusti–oktober 2009. Hagmarkerna öster om järnvägen lämnades utan hävd 2010, förutom tre kor med kalvar som betade ca tio dagar efter midsommar. Det mesta av det kvarstående gräset brändes av i mitten av april 2011. Området öster om järnvägen betades av nötkreatur under sommar och höst 2011–2016, samt även av en till två hästar några år. Samtliga nötkreatur som betat i området öster om järnvägen sedan 2008 har varit av lantrasen rödkulla. Sedan 2011 har det i hagmarken öster om järnvägen även funnits två örtrika slåtterängar på ca ett hektar, som slagits av i slutet av augusti med senare efterbete av nötkreatur. Även väster om järnvägen har det funnits mindre slåtterängar under båda tidsperioderna. Hagmarken på östra Prästgården har betats av nötkreatur båda undersökningsperioderna.

Inom hela området har det funnits många små kärr, som dock oftast helt torkat ut under sommaren. De som fanns i och intill de avverkade områdena 1974–1984 dikades ut. Däremot har de tiotal små kärren öster om järnvägen lämnats orörda. Här har t.o.m. ett par kärr haft högre vattenstånd på senare år när äldre diken har vuxet igen naturligt.

Under 1970-talet matades fåglarna vintertid med havre och talg vid boningshuset, men det har inte skett under senare årtionden. Däremot har fågelmatning förekommit i Stenbrohults kyrkby väster om och i Råshults by öster om undersökningsområdet. Under 1970-talet fanns från början 30 holkar inom området som fram till 1980 successivt minskade till ca 20, men under 2008–2016 bara några få holkar. Förekomsten av naturhål i gamla lövträd har varit riklig på den f.d. inägomarken under båda tidsperioderna. Under 1970-talet hittades fågelbon inuti 43 hålträd, varav flera hål utnyttjades i vissa träd.

Metod

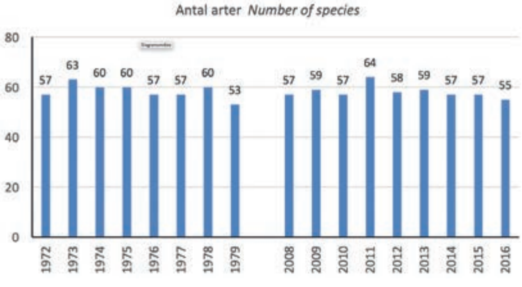
Alla år, förutom 1980, har undersöksområdet besökts minst två gånger i veckan från mitten/slutet av mars till slutet av juni. Den utsträckta inventeringsperioden under vår-sommar baserades på att olika fåglarnas sångaktivitet toppar under olika tidsperioder (Nilsson 1974b, 1977). Området genomkorsades längs i förväg bestämda rutter med 100 m avstånd (se figur i Nilsson 1974a). Rutternas start alternerade mellan södra och norra ändan av området och varannan gång gick jag mellan de tidigare 100-meters linjerna. Dagar med regn och blåst gjordes inga inventeringar. Alla fågelobservationer ritades in med artkoder på en besökskarta med kompletterande noteringar i en anteckningsbok. Varje inventering startade kring soluppgången hela säsongen och varade fyra till fem timmar per besök. Åren 1972–1979 användes en utökad karteringsmetod med årligen 21–28 morgonkarteringar kompletterat med boinventeringar av trastar, mesar, stjärtmes, nötväcka och stare. Boinventeringarna gjordes främst på eftermiddagarna och funna bon följdes upp med några dagars mellanrum för att konstatera häckningsutfallet (Nilsson 1984). Flera besök gjordes även kvällstid och förnätter i mars–april för att inventera sjungande trastar, ugglor, morkulla och enkelbeckasin. Min metod påminner mycket om den som beskrivs av Tomiałojć (1980). År 1980 karterades fåglarna under tio morgonbesök och några kvällsbesök april–juni, med boletning främst för stare. År 1980 inventerades inte de vanligaste arterna noga, förutom stare, och inte heller de nattaktiva arterna.

Särskild uppmärksamhet ägnades alla år åt samtidiga observationer av sjungande fåglar och samtidigt aktiva bon. När det gäller hackspettar noterades också om möjligt kön, eftersom båda könen kan trumma. Många revirhävdande fåglar flyttar snabbt mellan olika platser i reviren, varför sådana förflyttningar noterades noga. Det gällde även observationer strax utanför undersökningsområdet, särskilt för arter med stora revir. Utan dessa noteringar av samtidigt sjungande/trummande och snabbt förflyttande individer kan man lätt överskatta antal revir. Se vidare tidigare beskrivningar av metoden (Nilsson 1977, 1979a, 1979b).

Under åren 2008–2016 har området besökts lika ofta som 1972–1979, men de vanliga arterna har inte ägnats lika stor uppmärksamhet som tidigare. Riktad boletning har bara använts under senare år för stare och stjärtmes, men tidigare erfarenheter har använts för att utvärdera de observationer som gjorts av t.ex. trastar. De särskilt kvälls- och nattaktiva arterna har räknats vid flera kvälls- eller gryningsbesök per år. Särskilt har förekomsten av i trakten ovanligare arter följa upp särskilt noga även under senare år.

Vid utvärderingen av observationer har revirhävdande individer under en period på minst sju dagar på en plats bedömts som ett revir. Dessutom har revirhävdande individer under kortare perioder samt revir med mindre än halva reviret i området noterats. Ladusvalan har alla år häckat 100 m väster om och ibland i en lada 200 m öster om undersökningsområdet och har också alla år sökt föda över områdets hagmarker, men har ändå inte tagits med här. Fåglar som uppenbarligen sjungit under flyttning, t.ex. gransångare i april, samt bergfink och rödvingetrast under sträcktid har inte bedömts som revirhävdande. På samma sätt har överflygande sjöfåglar under häckningstid, men som inte häckat inom området, uteslutits.

Eftersom mycket noggranna täthetsberäkningar gjort på den undersökta gården kan det vara intressant att jämföra med de abundanser som anges för Kronobergs län i Ottosson m.fl. (2012). För att räkna ut tätheten i länet har det antal par som anges i boken dividerats med länets landyta på 8488 km^2. För de vanligaste arterna har bara tätheter räknats ut på Djäknabygd från de år antalet revir bedömts vara noga inventerat.



Figur 1. Antal arter de undersökta åren på gården Djäknabygd.
Number of species in the investigated years on the farm Djäknabygd.

Resultat

Antal revirhävdande arter har varierat mellan åren, men har årligen varit omkring 60 både under 1970- och 2010-talen (Figur 1). Totalt inräknades 77 arter under 1970-talet och 72 arter under motsvarande 9-årsperiod nyligen (Appendix). Av de under senare år ”nya” arterna är alla fem kortdistansflyttare (Tabell 1), även om gransångare kanske inte ska räknas som ny då en gransångare sjöng mitt i området 26 och 28 juni 1972. Av de åtta försvunna arterna är däremot fyra stannfåglar, medan tre är kortflyttare och göktytan tropikflyttare. Skata har visserligen besökt gården även under senare år, men bara tillfälligt. Skatan häckar fortfarande årligen med vardera ett till två par i Stenbrohults kyrkby och i Råshults by intill

Tabell 1. Arter som ökat eller minskat sedan 1970-talet på gården Djäknabygd i förhållande till arternas flyttningsstrategier.
Long-term species population trends at the farm Djäknabygd in relation to migratory habits.

	Flyttningsstrategi *Migration strategy*		
	Stannfåglar *Residents*	Kortflyttare *Short distance migrants*	Tropikflyttare *Tropical migrants*
Nya arter *New species*		Grågås *Anser anser* Trana *Grus grus* Skogsduva *Columba oenas* Gransångare *Phylloscopus collybita* Sävsparv *Emberiza schoeniclus*	
Ökning 50–100% *Increase 50–100%*	Blåmes *Cyanistes caeruleus*	Dubbeltrast *Turdus viscivorus* Stenknäck *C. coccothraustes*	Grå flugsnappare Muscicapa striata
Minskning 25–50% *Decrease 25–50%*	Nötskrika *Garrulus glandarius* Talgoxe *Parus major* Trädkrypare *Certhia familiaris*	Björktrast *Turdus pilaris* Taltrast *Turdus philomelos* Koltrast *Turdus merula* Rödhake *Erithacus rubecula* Grönsiska *Carduelis spinus*	Grönsångare *Phylloscopus sibilatrix*
Minskning 50–75% *Decrease 50–75%*	Svartmes *Periparus ater* Tofsmes *Lophophanes cirstatus* Entita *Poecile palustrios* Talltita *Poecile montanus*	Kungsfågel *Regulus regulus* Domherre *Pyrrhula pyrrhula* Bofink *Fringilla coelebs* Järnsparv *Prunella modularis*	Rödstjärt *Ph. phoenicurus* Trädgårdssångare *Sylvia borin* Lövsångare *Phylloscopus trochilus* Svartvit flugsnappare *Ficedula hypoleuca* Törnskata *Lanius collurio*
Minskning >75% *Decrease >75%*		Stare *Sturnus vulgaris*	Trädpiplärka *Anthus trivialis*
Försvunna arter *Disappeared species*	Tjäder *Tetrao urogallus* Fasan *Phasianus colchicus* Skata *Pica pica* Pilfink *Passer montanus*	Kaja *Coloeus monedula* Brandkronad kungsfågel *Regulus ignicapillus* Gulsparv *Emberiza citrinella*	Göktyta *Jynx torquilla*

Tabell 2. Genomsnittliga tätheter (revir/km^2) av häckfåglar på gården Djäknabygd på 1970-talet, motsvarande täthet 2008–2016 samt framräknad medeltäthet för Kronobergs län från boken Fåglarna i Sverige.
Average density (territories/km^2) of some species at the farm Djäknabygd in the 1970s, corresponding density in 2008–2016, and calculated mean density for Kronoberg county (G län) according to Ottosson et al. (2012).

Art *Species*	1970-tal	2010-tal	G län
Morkulla *Scolopax rusticola*	3,9	3,3	2,8
Ringduva *Columba palumbus*	7,0	8,1	4,2
Större hackspett *Dendrocopos major*	4,6	4,4	0,7
Nötskrika *Garrulus glandarius*	8,8	6,5	2,9
Stjärtmes *Aegithalos caudatus*	2,9	3,0	0,3
Talgoxe *Parus major*	34	18	16
Blåmes *Cyanistes caeruleus*	8,6	14	4,5
Svartmes *Periparus ater*	9,6	4,1	5,2
Tofsmes *Lophophanes cristatus*	2,5	0,8	2,4
Entita *Poecile palustris*	10	4,9	1,6
Talltita *Poecile montanus*	4,3	1,5	1,4
Nötväcka *Sitta europaea*	8,9	9,4	1,2
Trädkrypare *Certhia familiaris*	11	7,8	6,5
Gärdsmyg *Troglodytes troglodytes*	6,7	6,7	5,9
Taltrast *Turdus philomelos*	27	14	7,1
Koltrast *Turdus merula*	25	15	14
Rödhake *Erithacus rubecula*	58	29	21
Svarthätta *Sylvia atricapilla*	13	11	12
Trädgårdssångare *Sylvia borin*	18	7,5	5,3
Ärtsångare *Sylvia curruca*	2,7	1,2	1,8
Lövsångare *Phylloscopus trochilus*	69	28	41
Grönsångare *Phylloscopus sibilatrix*	11	5,9	0,7
Kungsfågel *Regulus regulus*	27	11	21
Grå flugsnappare *Muscicapa striata*	1,8	3,5	2,9
Svartvit flugsnappare *Ficedula hypoleuca*	16	5,6	5,5
Järnsparv *Prunella modularis*	19	8,1	3,5
Trädpiplärka *Anthus trivialis*	24	5,4	7,1
Törnskata *Lanius collurio*	2,5	0,6	0,2
Stare *Sturnus vulgaris*	21	2,5	2,4
Stenknäck *Coccothraustes coccothraustes*	1,1	3,0	0,1
Grönfink *Carduelis chloris*	2,4	2,7	1,8
Grönsiska *Carduelis spinus*	7,0	3,8	2,0
Domherre *Pyrrhula pyrrhula*	4,0	3,0	1,1
Bofink *Fringilla coelebs*	47	29	45

undersökningsområdet.

Av de stannfåglar som haft en trend i området sedan 1970-talet har hela elva arter minskat eller försvunnit, medan bara blåmesen ökat (Tabell 1). Blåmesen är en art som delvis lämnar området vintertid (egna observationer) och kunde kanske lika gärna anses vara en kortflyttare. Bland kortdistansflyttarna har sju arter ökat eller tillkommit, medan tretton arter minskat eller försvunnit. Bland tropikflyttande fåglar med ändrad täthet bedöms bara grå flugsnapparen ha ökat något, medan däremot åtta arter minskat eller försvunnit. Sammantaget har således betydligt fler arter minskat än ökat på gården Djäknabygd de senaste 45 åren. Det gäller särskilt stannfåglar och tropikflyttare.

Under åren 1972–1979, då noggranna täthetsberäkningar gjordes även för de vanligaste arterna, var mediantätheten på gården 579 revir per kvadratkilometer (bara arter med minst ett helt revir i området medtagna). Den högsta tätheten var 657 revir per kvadratkilometer år 1975 och den lägsta 427 efter den kalla vintern 1979. Tätheten i det varierade lövskogs- och hagmarks-området öster om järnvägen var 541 revir per kvadratkilometer år 1976 (område H i Nilsson 1979a). Tätheten i den gamla barrskogen var 481 revir per kvadratkilometer år 1977 (managed forest i Nilsson 1979b). Uppenbarligen varierade tätheten inte så mycket mellan olika naturtyper på gården under 1970-talet. Tätheten under senare år har varit betydligt lägre, men oftast drygt 300 revir per kvadratkilometer, men med stora variationer. Lägst täthet fanns i granplantagerna, men inga exakta beräkningar har gjorts.

För en del arter överensstämmer de tätheter som jag fann ungefär med de som räknats fram för Kronobergs län från Ottosson m.fl. (2012), men flera arter avviker markant (Tabell 2). Grönsångare, nötväcka, stjärtmes och stenknäck har mer än åtta gånger högre täthet på gården Djäknabygd jämfört med uppgifterna i boken Fåglarna i Sverige. Större hackspett, blåmes, entita, törnskata och domherre har tre till sex gånger så hög täthet på gården.

Svartvit flugsnappare, trädpiplärka och stare har minskat drastiskt på Djäknabygd sedan 1970-talet, så att de gått från att ha flera gånger så hög täthet som räknats fram för Kronobergs län från boken Fåglarna i Sverige till att nu ha ungefär samma tätheter som anges i boken (Tabell 2). På liknande sätt har tätheterna för de på 1970-talet vanligaste arterna bofink, talgoxe, taltrast, koltrast, rödhake, trädgårdssångare, lövsångare och kungsfågel minskat så att de nu ligger i nivå med eller lägre än skattningarna för Kronobergs läns genomsnittliga tätheter.

Diskussion

Det har skett stora förändringar i häckfågelfaunan på gården Djäknabygd under de senaste 45 åren, men antalet arter har varit högt under båda de undersökta tidsperioderna. En hel del av förändringarna kan sättas i samband med biotopförändringar, medan andra tycks bero på andra faktorer. Sammantaget har betydligt fler arter minskat än ökat på gården Djäknabygd de senaste 45 åren. Det gäller särskilt stannfåglar och tropikflyttare.

Att skata, pilfink och gulsparv har försvunnit kan bero på att vintermatningen upphörde vid boningshuset omkring 1990. Huvudsakligen erbjöds tidigare havre och talg, producerat på gården. Andra viktiga faktorer för dessa arter är sannolikt att sädesodlingen i trakten, som fortfarande var vanlig på många gårdar under 1970-talet, har minskat betydligt sedan dess. Detta kan också vara orsak till att kajan försvunnit från gården, trots att många lämpliga hålträd ännu finns kvar. Både kaja och pilfink häckar dock fortfarande på Stenbrohults prästgård, där årligen åkrar har såtts med blandsäd av havre och korn även under senare år.

Den mest drastiska förändringen av biotopen på gården är att ca 25 hektar gammal grandominerad blandskog ersattes av granplantager. Från att skogen varit luckig, olikåldrig med flera trädslag, och med de äldsta träden 100–150 år gamla, blev barrskogen en jämnårig granplantering med bara ett litet inslag av björk och tall (Nilsson 2006). Under 2008–2016 har barrskogen därför dominerats av 30–35 år gamla granplantager. Dessutom fanns det drygt ett hektar rena granbestånd från plantering av hagmarker 1960 (nästan lika mycket av dessa plantager blåste ned i stormen 2005), samt några hektar ungefär hundraårig grandominerad blandskog. Minskningen av svartmes, tofsmes, talltita, trädkrypare, rödhake, grönsångare, kungsfågel, järnsparv, grönsiska, domherre och bofink kan direkt sättas i samband med avverkningen av gammal grandominerad blandskog. Detta framgår från hur reviren fördelas under de två tidsperioderna (opublicerade artkartor).

Det är intressant att brandkronad kungsfågel under tre år på 1970-talet hävdade revir på olika platser i den gamla grandominerade skogen, där det fanns inslag av tall, björk, ek, bok och asp. Trots att den brandkronade kungsfågeln ökat markant i Sverige sedan dess har den inte återvänt till gården. Även en lundsångare hävdade revir under tre veckor i den gamla grandominerade skogen 1978. En annan intressant art i den gamla barrskogen var den tretåiga hackspetten. En hona sågs 13 april 1974 samt 2 november 1974 och en hane tre gånger under 9–19 april 1975. En hane sågs även 30 december 1981 (Ingvar Nilsson). På kyrkans tre anslutande gårdar i Stenbrohult fanns vid denna tid över 100 hektar med drygt 100-årig grandominerad skog. Det är troligt att ett par av tretåig hackspett då fanns i denna skog, åtminstone under några år. Under 1970-talet noterades den tretåiga hackspetten i två andra områden vid sjön Möckeln, även under häckningstid. Efter att de gamla barrskogarna vid sjön avverkats finns inga fler observationer av tretåig hackspett.

Det är viktigt att uppmärksamma hur drastiskt även markvegetationen har ändrats i gårdens barrträdsdominerade skogar de senaste 40 åren. På 1970-talet var marken nästan helt mosstäckt i dessa gamla skogar, bärris av blåbär och lingon täckte 60–80% av marken och kruståtel under 50% (Nilsson 2006). I de nya granplantagerna finns mest några vanliga mossor, fläckar med kruståtel och barr på marken, men nästan inget bärris. Att det är skogsbruket som ligger bakom bärrisets minskning framgår tydligt av att det i en kraftledningsgata genom norra delen ännu växer rikligt med högt blåbärs- och lingonris.

Blåbärsris minskar starkt med ökande täthet av gran, men ökar successivt till en platå när skogen blir över 80 år gammal (Hedwall m.fl. 2013). Fjärilslarver som lever på blåbärsris är en viktig föda för tjäderkycklingar och för insektsätande tättingar (Atlegrim 1989). Blåbärsrisets drastiska minskning i barrskogen kan bl.a. förklara tjäderns försvinnande från Djäknabygd, kanske i kombination med att tuvullens blomning minskat på tallhögmossen efter igenväxning (egna observationer). Senast jag såg en tjäderkull på gården var i juni 1963, men tjäder sågs under häckningstid även tre år under 1970-talet. Även för små insektsätande fåglar, samt kanske också för taltrast och koltrast, kan den drastiska minskningen av blåbärsris vara väl så viktig som barrskogens yngre ålder för att förklara minskningen av fåglarna. Detta behöver undersökas mer ingående, för att kunna förklara fåglars populationsförändringar i skogsmark. Både taltrast och koltrast tycks dock generellt ökat något på längre sikt i Sverige (Green m.fl. 2016).

De nötkreatursbetade hagmarkerna har varit ungefär lika stora båda undersökningsperioderna. Därför går det inte att förklara göktytans försvinnande samt trädpiplärkans och starens drastiska minskningar utifrån lokala habitatförändringar. Visserligen fanns många revir av piplärkan i den gamla luckiga barrskogen, men minskningen av trädpiplärkan kan inte bara förklaras av denna skogs försvinnande. Antalet revir har ungefär halverats i hagmarkerna sedan början av 1970-talet. Då fanns även tre revir trädpiplärka på tallmossen, som märkbart vuxit sig tätare sedan laggkärren dikats ut. Under senare år har trädpiplärkan helt försvunnit från skogsmarken, där det i början av 1970-talet fanns mer än tio revir i luckor i den barrträdsdominerade skogen. Det är anmärkningsvärt att trädpiplärkans bestånd på Djäknabygd halverades redan på 1970-talet, något som alltså skedde innan den landstäckande övervakningen av fågelfaunan började 1975. Orsaken till denna tidiga minskning finns inte i habitatförändringar på Djäknabygd, utan troligen på övervintringsområdet i Afrika. Notervärt är att även i Storbritannien minskade trädpiplärkan markant under 1970-talet.

Stararna på gården har hela tiden häckat i naturhål och mängden av dessa har bara ändrats marginellt. Flera ihåliga lövträd har avverkats 1974–1984, men hackspettarna har senare hackat ut nya hål, främst i aspar. Troligen ligger miljöändringar på flyttningsoch/eller övervintringsområdena åtminstone delvis bakom minskningar av göktyta, stare och trädpiplärka. Under de senaste 40 åren har dessa tre arter minskat markant i Sverige (Green m.fl. 2016), men orsakerna är inte uppenbara. På Kullaberg i Skåne har göktyta, stare och trädpiplärka minskat med mer än 90% från 1974 till 2014, trots att ytan av betade hagmarker inte minskat där (Nilsson & Peterz 2016). Arterna har sina utbredningscentra i Europa söder om mitt undersökningsområde, varför klimatförändringar i form av ökande temperaturer inte heller verkar ligga bakom minskningarna. Ett varmare klimat borde leda till ökning i norra delen av utbredningsområdena om andra faktorer vore oförändrade.

Flera av de nytillkomna och ökande arterna på gården Djäknabygd är sådana som generellt ökat i södra Sverige under de senaste 40 åren (Ottvall m.fl. 2008, Green m.fl. 2016), förutom skogsduva, grå flugsnappare och sävsparv som minskat. Både skogsduvan och flugsnapparen har ökat i Sverige under senare år, men minskat sedan 1975. Sävsparven har dock minskar inom alla tidshorisonter. Att sävsparven hävdat revir på Djäknabygd under senare år kan sättas i samband med att betesmarken öster om järnvägen blivit blötare efter att gamla diken vuxit igen. Kanske kan detta även förklara att den generellt minskande enkelbeckasinen hållit ställningarna på gården.

Den totala fågeltätheten på gården Djäknabygd var inte anmärkningsvärt hög ens på 1970-talet. I flera äldre lövträdsdominerade blandskogar vid sjön

Möckeln var tätheten i mitten av 1970-talet mellan 1037 och 1453 revir per kvadratkilometrar (Nilsson 1979a, 1979b, 1980). Om populationstätheten av olika arter på gården Djäknabygd jämförs med den beräknade i Kronobergs län kan den stora skillnaden för stjärtmes, blåmes, entita, nötväcka, grönsångare och stenknäck förklaras av den relativt stora ytan äldre ädellövskog på Djäknabygd och även andra gårdar kring sjön Möckeln (Rundlöf 2003). Att lövskogen blivit äldre inom området har även gynnat blåmes och stenknäck som ökat något sedan 1970-talet. Att tätheten av entita halverats på gården sedan 1970-talet kan däremot inte förklaras av förändringar av habitat. Eftersom entitan är stannfågel skulle en möjlig förklaring till artens minskning kunna vara konkurrens med den ökande blåmesen. Vid flera tillfällen har jag observerat att blåmesar tagit över bohål från entitor samma vår. Det finns indikationer på att en hög täthet av blåmes tvingar entitan att häcka i bohål med högre predationsrisk (Nilsson 1984). På Kullaberg har entitan minskat drastiskt från 1974 till 2014, trots att ytan lövskog ökat under perioden (Nilsson & Peterz 2016). Under samma period har blåmesens population ökat trefaldigt på Kullaberg, i linje med min hypotes. En negativ påverkan på entitans antal från talgoxen kan inte heller uteslutas (Wittwer m.fl. 2015).

Den svartvita flugsnapparen föredrar äldre ädellövskog, men antalet holkar har minskat på Djäknabygd och arten har också minskat generellt. På 1970-talet häckade många par i holkar, men under senare år däremot mest i ihåliga lövträd. För svartvita flugsnapparen är det således svårt att särskilja orsaken till minskningen från lokala habitatförändringar och andra faktorer. Det finns indikationer på att mesars konkurrens i kombination med klimatförändringar påverkat svartvita flugsnapparens population negativt (t.ex. Wittwer m.fl. 2015).

Det är välkänt att vissa stannfåglar påverkas negativt av kalla vintrar, vilket bl.a. visats för gärdsmyg, kungsfågel och nötväcka från data insamlade i Stenbrohult (Nilsson 1986, 1987). Efter den kalla vintern 1978/1979 försvann både stjärtmesen och gärdsmygen helt från Djäknabygd, men båda återkom 1980 (Appendix). Flera andra arter minskade också märkbart från 1978 till 1979. De senaste åren var 2009/2010 en kall vinter, med halverade bestånd av gärdsmyg och kungsfågel som en trolig konsekvens. Däremot kunde ingen effekt ses på stjärtmes eller nötväcka av denna kalla vinter. Den negativa effekten av en kall vinter kan dock buffras av en hög födotillgång (Nilsson 1987). Generellt är det svårt att förklara täthetsskillnader mellan de undersökta tidsperioderna med olika vinterväder. Flera vintrar var ovanligt milda även under 1970-talet.

Hur generella är de förändringarna av fågelfaunan som noterats på gården Djäknabygd? De senaste 50 åren har äldre bärrisrika grandominerade barrskogar i trakten ersatts av yngre granplantager med nästan inget bärris (egna observationer). Det är därför troligt att de minskningar av barrskogslevande fåglar som jag funnit på gården Djäknabygd är typiska för södra Småland. När det gäller hagmarkerna gäller detta däremot inte, eftersom beteshävden av många hagmarker har upphört i dessa skogsbygder sedan 1950-talet. I mitt undersökningsområde finns de däremot kvar. Inte heller när det gäller de äldre lövskogarna har de bevarats lika väl på andra gårdar som på Djäknabygd. Fågelarter som har sina föredragna habitat i hagmarker och gamla lövskogar kan därför inte förväntas ha klarat sig lika bra i regionen som på den undersökta gården de senaste 45 åren.

Slutsatser

Om vi ska kunna förklara orsakerna till populationsförändringar av fåglar behövs det långvariga lokala studier som relaterar habitatförändringar till hur antal par av arterna förändras. Jämförelser mellan vad som händer i brukade områden med relativt opåverkade kan ge värdefull kunskap, vilket visats från södra Finland (Virkkala 2016). Flera slutsatser kan dras från långtidsstudien av häckande fåglar på gården Djäknabygd när jämförelser görs med hur arternas habitat ändrats. T.ex. kan den drastiska minskningen av stare och trädpiplärka på den studerade gården inte enbart förklaras av lokala habitatförändringar. Däremot kan den drastiska minskningen av gammal barrträdsdominerad blandskog med riklig förekomst av bärris förklara många arters minskning. Flertalet av lövskogsfåglarna har däremot hållit ställningarna och är betydligt vanligare på gården jämfört med i regionen omkring. Sammantaget har betydligt fler arter minskat än ökat på gården Djäknabygd de senaste 45 åren. Det gäller särskilt stannfåglar och tropikflyttare, där antalet minskande arter inte vägts upp av antalet ökande arter lika mycket som för kortdistansflyttare.

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Summary

The breeding and territorial birds on a farm in the forest dominated region of central southern Sweden were counted both in 1972–1980 and 2008–2016. The study area of 70 hectare was visited about twice weekly from the end of March to the end of June in the early mornings. Visits started around sunrise and each visit usually lasted 4–5 hours. Observations of all birds were noted down on maps and in a note book, with special attention to movements of individuals and simultaneously singing birds of a species. Later in the day, nests were searched for, and the number of long-tailed tit *Aegithalos caudatus*, song trush *Turdus philomelos*, common blackbird *Turdus merula* and starling *Sturnus vulgaris* were mainly estimated from the number of nests found. The nests of all species were later visited to note their status and if birds were still present at the nests. The census method used is similar to the method described by Tomiałojć (1980).

Observations of species with large territories were also noted adjacent to the study area, and only if the majority of the home range was estimated to be within the study area one territory was noted. Less than half of the territory in the study plot is noted as X in the Appendix, which also is valid for territorial birds using the plot less than 7 consecutive days in a year. Singing birds obviously on migration are not included in this study.

The most important change of habitats in the study plot is the cutting of about 25 hectare of around 100 year old spruce-dominated mixed forest 1981-1984 and the plantation of spruce on these cuttings. At the same time, stands dominated by deciduous trees have grown older and the pastures have been grazed by cattle both study periods. The number of nest-boxes decreased during the 1970s from about 30 to 20, and during 2008-2016 only a few boxes were present. Only small boxes were available. The number of hollow trees, mainly deciduous species, were common in both periods. In the 1970s bird nests were found in natural cavities in 43 trees, with more than one cavity used in several trees.

More species decreased than increased between the two study periods, especially resident species and tropical migrants. For short distance migrants on the other hand, the number of decreasing species were balanced by about the same number of increasing species (Table 1). Density changes between the two study periods can be compared with the published estimated territory density in the region (Table 2). For most species, these local changes in densities can be attributed to the replacement of old mixed forest by 30-35 years old spruce plantations (unpublished species maps). Species preferring deciduous forest had much higher densities in the study plot than the regional averages (Table 2). However, the pied flycatcher *Ficedula hypoleuca* preferring deciduous forests decreased strongly. Since this species mainly bred in nest boxes in the 1970s, the change in numbers can be caused by habitat changes both within the study plot and elsewhere. Another species also preferring deciduous forest, the resident marsh tit *Poecile palustris*, also decreased possibly due to competition from the increasing blue tit *Cyanistes caeruleus*. On several occasions pairs of marsh tits were seen to be driven away from natural cavities, were they had started nest building, by blue tits.

Two species, the starling *Sturnus vulgaris* and the tree pipit *Anthus trivialis*, stands out as drastically decreasing much more than local habitat changes can explain. The tree pipit disappeared from the forests between the study periods, but also decreased in the local pastures without any obvious change in management. The starlings mainly foraged in the pasture and the number of suitable tree cavities did not change noticeably. All starlings used hollow trees in both study periods and did not use the nest boxes, which were possibly too small for this species. The decrease of both the starling and the tree pipit seem mainly to be caused by factors outside the study area.

Appendix. Antal revir/par av fåglar på gården Djäknabygd, södra Småland under två tidsperioder. X betyder del av revir eller revirhävdande/förekomst under kortare tid än 7 dagar under häckningstid ett visst år. Fet siffra eller x betyder konstaterad häckning. Ett + efter en siffra anger att det är en minimisiffra och att det verkliga antalet kan vara större.
Number of territories or pairs at two different time-period at the farm Djäknabygd. X means part of a territory or singing/occurrence during the breeding period during less than 7 days in a year. Fat figures mean that breeding was confirmed. A + after a figure denote a minimum figure, with the actual number possibly higher.

1972	1973	1974	1975	1976	1977	1978	1979	1980	Art / År Species / Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	**3**	**2**	**3**	**1**	**3**	**3**	1	2	Gräsand *Anas platyrhynchos*	2	1	2	**2**	**2**	2	1	1	**2**
1	**1**	0	0	0	0	0	1	0	Kricka *Anas crecca*	0	x	0	1	1	**1**	**1**	1	2
0	0	0	0	0	0	0	**1**	0	Knipa *Bucephala clangula*	x	0	x	x	x	**1**	0	0	0
0	0	0	0	0	0	0	0	0	Grågås *Anser anser*	x	x	0	x	0	**1**	1	1	**1**
x	x	x	x	x	x	x	1	?	Ormvråk *Buteo buteo*	**1**	1	1	**1**	1	x	x	x	1
0	x	0	x	x	x	0	x	?	Sparvhök *Accipiter nisus*	1	**1**	0	x	0	x	x	x	**1**
0	x	x	0	x	x	x	0	?	Duvhök *Accipiter gentilis*	0	0	0	0	x	0	0	x	0
0	x	0	0	0	0	0	0	?	Röd glada *Milvus milvus*	0	x	0	x	0	x	0	0	0
x	x	x	x	x	0	0	x	x	Bivråk *Pernis apivorus*	x	x	x	x	**1**	x	x	x	0
x	x	0	0	0	0	x	0	0	Tjäder *Tetrao urogallus*	0	0	0	0	0	0	0	0	0
1	0	0	0	0	x	1	0	0	Fasan *Phasianus colchicus*	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	Trana *Grus grus*	0	x	x	x	x	1	1	x	1
1	1	0	1	0	0	1	2	1	Enkelbeckasin *Gallinago gallinago*	2	2	1	1	2	1	1	1	1
3	**3**	3	3	3	**3**	**2**	2	?	Morkulla *Scolopax rusticola*	2	3	2	3	2	3	2	2	2
2	**1**	1	2	**1**	1	1	1	1	Skogssnäppa *Tringa ochropus*	1	1	1	2	2	1	**1**	1	2
0	0	0	0	0	0	0	0	0	Skogsduva *Columba oenas*	1	0	x	x	x	0	0	0	0
5	**4**	**5**	**6**	**5**	5	5	3	?	Ringduva *Columba palumbus*	5	6	7	**5**	6	6	6	**5**	**5**
0	x	x	x	x	x	x	x	x	Gök *Cuculus canorus*	x	x	x	0	x	x	x	x	x
0	0	0	0	1	x	1	0	?	Sparvuggla *Glaucidium passerinum*	0	1	0	0	1	1	0	0	0
?	1	1	**1**	1	1	1	?	?	Kattuggla *Strix aluco*	**1**	**1**	1	1	1	1	1	**1**	1
0	x	0	0	0	x	0	0	?	Hornuggla *Asio otus*	0	0	0	**x**	0	0	0	0	0
1	**1**	1	**1**	**1**	1	**1**	1	1	Gröngöling *Picus viridis*	1	1	1	**1**	1	1	**1**	1	**1**
2	**2**	**3**	**4**	**4**	**4**	**3**	**3**	**4**	Större hackspett *Dendrocopos major*	**4**	**3**	2	**3**	**3**	**4**	**3**	**3**	**3**
x	0	x	x	x	0	0	0	0	Mindre hackspett *Dendrocopos minor*	1	**1**	x	1	0	**x**	**x**	**x**	0
0	0	x	x	0	0	0	0	0	Tretåig hackspett *Picoides tridactylus*	0	0	0	0	0	0	0	0	0
x	x	x	x	x	**1**	x	x	**1**	Spillkråka *Dryocopus martius*	1	1	1	1	**1**	1	**1**	1	**1**
1	**2**	1	2	0	0	1	0	1	Göktyta *Jynx torquilla*	0	0	0	0	0	0	0	0	0
0	0	0	0	x	0	0	0	0	Sommargylling *Oriolus oriolus*	0	0	0	0	0	0	0	0	0
x	x	x	x	x	x	x	x	x	Korp *Corvus corax*	x	x	x	x	x	x	x	x	x
1	**1**	1	1	1	**1**	2	1	1	Kråka *Corvus corone*	1	1	x	1	1	x	x	x	x
1	**1**	**1**	**1**	**1**	**1**	**2**	**2**	1	Kaja *Corvus monedula*	0	0	0	0	0	0	0	0	0
1	**1**	**1**	**1**	0	0	x	1	1	Skata *Pica pica*	0	x	x	x	x	x	x	0	x

1972	1973	1974	1975	1976	1977	1978	1979	1980	Art / År Species / Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
x	0	x	0	0	1	x	1	?	Nötkråka *Nucifraga caryocatactes*	1	1	1	1	0	0	0	1	1
6	**6**	**8**	**7**	**6**	**7**	**5**	4	?	Nötskrika *Garrulus glandarius*	**5**	**5**	5	**4**	5	**5**	**4**	**4**	4
3	**2**	**3**	**4**	**1**	**2**	**2**	0	**1**	Stjärtmes *Aegithalos caudatus*	**3**	2	**2**	**3**	**3**	**2**	**2**	**1**	**1**
22	**24**	**24**	**35**	**19**	**18**	**18**	**12**	?	Talgoxe *Parus major*	**10**	**15**	**10**	**15**	13	**10**	15	**12**	12
6	**7**	**6**	**9**	**4**	**5**	**6**	**3**	?	Blåmes *Cyanistes caeruleus*	**8**	**11**	**8**	**12**	**9**	**8**	**12**	**8**	10
7	**6**	**8**	**10**	**7**	**5**	**5**	**6**	?	Svartmes *Periparus ater*	3	3	3	3	2	3	3	3	3
3	**2**	**2**	**2**	2	2	1	x	1	Tofsmes *Lophophanes cristatus*	0	1	x	1	1	x	0	1	0
7	**7**	**8**	**8**	**8**	**8**	**4**	**4**	?	Entita *Poecile palustris*	4	3	4	4	**3**	**3**	**3**	**3**	**4**
3	**3**	4	**3**	2	**3**	3	**2**	2	Talltita *Poecile montanus*	2	1	x	2	1	1	1	x	x
5	**9**	**8**	**10**	**6**	**7**	**4**	**3**	**4**	Nötväcka *Sitta europaea*	8	6	8	3	**8**	**6**	6	7	**7**
7	**8**	**9**	**8**	**7**	**8**	**8**	**5**	?	Trädkrypare *Certhia familiaris*	**6**	**6**	5	6	5	5	6	**5**	5
4	**6**	**8**	**10**	**4**	**4**	4	0	2	Gärdsmyg *Troglodytes troglodytes*	6	6	3	4	4	3	6	5	5
0	0	0	0	1	1	0	0	?	Dubbeltrast *Turdus viscivorus*	**2**	1	**1**	**2**	1	1	1	1	1
x	x	x	x	1	**1**	0	x	1	Björktrast *Turdus pilaris*	0	x	0	1	x	0	x	0	0
25	**20**	**21**	**19**	**14**	**20**	**16**	**16**	?	Taltrast *Turdus philomelos*	8+	6+	**6+**	**7+**	**10+**	11+	11+	**8+**	**6+**
20	**20**	**18**	**19**	**18**	**19**	**15**	**9**	?	Koltrast *Turdus merula*	**5+**	**10+**	6+	**6+**	**8+**	10+	**10+**	**10+**	**10+**
0	0	1	**3**	0	0	1	0	x	Buskskvätta *Saxicola rubetra*	x	0	x	x	0	x	0	0	0
0	0	x	x	0	0	1	**1**	0	Rödstjärt *Phoenicurus phoenicurus*	0	0	0	x	0	0	0	0	1
48	**44**	**50**	**41**	**32**	**32**	46	32	?	Rödhake *Erithacus rubecula*	10+	15+	20+	15+	10+	10+	**20**	**20**	20
0	0	x	0	0	0	1	0	?	Härmsångare *Hippolais icterina*	x	0	0	x	0	0	0	0	x
10	**9**	**9**	**9**	8	**9**	9	8	?	Svarthätta *Sylvia atricapilla*	5+	7	5+	8	5+	8	6+	6+	8
10	**11**	**12**	**14**	16	**13**	11	14	?	Trädgårdssångare *Sylvia borin*	5	6	4	6	7	5	4	**5**	5
0	1	1	1	1	2	1	1	1	Törnsångare *Sylvia communis*	1	1	1	**2**	1	x	x	x	1
2	2	**2**	**2**	2	2	1	2	1	Ärtsångare *Sylvia curruca*	2	1	1	1	1	x	1	0	0
54	**56**	**58**	**51**	**44**	44	**35**	43	?	Lövsångare *Phylloscopus trochilus*	?	19	15+	20	20	15	17	24	22
x	0	0	0	0	0	0	0	0	Gransångare *Phylloscopus collybita*	x	0	0	1	x	x	1	0	1
11	**11**	**9**	**6**	**8**	3	8	9	7	Grönsångare *Phylloscopus sibilatrix*	4	**5**	3	5	2	4	7	3	4
0	0	0	0	0	0	1	0	0	Lundsångare *Phylloscopus trochiloides*	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	x	0	0	Kärrsångare *Acrocephalus palustris*	0	x	x	x	0	0	0	0	0
23	30	24	28	13	13	14	7	?	Kungsfågel *Regulus regulus*	3+	8	4+	8	7	7	5+	5+	8
0	1	0	1	x	0	0	0	0	Brandkronad kungsfågel *Regulus ignicapilla*	0	0	0	0	0	0	0	0	0

1972	1973	1974	1975	1976	1977	1978	1979	1980	Art / År Species / Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
x	1	**1**	**1**	1	**1**	**1**	2	3	Grå flugsnappare *Muscicapa striata*	**4**	3	**2**	**2**	**2**	**3**	**2**	2	2
14	**11**	**15**	**11**	**11**	**8**	**9**	**10**	?	Svartvit flugsnappare *Ficedula hypoleuca*	3	**3**	4	**5**	6	**3**	3	4	4
x	x	0	0	0	0	0	0	0	Mindre flugsnappare *Ficedula parva*	1	0	0	0	0	0	0	x	0
20	**16**	**16**	**14**	**13**	**8**	**8**	12	?	Järnsparv *Prunella modularis*	5	7	5	7	5	6	6	5	5
22	**24**	23	17	15	13	11	11	?	Trädpiplärka *Anthus trivialis*	3	4	3	3	**4**	**4**	5	**4**	**4**
1	**1**	1	2	2	**2**	2	2	1	Sädesärla *Motacilla alba*	1	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
1	**2**	**1**	**3**	**2**	**3**	x	2	2	Törnskata *Lanius collurio*	0	0	0	0	x	x	**1**	**1**	1
25	**18**	**9**	**16**	**17**	**11**	**12**	**9**	**16**	Stare *Sturnus vulgaris*	**2**	**3**	2	**2**	**1**	**1**	1	**2**	**2**
1	1	x	**1**	**1**	**1**	1	0	x	Stenknäck *C. coccothraustes*	**2**	**2**	**3**	**2**	3	**2**	**2**	2	**1**
2	**3**	**2**	**2**	**1**	1	1	1	2	Grönfink *Carduelis chloris*	**3**	3	1	2	2	**2**	1	2	1
6	4	1	14	3	8	1	3	4	Grönsiska *Carduelis spinus*	2	2	3	3	7	2	3	1	1
4	**5**	3	**5**	3	**4**	3	4	4	Domherre *Pyrrhula pyrrhula*	2	2	2	2	2	2	3	2	2
0	0	0	0	0	0	0	0	0	Rosenfink *Carpodacus erythrinus*	0	0	x	0	0	0	0	0	0
x	x	0	8	0	1	0	2	0	Mindre korsnäbb *Loxia curvirostra*	0	0	3	4	6	0	2	1	1
0	0	0	0	0	0	0	0	0	Större korsnäbb *Loxia pytyopsittacus*	0	0	0	0	0	0	x	0	0
36	**26**	**35**	**38**	27	31	32	36	?	Bofink *Fringilla coelebs*	?	20	?	10+	10+	15+	10+	20	15+
0	x	x	0	0	0	0	0	0	Bergfink *Fringilla montifringilla*	0	0	0	0	0	0	0	0	0
0	1	3	1	1	2	2	2	1	Gulsparv *Emberiza citrinella*	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	Sävsparv *Emberiza schoeniclus*	1	1	0	0	0	0	0	x	0
1	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	Pilfink *Passer montanus*	0	0	0	0	0	0	0	0	0

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Changes in local distribution and numbers of staging and wintering Bean Geese *Anser fabalis* in Scania, south Sweden 1977/1978–2016/2017

Förändringar i lokalutbredning och antal hos rastande och övervintrande sädgäss Anser fabalis *i Skåne, södra Sverige 1977/1978–2016/2017*

LEIF NILSSON

Abstract

Scania in southern Sweden is an important staging and wintering province for the Bean Goose *Anser fabalis*, especially for the Taiga form *A. f. fabalis*. Based on counts in October, November and January 1977/1978–2016/2017, and observations of neck-banded individuals, the changes in local distribution are described. When the counts started, large numbers were counted already in October, but autumn numbers steadily decreased as the geese stayed further north in Sweden. The January counts on the other hand increased as the geese wintered in Scania in successively larger numbers rather than leaving Sweden. In January 2017, more than 40 000 or two-thirds of the global population of Taiga Bean Goose were counted in Scania. Within the province, more and more geese concentrated to inland areas and instead of using the Öresund coastal region as in earlier years. Birds from different breeding areas, e.g. from Finland and Sweden, used different parts of Scania. In recent years 3000–9000 of Tundra Bean Geese *Anser f. rossicus* have been wintering in a small area in northeast Scania.

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Introduction

Most European Goose populations have shown remarkable increases during recent decades (e.g. Fox et al. 2010, Nilsson 2013). This does, however, not apply to the Taiga Bean Goose *Anser f. fabalis*, which recently was red-listed because of an unfavorable conservation status (Marjankangas et al. 2015). Accordingly, an International Single Species Action Plan (ISSAP) was established for the Taiga Bean Goose by AEWA (The African-Eurasian Waterfowl Agreement; Marjankangas et al. 2015), and work to change the situation has been initiated under the newly established European Goose Management Platform (EGMP). However, there was concern about the situation for this subspecies much earlier, and in 1975 the Nordic Collegium for Wildlife Research (NKV) established a Nordic Bean Goose Project (Nilsson & Fog 1984). This lead to the start of large-scale neck-banding programs in the Nordic countries in addition to regular goose counts in Sweden (Nilsson 2013).

It was early established that Sweden was a key area for the Taiga Bean Goose, especially during migration but also in normal winters (Nilsson 1984, Nilsson et al. 1999, Fox et al. 2010). Within Sweden, the southernmost province, Scania, was of special importance for the Taiga Bean Geese. In the 1950s, during the first major studies of the species in the country (Markgren 1963, Mathiasson 1963), the absolute majority of autumn staging and wintering Bean Geese were found in this province. Over the years, there has been a change in the distribution of especially autumn staging Bean Geese in the country which now changed their autumn staging to sites further north in the country (short stopping). Scania is not so important anymore at this time of the year and the Bean Geese arrive later in Scania in more recent years compared to before (Nilsson 2013). Scania is still the most important winter area for the Bean Geese in the country. Internationally, a large proportion of the entire population of Taiga Bean Geese are found in the province during the winter (Fox et al. 2010, Nilsson 2013, Marjankangas et al. 2015).

In the present contribution, I analyze count data from the national goose counts and local sightings

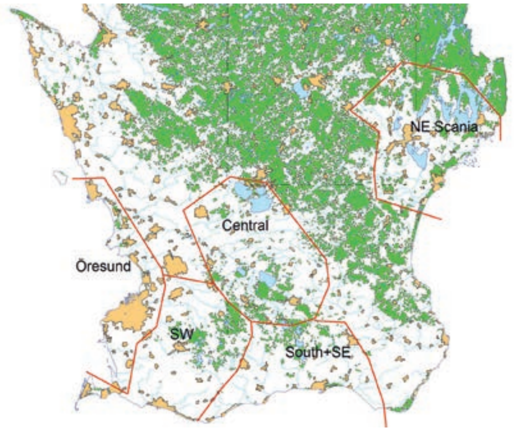

Figure 1. Map of Scania, southernmost Sweden with the division into units used for analyzing the goose counts in the province. The four areas Öresund, SW, Central and South + SE form the larger unit SW Scania.
Karta över Skåne med indelning i större delområden för analys av gåsinventeringarna i provinsen. The fyra delområdena Öresund, SW, Central samt South + SE utgör tillsammans den större enheten SV Skåne.

in Scania from different neck-banding programs to establish the present use of different parts of the province by the Bean Geese and to elucidate changes in the pattern of local distribution and numbers over the last forty years. The knowledge of the local distribution of Bean Geese, especially the differences in local distribution between the two forms of the species is of importance for the adaptive management plan for the Taiga Bean Goose which occur close to the more common Tundra Bean Goose.

Material and methods

The goose counts in Scania are part of the national and international goose counts coordinated by Wetlands International. Counts in Scania started in 1977/1978 and they have continued ever since. In the present contribution, data is included from counts in October, November and January from the start up to and including 2016/2017, i.e. for 40 years. During the first decade, counts were made every month from October to March/April. Counts from the early years for these months have been analyzed and presented by Nilsson & Persson (1984). Linear regression was used to test for possible trends in the goose counts.

The main goose areas in Scania lie in the southwest and northeast (Figure 1). The areas shown in the map were covered during the counts by observers that checked every possible field for the occurrence of staging and wintering geese. NE Scania consists of six counting units, but is treated as a unit here as there were no consistent differences in appearance of the Bean Geese between the units during different times of the year. In the same way, SW Scania has 17 units, but for the present analysis they are pooled into four larger groups showing similar seasonal appearance of the geese.

Over the years, the Taiga Bean Geese and Tundra Bean Geese have regularly been separated in SW Scania, where normally very few Tundra Bean Geese have been found (Kampe-Persson 2011). The same also applied to NE Scania during the early years, but in later years, Tundra Bean Geese have started to winter here in numbers. During the last four winters the two forms have been separated also in NE Scania.

Neck banding was an important part of the Nordic Bean Goose Project. During 1976–1980, 156 Bean Geese were caught by cannon nets and neck-banded at Lake Vombsjön in SW Scania (Figure 4, see Nilsson 1984). Neck banding started in Finland in 1978 and during the period 1978–1994, 710 Bean Geese were marked. Catching and neck banding was resumed in 2002, and during 2002–2009 another 173 Bean Geese were neck-banded in Finland. Neck banding of Bean Geese in Finland were mainly undertaken in the breeding (and moulting) areas but also on some spring staging areas in the north. For more information about these marking operations, see Nilsson 1984, Nilsson & Pirkola 1991 and Nilsson 2011). Finally, Bean Geese were neck banded during spring migration in 2008 and 2009 in staging sites close to Umeå and Luleå in northern Sweden. In all, 45 Taiga Bean Geese and 30 Tundra Bean Geese were neck-banded here during these two springs.

As a part of the Bean Goose project, the staging and wintering areas were actively searched for neck-banded geese. During the monthly counts, all Bean Goose flocks seen on the ground were actively scanned for the occurrence of neck-banded birds. The same applies to the regular goose counts during later years. In addition to the counts, known concentration areas for the species were regularly checked for the occurrence of marked birds during the entire season. In addition, observations were collected from birdwatchers active in the province (for further details see Nilsson 1984, Nilsson & Pirkola 1991).

Results

Goose counts in Scania

During the first eight years of goose counting, 10 000–25 000 Bean Geese were counted in SW Scania in October (Figure 2). Numbers then decreased markedly and very few Bean Geese were counted in this month in the last two decades. October numbers in NE Scania were low for the entire period. The decrease in October counts for Scania was highly significant (linear regression r= –0.80, P<0.001, d.f. = 39). As was shown in the national analysis, the Bean Geese were short stopping and new staging habits established further north in south Sweden (Nilsson 2013).

November totals for Scania were also high during the early years of goose counting but decreased during the years (Figure 2). Still, the overall picture shows a decrease over forty years (r = –0.48, P<0.002, d.f. = 39). The decrease was concentrated to SW Scania (r = –0.75, P<0.001, d.f. = 39). Counts in NE Scania did not show any clear long-term trend but fluctuated between years (r = 0.27, n.s., d.f.=39). A larger proportion of all Bean Geese counted in Scania stayed in the NE part of the province in later years.

January totals for Scania showed a marked and significant increase over the four decades from about 10 000 to 20 000 during the first four years to between 30 000 and 40 000 during recent years with a peak of more than 45 000 in January 2017 (Figure 2). The increase was highly significant (r = 0.60, P<0.001, d.f. =39). The increase was mostly localized to SW Scania (r = 0.63, P<0.001, d.f. = 39) whereas the increase was not so marked for NE Scania (R = 0.31, P=0.05, d.f. = 39).

In the last few years it was found that a proportion of the Bean Geese in NE Scania were Tundra Bean Geese even if the majority were Taiga Bean Geese. During the last four seasons, the observers have separated the two forms of Bean Geese (Table 1) even if it was not possible in all cases. Number of Tundra Bean Geese counted in NE Scania in the four winters varied between 800 and 6631. In SW Scania, the number of Tundra Bean Geese have been small with the exception of 2015 when 4073 individuals were counted.

In NE Scania, there were no clear differences in the distribution of the wintering Bean Geese between the counting units during the whole period of four decades. On the other hand, in SW Scania there were marked changes in the utilization of the different parts of the area over the 40-year period both for staging Bean Geese in late autumn and for wintering Bean Geese (Figure 3). During the first half of the study period staging Bean Geese in November used the Öresund region in decreasing numbers. The decrease was parallel to the overall decrease in staging Bean Geese found in the counts for Scania.

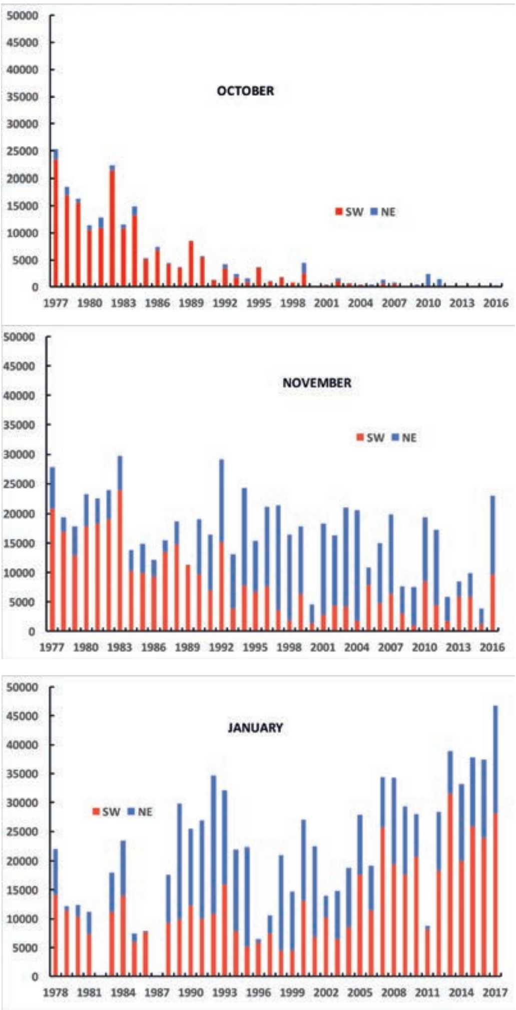

Figure 2. Total number of Bean Geese *Anser fabalis* counted in SW and NE Scania in October, November and January 1977/78–2016/17.
Totalantalet sädgäss Anser fabalis *räknade i SW resp. NE Skåne i oktober, november och januari 1977/78–2016/17.w*

In the first ten years, the wintering Bean Geese regularly used the coastal districts. In the cold winter of 1979, close to 10 000 Bean Geese were found

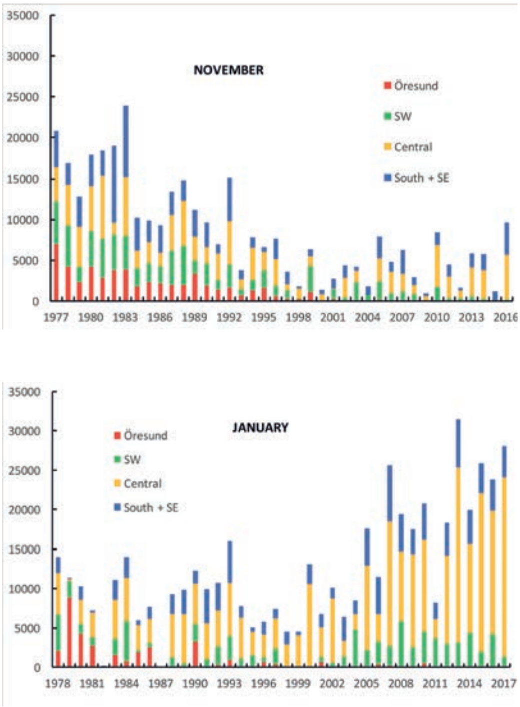

Figure 3. Total number of Bean Geese *Anser fabalis* in the four subdivisions of SW Scania (see Figure 1) in November and January 1977/78–2016/17.
Antalet sädgäss Anser fabalis *i fyra delområden av SV Skåne (se Figur 1) i november och januari 1977/78–2016/17.*

in the Öresund region in January, related to much snow in inland Scania this cold winter. Few Bean Geese remained in Scania during the following hard winters in 1982 and 1987. The last winter with any larger flocks counted in the Öresund area was 1990. Later hardly any Bean Geese were counted at the Öresund coast in winter. In later years, the central area in the SW of Scania took a more dominating position as a staging and wintering area for Bean Geese.

Local neckband sightings

The majority of the Bean Geese caught and neckbanded at Lake Vombsjön in SW Scania during 1976–1980 (Figure 4) stayed in the general feeding areas around the lake during autumn and winter. There were some movements from Vombsjön to the coast at Barsebäck in the Öresund during November and December; Barsebäck being an important staging area for Bean Geese during the early years of the study. In January and February, relatively few local sightings were obtained showing a spread over SW Scania. The Bean Geese showed no differences in local distribution between the marking year and later winter seasons.

The Bean Geese marked during the early period (1978–1994) in Finland (Figure 5) were found in good numbers both in NE and SW Scania. In the arrival period in October, relatively few sightings were made in both parts of Scania but in Novem-

Table 1. Number of Bean Geese counted in Scania in January 2014–2017 separated on Taiga Bean Geese *Anser fabalis fabalis* and Tundra Bean Geese *Anser fabalis rossicus*.
Antalet sädgäss räknade i Skåne i januari 2014–2017 uppdelade på taigasädgäss Anser fabalis fabalis *och tundrasädgäss* Anser fabalis rossicus.

	2014	2015	2016	2017
NE SCANIA				
Taiga Bean Goose	2610	6359	7250	13340
Tundra Bean Goose	9116	800	3515	2680
Taiga/Tundra Goose	1185	4316	2743	4536
Total	12911	11475	13508	18711
SW SCANIA				
Taiga Bean Goose	19830	21960	23528	24256
Tundra Bean Goose	80	4073	90	286
Total	19910	26033	23618	24542

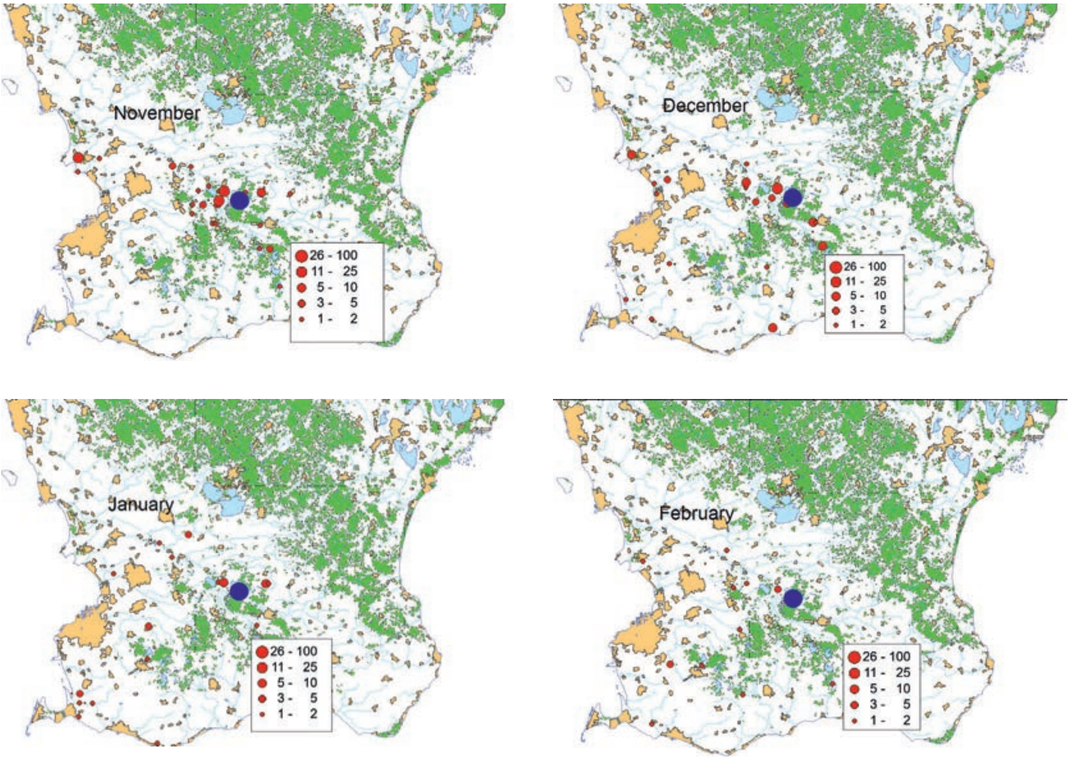

Figure 4. Local distribution of sightings in Scania of Bean Geese *Anser fabalis* neck-banded at Vombsjön (Blue) in 1977–1980.
Lokal fördelning av observationer i Skåne av sädgäss Anser fabalis *halsmärkta vid Vombsjön (Blå cirkel) 1977–1980.*

ber they were well spread in both the SW and the NE. As was the case for the geese neck-banded at Lake Vombsjön some Finnish marked Bean Geese were seen at Barsebäck in the Öresund area during the early years, but most stayed in the inland areas, especially in the central part of SW Scania. There were also a few sightings from the coast in the SW.

Comparing the distribution of sightings of neck-banded Bean Geese from the second marking period in Finland (2002–2009) with the first period (1978–1994), some differences were found (Figure 5, 6). During the latter period fewer Bean Geese arrived to Scania during the early part of the autumn, with only small numbers of re-sightings from October and November. The Bean Geese from the later period were clearly more concentrated to NE with relatively few sightings from the SW during October–December. In January, marked Bean Geese were seen in numbers spread over both parts of Scania. In February, the geese in both parts of Scania were more concentrated than in January. By March most Bean Geese had left Scania, fewer remained in SW Scania then in NE.

The majority (81% of 53 individuals) of the Taiga Bean Geese marked on spring migration in northern Sweden, staging and wintering in Scania, were concentrated to SW Scania while only 9% were found in NE Scania (Figure 7). Tundra Bean Geese marked in spring in northern Sweden were mostly sighted in NE Scania (81% of 32 individuals; Figure 7, also cf. De Jong et al. 2013). The remaining individuals of both forms were reported from sites north of Scania.

In contrast to the concentration of the sightings of Taiga Geese from northern Sweden to SW Scania (81% of 53 sightings), the Taiga Bean Geese from northern Finland in the later period were more spread over the two parts of Scania. 44% (of 243) sightings were from SW Scania, whereas 56% were from NE.

Discussion

With a wintering population of probably at least 40 000 Taiga Bean Geese in Scania in January 2017, the area is clearly the globally most import-

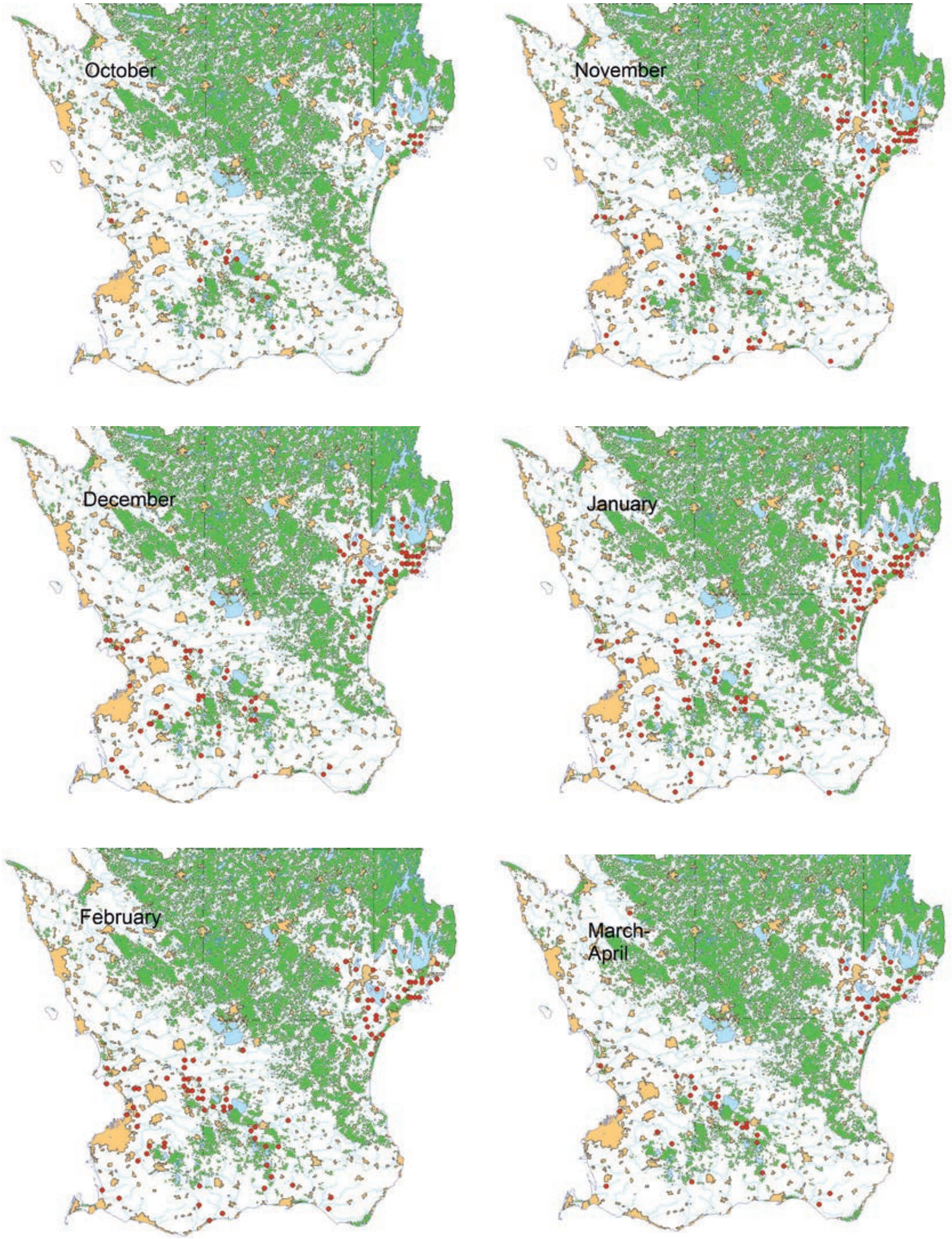

Figure 5. Local distribution of sightings in Scania of Bean Geese *Anser fabalis* neck-banded in Finland in 1978–1994.
Lokal fördelning av observationer i Skåne av sädgäss Anser fabalis *halsmärkta i Finland 1978–1994.*

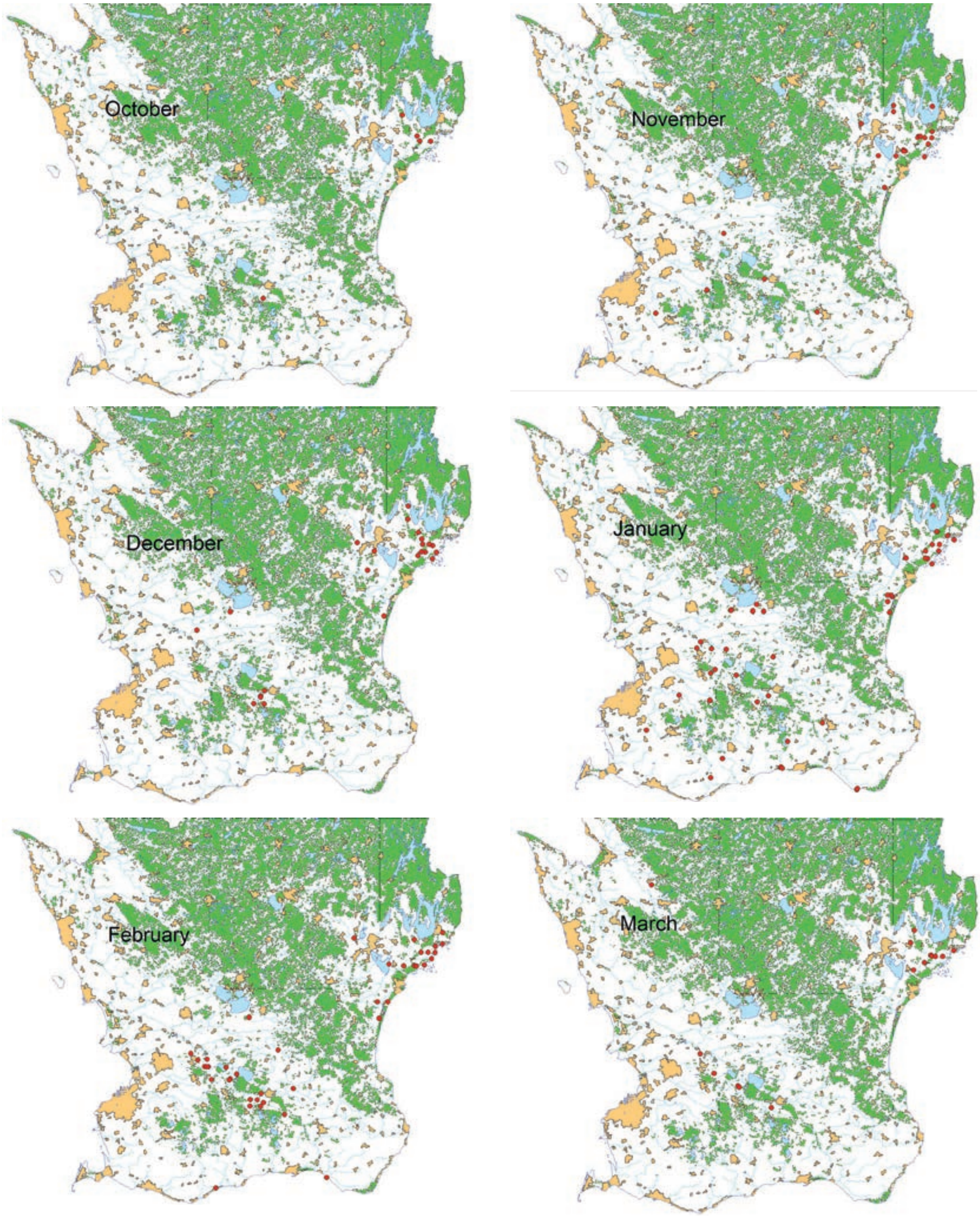

Figure 6. Local distribution of sightings in Scania of Bean Geese *Anser fabalis* neck-banded in Finland in 2002–2009.
Lokal fördelning av observationer i Skåne av sädgäss Anser fabalis *halsmärkta i Finland 2002–2009.*

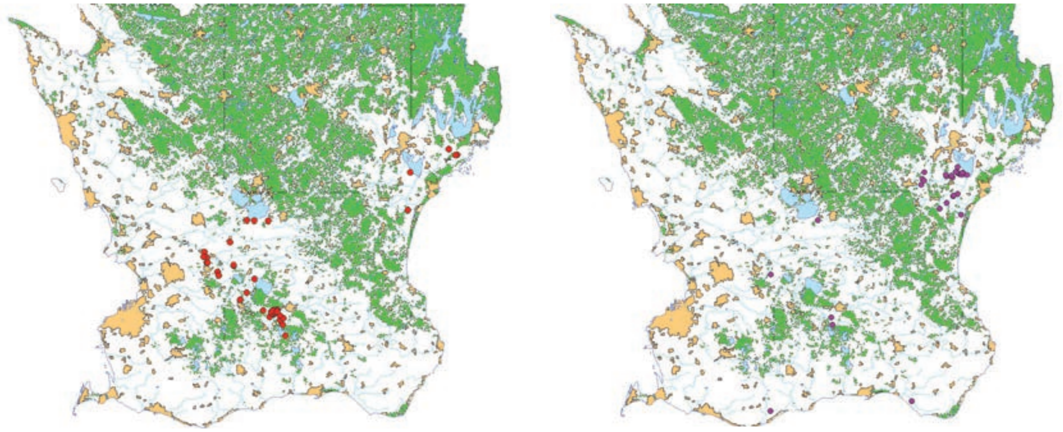

Figure 7. Local distribution of sightings in Scania of Bean Geese *Anser fabalis* neck-banded during spring migration in northern Sweden (Umeå and Luleå) in 2008 and 2009. Left map Taiga Bean Goose *Anser f. fabalis* and Right map Tundra Bean Goose *Anser f. rossicus*.

Lokal fördelning av observationer i Skåne av sädgäss Anser fabalis *halsmärkta i norra Sverige (Umeå och Luleå) 2008 och 2009. Vänstra kartan visar Taigasädgås* Anser f. fabalis *och högra kartan tundrasädgås* Anser f. rossicus.

ant winter area for the subspecies. This is about 65% or more of the total winter population of the subspecies. However, the estimates of the total population of Taiga Bean Geese varies between different reports. In the action plan for the Taiga Bean Goose (Marjankangas et al. 2015) the counts reported from the winter of 2014/2015 yielded a total of c 52 600 Taiga Bean Geese. This is lower than the estimate of 63 000 presented by Fox et al. (2010). The 2016 counts from Sweden indicates an autumn population in the country of at least 60 000 (Hakon Kampe-Persson, pers. comm.), implying an even higher total population for the Taiga Bean Goose globally.

The proportion of the total population of Taiga Bean Geese staying in Scania for the winter has increased during the last forty years, the local January trend presented here being significantly increasing at the same time as the total population has decreased. In the early neck-banding studies, some Bean Geese migrated to the southwest being seen in Denmark, Germany and the Netherlands (Nilsson 1984, Nilsson & Pirkola 1991), and in cold winters hardly any Taiga Bean Geese remained in Sweden (Nilsson 2013). On the other hand, no geese from the later Finnish study period migrated to western Germany or the Netherlands (Nilsson 2011).

When the studies started, Scania was also an important autumn staging area for the Taiga Bean Geese but especially in October, and also November, counts decreased markedly, and in the latter part of the study period, very few Bean Geese reached Scania in October. As has been documented in Nilsson & Persson (1984) and in Nilsson (2013), the Bean Geese stopped for staging further north in south Sweden and a number of new major staging areas were established there, some of which had been used for spring staging earlier.

This short stopping seen over the entire range of Taiga Bean Geese is certainly an effect of the milder autumns and winters that make it possible for the geese to stay further north than in earlier years. The same phenomenon was also reported for other goose species such as the Greylag Goose *Anser anser* (Nilsson 2006, 2013, Ramo et. al. 2015).

Nilsson & Persson (1991b) analyzed the local distribution of Bean Geese in Scania during the early years of the Nordic Bean Goose project. About half (40 out of 79) of the individuals re-sighted during the same season stayed in the Vomb-area where they were marked but the rest spread over the province. Several of the Bean Geese marked at Vomb were later in the season found at the coast, but this exchange with the coast was not found in the geese marked later (Finnish breeding birds); this pattern is also apparent from the count data.

When comparing the local distribution of the birds marked at Lake Vombsjön in the early years with Finnish marked Bean Geese from the first study period, the distribution in SW Scania was similar between the two data sets. The re-sightings from both groups were concentrated to the central areas around Vomb but the Finnish-marked birds were more dispersed over other parts of SW Scania. Moreover, an important proportion of them were also seen in NE Scania.

Both the count data and the re-sighting data clearly show a concentration of the Bean Goose to the inland parts of Scania in the latter part of the study. This applies both to the decreasing numbers arriving into Scania already in November and to the increasing wintering population in the province. The reasons for this change in local distribution are not clear. There have been no marked changes in the availability of different crops suitable for feeding Bean Geese between the coastal areas and the other parts of SW Scania during the study period (Nilsson & Persson 1991a, Nilsson & Kampe-Persson 2013).

During the study period, there has also been marked changes in staging and wintering numbers of other goose populations in Scania (Nilsson 2013). The local breeding population of Greylag Geese in Scania was very small in the late 1970s but have increased exponentially over the years. In the early years of the study, the Greylag Geese left Scania quite early in the autumn, but habits changed, and in recent years large numbers of Greylag Geese winter in south Sweden. In the same way, large numbers of Barnacle Geese *Branta leucopsis* also started to use Scania as an important autumn staging area in recent years. However, there is no clear indication of competition between the goose species, the Bean Geese had stopped using the coastal areas several years before the changes in occurrence was noted in the Greylag Goose and Barnacle Goose.

In the material presented here, Bean Geese from different breeding regions show differences in their appearance in the winter quarters. Taiga Bean Geese marked in the breeding areas of northern Finland were more spread over the goose areas in Scania, whereas Taiga Bean Geese marked on spring staging at the coast of the Bothnian Bay were mostly seen in the SW part of Scania. In this context, it is also interesting to note that the Tundra Bean Geese marked on the same spring staging areas as the Taiga Bean Geese in northern Sweden were concentrated to a relatively small area in NE Scania. These differences in local distribution in the winter areas can be of importance for the management of goose populations.

Acknowledgements

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Sammanfattning

De flesta europeiska gåsbestånden har visat en markant ökning under senare år (Fox et al. 2010, Nilsson 2013). Detta gäller dock inte taigasädgåsen *Anser fabalis fabalis*, som blivit rödlistad. Som en följd av detta har man inom AEWA (African Eurasian Waterfowl Agreement) tagit fram en aktionsplan för att försöka återställa en mer positiv situation för denna gåsform. Redan tidigt har dock sädgåsen väckt bekymmer och 1975 startade Nordisk Kollegium för Viltforskning (NKV) ett sädgåsprojekt (Nilsson & Fog 1984). Detta ledde till omfattande halsringmärkning av sädgäss och till starten av regelbundna gåsinventeringar i Sverige. Redan tidigt fastställdes att Sverige utgör ett nyckelområde för Taigasädgåsen samt att Skåne under stora delar av året är ett speciellt viktigt område för denna gåsform.

I föreliggande uppsats analyseras data från de nationella gåsinventeringarna samt från olika halsmärkningsprojekt för att belysa sädgåsens utnyttjande av Skåne samt förändringar i antal och lokal utbredning under de senaste fyrtio åren.

Material och metoder

Gåsinventeringarna utgör en del av de nationella och internationella gåsinventeringarna, vilka samordnas av Wetlands International. Inventeringarna startade 1977/78 och pågår fortfarande. I denna studie analyseras inventeringar till och med 2016/17, dvs. de senaste 40 åren. Inventeringarna omfattar månaderna oktober, november och januari.

De viktigaste gåsområdena i Skåne ligger i sydväst resp. nordost (Figur 1). NO Skåne delas i 6 delområden, medan SV (och S) Skåne delas i 17 områden. För de aktuella analyserna utgör NO Skåne en enhet, medan SV Skåne i vissa fall delas i fyra mindre enheter. I SV Skåne har de båda formerna av sädgås (taiga och tundra) regelbundet separerats, men tundragässen har normalt varit få. Under senare år påträffades större antal tundragäss i NE och de fyra senaste vintrarna har man försökt skilja underarterna vid inventeringarna.

Halsmärkning av gäss var en viktig del i det nordiska sädgåsprojektet och 156 gäss fångades och märktes i Vombområdet 1976–1980, medan 710 gäss märktes i Finland under 1978–1994, varefter ytterligare 173 gäss halsmärktes i Finland 2002–2009. I samband med undersökningar kring Botniabanan i Umeå halsmärktes 45 Taigasädgäss och 30 Tundrasädgäss vårarna 2008–2009. Intensiva observationer för att kontrollera förekomsten av märkta gäss genomfördes i bl.a. Skåne under den aktuella perioden.

Gåsinventeringar i Skåne

När inventeringarna startade inräknades mellan 10 000 och 25 000 sädgäss i SV Skåne i oktober (Figur 2). Antalet sädgäss i oktober minskade signifikant och under de senaste åren observerades mycket få sädgäss i landskapet i oktober. Gässen stannade längre norrut i Sverige (Nilsson 2013). Novemberinventeringarna visade samma bild, mest för SV Skåne, medan räkningarna inte visade någon klar tendens för den NE delen av landskapet.

Inventeringarna i januari visade å andra sidan en markant ökande trend från ca 10 000–20 000 under de första åren till mellan 30 000 och 40 000 de senaste åren (Figur 2). Ökningen var signifikant för både SV och NE Skåne, men mest markant i SV. I de två kallaste vintrarna under perioden (1982 och 1987) sågs knappt några sädgäss i landskapet. Antalen var låga också under andra kalla vintrar, speciellt saknades sädgäss då i den nordöstra delen av landskapet.

Under de senaste åren konstaterades att ett större antal tundrasädgäss övervintrade i Skåne. Dessa har alltid (med ett undantag) varit sparsamma i sydväst, men i nordöstra Skåne har de separerats först under vintrarna 2014–2017 (Tabell 1).

I SV Skåne konstaterades skillnader i gässens antalsutveckling inom de olika delområdena (Figur 1 och Figur 3). I början av studierna var sädgäss regelbundet förekommande i Öresundsområdet under vintern, men under senare år var de mer och mer koncentrerade till de inre delarna av området.

Observationer av halsmärkta gäss

Merparten av de sädgäss som märktes vid Vombsjön under höstarna 1977–1980 stannade på födosöksområdena nära Vomb (Figur 4). Under hösten och förvintern noterades en del rörelser till kusten av Öresund främst vid Barsebäck som under dessa år var ett viktigt område för arten.

De sädgäss som märktes i Finland under 1978–1994 observerades i betydande antal både i SV och NE Skåne (Figur 5) och var väl spridda över resp. område. Liksom Vombgässen observerades rörelser till Öresundskusten under de första undersökningsåren. Senare (2002 – 2009) märkta sädgäss från Finland (Figur 6) visade en klart annan utbredning än de märkta gässen från den tidiga perioden. De anlände dessutom betydligt senare till Skåne.

När det gäller sädgässen märkta på vårlokaler i norra Sverige, så visade taigagässen en markant koncentration till sydvästra Skåne, medan tundrasädgässen var koncentrerade till nordöstra Skåne (Figur 7). En jämförelse mellan taigagässen från de svenska rastlokalerna visade en annan bild än sädgässen från den senare märkperioden i norra Finland. Till skillnad från de svenska gässen var de finska mer jämnt fördelade över både sydvästra och nordöstra Skåne.

Diskussion

Med åtminstone 40 000 Taigasädgäss i Skåne vid januariinventeringen 2017 utgör området det klart viktigaste vinterområdet för denna gåsform med ungefär 65% eller mer av det totala beståndet för underarten. Till en del kan denna ökning förklaras av att färre sädgäss flyttar vidare mot sydväst jämfört med tidigare år. Denna förskjutning norrut av utbredningen kan också ses i fördelningen av sädgässen i landet vid höstinventeringarna där de i högre grad rastar längre norrut i landet än tidigare (Nilsson 2013). En liknande tendens till ”short-stopping” har konstaterats hos andra gåsarter, t.ex. grågåsen (Nilsson 2006, 2013, Ramo et al. 2015).

Märkningar av sädgäss har företagits under olika perioder. Som påvisats här förekommer en hel del skillnader i den lokala utbredningen mellan de olika grupperna av märkta gäss. En tydlig tendens är att sädgässen knappast förekommer i områdena vid Öresund längre. Dessa områden torde tidigare utnyttjats mer då de till skillnad från inlandet har haft mindre snö och därmed gett sädgässen lättare födosöksmöjligheter. Man skulle kanske kunna tänka sig en konkurrenssituation eftersom flera andra gäss ökat under perioden och börjat övervintra i landet. Emellertid övergav sädgässen kustområdena redan innan dessa började utnyttjas av större antal av de andra gåsarterna.

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Green Warbler *Phylloscopus nitidus* ringed at Blåvand: molecular confirmation of a Danish first and European eighth vagrant record

Kaukasisk lundsångare Phylloscopus nitidus *ringmärkt i Blåvand: Danmarks första och Europas åttonde raritetsfynd bekräftas molekylärt*

MARTIN STERVANDER, HENRIK KNUDSEN & ANDREAS BRUUN KRISTENSEN

Abstract

On 27 May 2015, a Green Warbler *Phylloscopus nitidus* was caught and ringed at Blåvand Bird Observatory, the westernmost point in Denmark. The species is challenging to identify on morphological basis alone, and the bird's identity was confirmed with phylogenetic analyses of mitochondrial DNA sequences. This constitutes the first record of Green Warbler in Denmark, the third record in Fennoscandia – following records on Öland, Sweden, on 29 May 2003, and Åland, Finland, on 20 May 2012 – and the eighth vagrant record in Europe outside the species' very restricted peripheral breeding range.

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Introduction

Green Warbler *Phylloscopus nitidus* breeds from northern Turkey eastwards to Iran, and winters in India and southeast Asia (del Hoyo et al. 2006). It reaches marginally into Europe in southern Russia and northern Georgia (del Hoyo et al. 2006). East of its breeding distribution the Greenish Warbler *Ph. trochiloides* and the Two-barred Warbler *Ph. plumbeitarsus* display a continuous distribution along a broken ring around the Tibetan Plateau, with several discernible subspecies/populations (Irwin et al. 2001).

The relationship between Green Warbler, Greenish Warbler, and Two-barred Warbler is complex (Irwin et al. 2001) and the Green Warbler has traditionally been regarded as a subspecies of Greenish Warbler. It was raised to species status by the British Ornithologists' Union in 2008 (Knox et al. 2008, BOU 2009), and by the Clements Checklist of Birds of the World in 2009 (Clements et al. 2009), while the International Ornithological Union regarded it as a species already in its first edition (Gill & Wright 2006). The Two-barred Warbler was given species status later (Gill & Wright 2006, Clements et al. 2014).

Before this first Danish record of Green Warbler there were two records from Fennoscandia and another five from remaining Europe. Two new records were added in 2016, making the total until and including 2016 ten records outside the restricted European breeding range (Table 1). Furthermore, there are seven accepted records in Israel (Slack 2009, IRDC 2016).

Description

On Wednesday 27 May 2015, the daily standardized ringing at Blåvand Bird Observatory could not be done because of strong wind (NW 12 m/s) and rain. Around noon, the wind decreased to 5 m/s the rain stopped, and the sun began to shine. Some of the mist nets were opened and after about one hour, one bird was caught. Surprisingly, this turned out to be a Greenish Warbler type. However, this bird clearly differed from the Greenish Warblers that are caught almost every year at Blåvand. The date was also quite early for Greenish Warbler at Blåvand, as most records of Greenish Warbler at Blåvand are from June. Because of the colouration, the bird was

Table 1. European records outside the peripheral breeding grounds of Green Warbler *Phylloscopus nitidus*.
Europeiska fynd utanför det perifera häckningsområdet av kaukasisk lundsångare Phylloscopus nitidus.

*Treatment/decision by national rarities committee. *Behandling/beslut av nationell raritetskommitté.*
**Another record, made 2000-09-27 in Greece, was listed by Hudson (2010), but this has been rejected by the Hellenic Rarities Committee (Nikos Probonas *in litt*.). *Ytterligare ett fynd i Grekland 2000-09-27 rapporterades av Hudson (2010), men detta fynd har underkänts av den grekiska raritetskommittén (Nikos Probonas* in litt.*).*

Area, country *Område, land*	**Site** *Lokal*	**Date (YMD)** *Datum (ÅMD)*	**RC treatment*** *Rk-behandling**	**Sequenced** *Sekvenserad*	**Reference** *Referens*
Fennoscandia					
Sweden	Ottenby, Öland	2003-05-29	accepted	yes	Irwin & Hellström 2007
Finland	Lågskär, Åland	2012-05-20	accepted	no	Väisänen et al. 2015
Denmark	Blåvand, Jylland	2015-05-27	pending	yes	this study
Remaining NW Europe					
Germany	Helgoland	1867-10-11	accepted	no	Gätkhe 1900
UK	St Mary, Isles of Scilly	1983-09-26	accepted	no	Hudson 2010
Faroe Islands	Nolsoy	1997-06-08	accepted	yes	Sørensen & Jensen 2001
UK	Foula, Shetland	2014-05-31	accepted	no	Pennington *in litt.*
UK	Unst, Shetland	2016-05-12	accepted	yes	Pennington 2016
SE Europe					
Greece**	Antikythira Island	1998-09-18	accepted	no	Hellenic Rarities Committee 2006 & 2009
Romania	Chituk	2016-10-05	pending	no	Milvus Group 2016

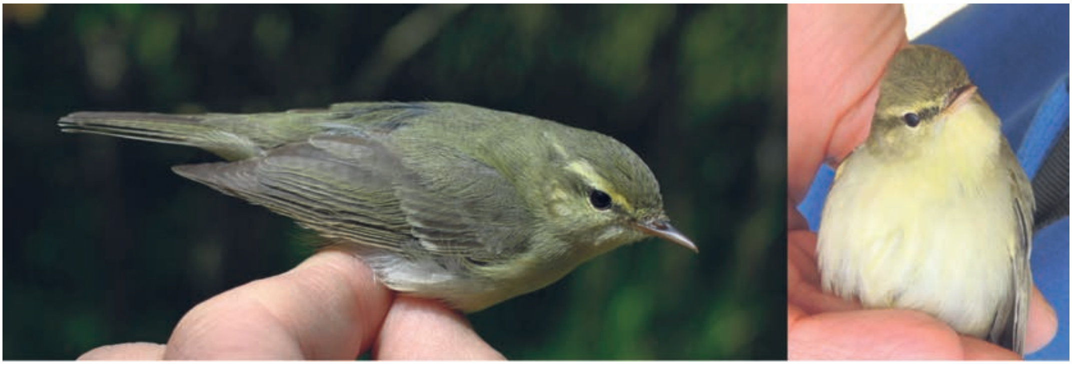

Figure 1. Green Warbler *Phylloscopus nitidus*, caught on 27 May 2015, in Blåvand, Denmark. Note rather green upperparts, one clearly visible wing-bar on the greater coverts, and yellowish breast, which are characters that distinguish it from Greenish Warbler *Ph. trochiloides* and Two-barred Warbler *Ph. plumbeitarsus*. Photos: Henrik Knudsen (left) and Morten Bentzon Hansen (right).
Kaukasisk lundsångare Phylloscopus nitidus*, fångad 27 maj 2015 i Blåvand, Danmark. Notera tämligen grön översida, endast ett synligt vingband längs de större armtäckarna samt gultonat bröst, vilka är karaktärer som skiljer den från lundsångare* Ph. trochiloides *och sibirisk lundsångare* Ph. plumbeitarsus*. Foton: Henrik Knudsen (vänster) och Morten Bentzon Hansen (höger).*

immediately suspected of being a probable Green Warbler.

The bird was measured and photographed (Figure 1). The wing length (maximum chord; Svensson 1992) was recorded at 61.5 mm, primary 3–4 formed the wing tip, and the tip of the second primary fell at the tip of primary 7. During the process, the bird shed two downs which were collected for DNA typing, as the species determination was not conclusive. After five hours, the bird was relocated and seen clearly in the field. The next day, however, the bird could not be found.

The colouration of the bird was quite different compared to a Greenish Warbler. The upperparts were bright green without the greyish wash, which is typical of Greenish Warbler. The supercilium was yellow, not white, as in Greenish Warbler. The throat and upper breast were yellow contrasting to the white lower breast and belly. The wing bar on the tip of the greater secondary coverts was prominent and broader compared to Greenish Warblers seen in the spring (Figure 1). In the hand, the size and shape of the bird was not perceived as different from Greenish Warbler, but on some photos the head looks larger and more robust than that of Greenish Warbler. The bird was not heard, but when a recording of Green Warbler song was played, the bird duly appeared. Regrettably, no recording of Greenish Warbler was played, so the potential response to that species is unknown.

Methods

The bases of the collected downs were cut off and digested for three hours at 56 °C in 100 µl lysis buffer (0.1 M Tris, 0.005 EDTA, 0.2% SDS, 0.2 M NaCl, pH 8.5) with 1.5 µl proteinase K (10 mg/ml) and then precipitated with ethanol and eluted in 20 µl ddH$_2$O. For typing of the mitochondrial cytochrome *b* (cyt*b*) gene, we used the Qiagen Multiplex PCR Kit (Qiagen Inc.), with amplification reactions containing 5 µl Qiagen Multiplex PCR Master Mix, 0.2 µl each of 10 µM primers ND5-Syl (Stervander et al. 2015) and mtF-NP (Fregin et al. 2009), 2 µl template DNA (non-diluted elution), and 2.6 µl water. We ran the PCR reactions for activation at 95 °C for 15 min. Then followed 40 three-step cycles with denaturation at 94 °C for 30 s; annealing for 20 cycles in a touchdown profile decreasing by 0.5°C per cycle from 55°C, followed by 20 cycles at 45°C for 90 s; and extension at 72 °C for 90 s. Finally, we allowed extension at 72 °C for 10 min. PCR products were checked on a 1% agarose gel, precipitated with NH4Ac and ethanol, and then dissolved in 25 µl water. We used 2 µl for sequencing with the internal sequencing primer Cytb_seq_H15541 (Stervander et al.2015) with the BigDye sequencing kit (Applied Biosystems) in an ABI Prism 3100 capillary sequencer (Applied Biosystems).

The cyt*b* sequence was manually inspected and edited in Geneious v. 10 (Biomatters). GenBank sequences of >900 bp were downloaded for all *Phylloscopus/Seicercus/Abrornis* (different genus names used for one monophyletic clade) and outgroups (*Cettia/Horornis, Aegithalos, Acrocephalus, Cisticola, Sylvia*), and aligned with the MAFFT v7.222 (Katoh et al. 2002) Geneious plugin. The 394 reference sequences included in this study are specified in Appendix 1.

Substitution models were evaluated with jModelTest v. 2.1.4 (Guindon & Gascuel 2003, Darriba et al. 2012), selecting from 88 available models allowing for rate heterogeneity according to four gamma categories and for a proportion of invariable sites. Model selection was performed per the Bayesian Information Criterion (BIC; Schwarz 1978).

Cyt*b* gene trees were computed within a Bayesian inference (BI) framework with BEAST v. 2.4.4 (Bouckaert et al. 2014), using a Yule tree prior, and a strict molecular clock with a rate of 0.0105 substitution/site/lineage/million years, based on overall cyt*b* substitution rates for a wide range of avian species (Weir & Schluter 2008). We applied four discrete categories over the gamma distribution, and estimated the frequency of invariant sites as well as the base frequencies. We performed two replicate runs, and sampled trees every 1,000 generations, over 30 million generations, of which the first 10% were discarded as burn-in. The results were inspected using Tracer v. 1.6 (Rambaut et al. 2013), ensuring stationarity and effective sample sizes (ESS) of >200, and ascertaining congruence between replicate runs.

The maximum clade credibility tree was calculated with TreeAnnotator (Bouckaert et al. 2014), using average node heights, and excluding 10% as burn-in. This tree was visualized and annotated in FigTree v.1.4.3 (Rambaut 2016) and Mega 7 (Kumar et al. 2016).

Results

The trimmed sequence from the Blåvand bird was 681 bp, of which 633 bp covered parts of the cyt*b* gene from its start, preceded by the last 40 bp of the ND5 gene and 8 intergenic bp. The cyt*b* sequence

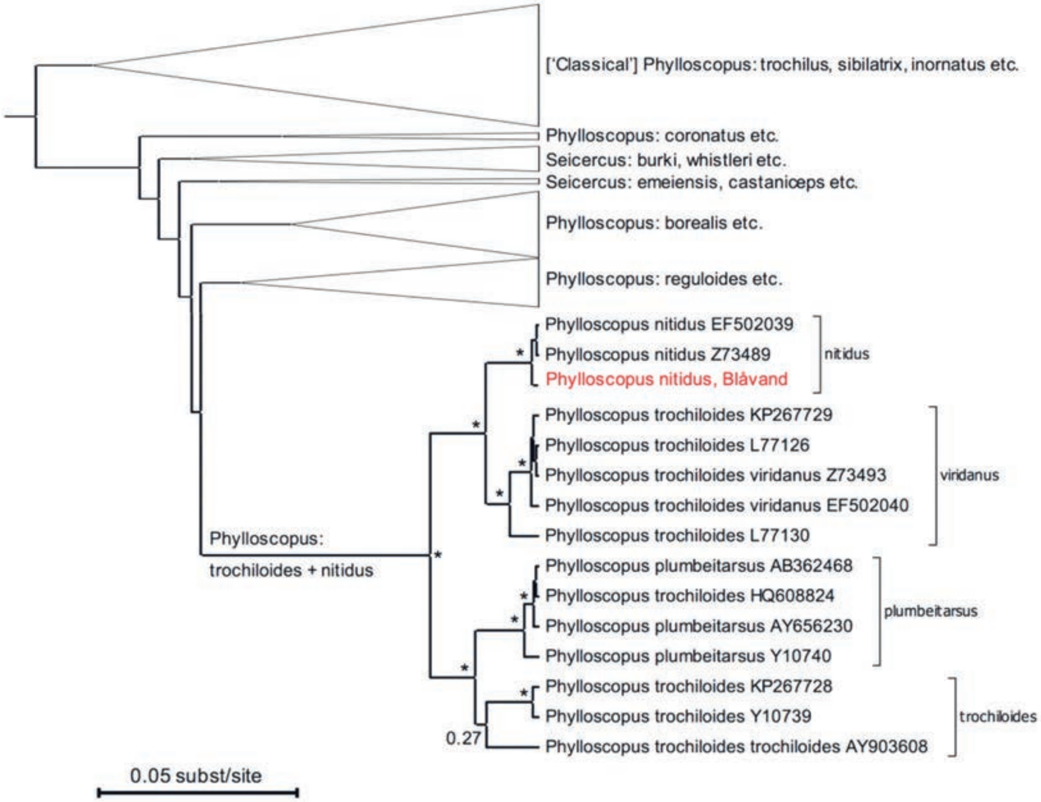

Figure 2. Phylogeny of *Seicercus* and *Phylloscopus* warblers, based on Baeysian inference of 394 cytochrome *b* sequences, which places the Blåvand bird (highlighted in red font) in the Green Warbler *Ph. nitidus* clade with maximal support. Sequences from the complex containing Green Warbler and Greenish Warbler *Ph. trochiloides* are shown with their taxon names as submitted to Genbank, with bracket annotations stating which clade they correspond to. Posterior probability (PP; 0.0–1.0) is indicated for nodes in this clade: * indicates PP = 1.0, PP otherwise stated with a number at the node. All other clades have been collapsed, with the height of the triangle corresponding to number of sequences, and labels including taxa representative of the clade. For a full list of included taxa, and all Genbank accession numbers, see Appendix 1. Note that the traditional use of the genus names *Seicercus* and *Phylloscopus* does not reflect monophyletic groups. The outgroups have been removed for clarity.
Fylogeni över sångare inom släktena Seicercus *och* Phylloscopus*, baserad på bayesiansk inferens av 394 cytokrom* b*-sekvenser, vilken placerar fågeln från Blåvand (markerad med röd text) i kladen med kaukasisk lundsångare* Ph. nitidus *med maximalt statistiskt stöd. Sekvenser från komplexet som omfattar kaukasisk lundsångare och lundsångare* Ph. trochiloides *visas namngivna såsom de skickats in till Genbank, med klamrar som indikerar vilken klad de tillhör. Posteriorisannolikhet (PP; 0,0–1,0) visas för noder inom denna klad: * indikerar PP = 1,0, PP visas annars med en siffra vid noden. Alla andra klader har minimerats och triangelns höjd motsvarar antalet sekvenser som ingår i kladen. Representativa taxa har listats bredvid triangeln. För den fulla listan över inkluderade taxa, samt deras Genbank-nummer, se Appendix 1. Notera att den traditionella användningen av släktesnamnen* Seicercus *och* Phylloscopus *inte motsvarar monofyletiska grupper. Utgrupperna har uteslutits från figuren för tydlighet.*

aligned with no gaps to cyt*b* sequences of related species, and is available at Genbank with the accession number MF188243.

The best estimated substitution model was HKY (Hasegawa et al. 1985) with rate variation following a discrete gamma distribution with four rate categories (G) and with an estimated fraction of invariant sites (I).

The computed cyt*b* phylogeny groups the Blåvand bird with full statistical support (posterior probability 1.0) together with two sequences of Green Warblers in a *nitidus* clade, that is sister to the *viridanus* clade (Figure 2). Those two clades, in turn, make up as a sister clade to the clade containing the sisters *trochiloides* and *plumbeitarsus* (Figure 2).

Discussion

Green Warbler may be an overlooked species in western and northern Europe because it is rather similar to Greenish Warbler. Even with good views the two species may be difficult to distinguish, and good views may be hard to achieve owing to the restless nature of the species and their habit of foraging high above the ground. However, very few Green Warblers have been caught in Europe compared to the number of Greenish Warblers, so the species is probably a quite rare vagrant in Europe.

The phylogenetic analysis clearly confirms that the Blåvand bird is a Green Warbler (Figure 2). It further highlights the special case that the Green/Greenish/Two-barred Warbler complex constitutes. Under a phylogenetic species concept, a species must be monophyletic, i.e. all of its subspecies/populations/individuals must be most closely related to each other, and together form a clade that contains no other taxa. However, the cyt*b* phylogeny shows that the two Greenish Warbler clades (*trochiloides* and *viridanus*; Figure 2) are not each other's closest relatives, but instead make up sister clades with Two-barred Warbler (*plumbeitarsus*) and Green Warbler (*nitidus*), respectively. Thus, judging from the cyt*b* phylogeny alone, Greenish Warbler is paraphyletic, and either all taxa within the complex represent one species, or all should be regarded separate species.

However, while mitochondrial markers such as cyt*b* are appropriate for taxon identification, taxonomic conclusions should not rest solely on such information. Mitochondrial genetic markers differ from nuclear genetic markers because of a faster molecular substitution rate, and because of maternal inheritance. When populations diverge, mitochondrial and nuclear genetic markers may leave different phylogenetic signatures because they sort at different rates. Also, if diverged populations later come into secondary contact, mitochondrial and nuclear genetic markers will be differentially prone to introgression depending on the stage of divergence (Rheindt & Edwards 2011). For that reason, interpretations of phylogenetic relationship should best be based on multi-locus analyses including nuclear genetic markers (e.g. Rheindt & Edwards 2011, Stervander et al. 2015).

Further, the Greenish/Green/Two-barred Warbler clade is unusually well studied, and illustrates some of the problems highlighted above. The Greenish and Two-barred Warbler occur in a broken ring around the Tibetan plateau. The Two-barred Warbler occupies the north-eastern part of the ring, and is isolated with a break in the ring to the south, while it meets the Greenish Warbler in a contact zone to the west. Despite the contact, the two species remain their integrity. The distribution of the Greenish warbler continues counter-clockwise around the Tibetan plateau until the gap the occurs east of the plateau, before reaching the distribution of the Two-barred Warbler. When Irwin at el. (2001) analysed divergence in song and mitochondrial DNA along the broken ring, they concluded that the complex had likely evolved along the ring. Neighbouring populations were only slightly differentiated, but the differentiation progressed on a gradient along the ring, and reproductive isolation was complete in the two end-points, represented by the Siberian populations of Greenish and Two-barred Warbler. However, when Alcaide et al. (2014) made use of "next generation sequencing" of massive amounts of nuclear DNA, they revealed that this interpretation was not correct. Instead they uncovered that there have been multiple historical breaks in gene flow, when populations have been isolated at several locations along the ring. Nevertheless, while this species complex may not represent a rare case of a "ring species", it illustrates a complex evolutionary history resulting in varying levels of genetic differentiation between subspecies and species.

Finally, it is worth to mention that the two genera *Phylloscopus* and *Seicercus*, which presently constitute the family Phylloscopidae, are paraphyletic (Figure 2; Olsson et al. 2004). The family will therefore likely be split into multiple genera that better reflect their evolutionary relationships (P. Alström *pers. comm.*, Gill & Donsker 2017).

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Author contributions

H. K. trapped the bird and wrote the description; A. B. K. researched previous records and contributed to the manuscript; M. S. performed the lab work and the phylogenetic analyses, and wrote the manuscript.

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Sammanfattning

Den 27 maj 2016 fångades och ringmärktes en lundsångarliknande fågel vid Blåvands fågelstation, som är belägen vid Danmarks västligaste punkt. Datumet är tidigare än tyngdpunkten för lundsångarfynd vid Blåvand, och fågeln avvek något i dräkt från lundsångare *Phylloscopus trochiloides*. Redan vid fångsten misstänktes att fågeln var en kaukasisk lundsångare *Ph. nitidus*, men dessa är svåra att säkert bestämma enbart baserat på morfologi. Färgsättningen skilde sig jämfört med lundsångare på så sätt att den aktuella fågeln hade en tydligare grön ovansida, utan gråton (Figur 1). Dessutom var ögonbrynsstrecket gult snarare än vitt och strupe samt övre bröst var gula, tydligt kontrasterande mot vitt nedre bröst och mage (Figur 1). Vingbandet, format av de större armtäckarnas ljusa spetsar, var bredare och tydligare jämfört med lundsångare (Figur 1).

Vid hanteringen tappade fågeln två dun, vilka användes för utvinning av DNA. Med hjälp av PCR mångfaldigades en DNA-sekvens från den maternellt nedärvda mitokondriegenen cytokrom *b*. En fylogenetisk analys av denna sekvens, tillsammans med alla publikt tillgängliga cytokrom *b*-sekvenser från fåglar inom släktena *Phylloscopus/Seicercus/Abrornis* (olika släktesnamn som används för en och samma monofyletiska klad) samt utgrupper (taxa från släktena *Cettia/Horornis, Aegithalos, Acrocephalus, Cisticola* och *Sylvia*) bekräftar att fågeln var en kaukasisk lundsångare (Figur 2).

Det fylogenetiska trädet (Figur 2) belyser ett par speciella förhållanden. *Phylloscopus* och *Seicercus* är båda parafyletiska släkten, dvs. de omfattar inte bara taxa som är närmast besläktade med varandra och bildar obrutna monofyletiska grupper. I stället förekommer arter som kallas *Phylloscopus* och *Seicercus* på olika ställen i fylogenin (Figur 2). Därmed är en taxonomisk revision att vänta för hela familjen Phylloscopidae. Dessutom uppvisar lundsångarkomplexet, med lundsångare, kaukasisk lundsångare och sibirisk lundsångare *Ph. plumbeitarsus*, ett osedvanligt komplicerat inbördes förhållande. Medan den kaukasiska lundsångaren har ett isolerat utbredningsområde huvudsakligen i Kaukasus och norra Iran återfinns lundsångaren och den sibiriska lundsångaren öster därom i en bruten ring kring Tibetanska högplatån. De två arterna möts, utan att blandas, i östra Sibirien, medan urskiljbara populationer av lundsångaren förekommer med en kontinuerlig utbredning motsols till platåns östra sida. Tidigare, med stöd av analyser av mitokondriellt DNA och sång, har detta komplex tolkats som representanter för en s.k. ringart, där en art spridits och differentierats kontinuerligt längs en ring, så att ändarna, där de möts, är fullgoda arter, medan populationerna dem emellan endast skiljer sig gradvis. Nyare studier, baserade på analyser av stora delar av cellkärnans arvsmassa hos flera av arterna, visar att det inte alls handlar om en ringart, utan att flera av populationerna runt ringen tidvis har varit isolerade. Hybridisering och introgression av genetiskt material mellan arterna har skapat ett komplext fylogenetiskt mönster, där det mitokondriella fylogenetiska trädet inte speglar artträdet (Figur 2).

Fyndet i Blåvand utgör Danmarks första fynd av kaukasisk lundsångare, Fennoskandias tredje – efter fynd på Öland den 29 maj 2003 och Åland den 20 maj 2012 – och Europas åttonde fynd (Tabell 1) utanför ett begränsat och perifert europeiskt häckningsområde i södra Ryssland och norra Georgien.

Appendix 1

Taxa and GenBank accession number for cytochrome *b* sequences included in the phylogenetic analysis.
Taxa och GenBank-nummer för de cytokrom b*-sekvenser som inkluderats i den fylogenetiska analysen.*

Taxon	**Accession no**
Taxon	***Genbank-nr***
Abrornis chloronotus	KJ456391
Abrornis chloronotus simlaensis	DQ008504
Abrornis humei	KJ456394
Abrornis humei humei	Z73488
Abrornis inornata	AY635054
Abrornis inornata	DQ792799
Abrornis inornata	DQ792800
Abrornis inornata	KF742677
Abrornis inornata	L77135
Abrornis inornata	NC_024726
Abrornis inornata	Y10734
Abrornis maculipennis	HQ608828
Abrornis maculipennis	KJ456395
Abrornis maculipennis	Y10731
Abrornis maculipennis maculipennis	AY635055
Abrornis proregulus	AY635058
Abrornis proregulus	DQ792796
Abrornis proregulus	DQ792797
Abrornis proregulus	DQ792798
Abrornis proregulus	HQ608830
Abrornis proregulus	L77134
Abrornis proregulus	Y10733
Abrornis yunnanensis	HQ608833
Acrocephalus schoenobaenus	Z73475
Acrocephalus scirpaceus scirpaceus	Z73483
Aegithalos concinnus	JX398849
Aegithalos concinnus concinnus	KF951091
Cettia fortipes	L77122
Cisticola juncidis	Z73474
Horornis diphone	AB159194
Horornis diphone	AB159195
Horornis diphone	AB159196
Horornis diphone	AB159197
Horornis diphone	AB159198
Horornis diphone	AB694915
Horornis diphone	AB694916
Horornis diphone	HQ608838
Horornis seebohmi	AB281094
Horornis seebohmi	AB281095
Horornis seebohmi	AB281096
Phylloscopus affinis	DQ008503
Phylloscopus affinis	KJ456389
Phylloscopus affinis	L77128
Phylloscopus affinis	Y10730
Phylloscopus amoenus	AY887676
Phylloscopus armandii	HQ608831
Phylloscopus bonelli	AY944179
Phylloscopus bonelli	L77127
Phylloscopus bonelli bonelli	Z73485
Phylloscopus bonelli bonelli	Z73486
Phylloscopus reguloides reguloides	AY656235
Phylloscopus reguloides reguloides	AY656236
Phylloscopus reguloides reguloides	AY656237
Phylloscopus reguloides reguloides	AY656238
Phylloscopus reguloides ticehursti	AY656205
Phylloscopus reguloides ticehursti	AY656206
Phylloscopus reguloides ticehursti	AY656207
Phylloscopus reguloides ticehursti	AY656233
Phylloscopus reguloides ticehursti	AY656234
Phylloscopus reguloides ticehursti	AY656242
Phylloscopus reguloides ticehursti	AY656243
Phylloscopus ricketti	AY656239
Phylloscopus ricketti	GU045622
Phylloscopus ricketti	GU045623
Phylloscopus ricketti	GU045624
Phylloscopus ricketti	GU045625
Phylloscopus ruficapilla minullus	AY635060
Phylloscopus sarasinorum sarasinorum	AY656240
Phylloscopus schwarzi	AY635061
Phylloscopus schwarzi	HQ608825
Phylloscopus schwarzi	Y10728
Phylloscopus sibilatrix	AY944178
Phylloscopus sibilatrix	L77123
Phylloscopus sibilatrix	Z73491
Phylloscopus sindianus	L77136
Phylloscopus sindianus lorenzii	HQ706180
Phylloscopus sindianus lorenzii	Z73478
Phylloscopus subviridis	KJ456398
Phylloscopus trivirgatus	L77145
Phylloscopus trivirgatus trivirgatus	AY656244
Phylloscopus trochiloides	HQ608824
Phylloscopus trochiloides	KP267728
Phylloscopus trochiloides	KP267729
Phylloscopus trochiloides	L77126
Phylloscopus trochiloides	L77130
Phylloscopus trochiloides	Y10739
Phylloscopus trochiloides trochiloides	AY903608
Phylloscopus trochiloides viridanus	EF502040
Phylloscopus trochiloides viridanus	Z73493
Phylloscopus trochilus	AJ004326
Phylloscopus trochilus	AY944177
Phylloscopus trochilus	DQ174582
Phylloscopus trochilus	DQ174583
Phylloscopus trochilus	DQ174584
Phylloscopus trochilus	DQ174585
Phylloscopus trochilus	DQ174586
Phylloscopus trochilus	DQ174587
Phylloscopus trochilus	DQ174588
Phylloscopus trochilus	DQ174589
Phylloscopus trochilus	DQ174590

Phylloscopus borealoides	AB362459
Phylloscopus borealoides	AB362467
Phylloscopus borealoides	AY887677
Phylloscopus brehmi	AJ004325
Phylloscopus brehmi	Z73476
Phylloscopus calciatilis	GU045613
Phylloscopus calciatilis	GU045614
Phylloscopus calciatilis	GU045615
Phylloscopus calciatilis	GU045616
Phylloscopus calciatilis	GU045617
Phylloscopus calciatilis	GU045618
Phylloscopus calciatilis	GU045619
Phylloscopus calciatilis	GU045620
Phylloscopus calciatilis x ricketti	GU045621
Phylloscopus canariensis	Z73477
Phylloscopus cantator	KJ456390
Phylloscopus cantator cantator	AY656208
Phylloscopus cebuensis	JN827147
Phylloscopus cebuensis	L77144
Phylloscopus claudiae	AY656209
Phylloscopus claudiae	AY656210
Phylloscopus claudiae	AY656211
Phylloscopus claudiae	AY656212
Phylloscopus claudiae	AY656213
Phylloscopus collybita	AJ004324
Phylloscopus collybita	HQ608821
Phylloscopus collybita	L77125
Phylloscopus collybita abietinus	DQ174604
Phylloscopus collybita abietinus	DQ174605
Phylloscopus collybita abietinus	DQ174606
Phylloscopus collybita abietinus	DQ174607
Phylloscopus collybita abietinus	DQ174608
Phylloscopus collybita abietinus	HQ121526
Phylloscopus collybita abietinus	Z73479
Phylloscopus collybita brevirostris	Z73480
Phylloscopus collybita caucasicus	Z73481
Phylloscopus collybita collybita	Z73487
Phylloscopus collybita menzbieri	AF136374
Phylloscopus collybita tristis	HF562844
Phylloscopus collybita tristis	HF562845
Phylloscopus collybita tristis	HF562846
Phylloscopus collybita tristis	Z73482
Phylloscopus coronatus	AB362460
Phylloscopus coronatus	AY635053
Phylloscopus coronatus	HQ608834
Phylloscopus coronatus	L77139
Phylloscopus davisoni	AY656214
Phylloscopus davisoni disturbans	AY656217
Phylloscopus davisoni klossi	AY656215
Phylloscopus emeiensis	AY656218
Phylloscopus fuligiventer	KJ456392
Phylloscopus fuscatus	DQ119527
Phylloscopus trochilus	DQ174591
Phylloscopus trochilus	DQ174592
Phylloscopus trochilus	DQ174593
Phylloscopus trochilus	DQ174594
Phylloscopus trochilus	DQ174595
Phylloscopus trochilus	DQ174596
Phylloscopus trochilus	DQ174597
Phylloscopus trochilus	DQ174598
Phylloscopus trochilus	JX869889
Phylloscopus trochilus	L77124
Phylloscopus trochilus trochilus	DQ673875
Phylloscopus trochilus trochilus	Z73492
Phylloscopus tytleri	AY887679
Phylloscopus tytleri	L77132
Seicercus affinis	KJ456460
Seicercus affinis intermedius	AY635066
Seicercus affinis intermedius	AY635069
Seicercus affinis intermedius	AY635070
Seicercus affinis intermedius	AY635071
Seicercus affinis ocularis	AY635063
Seicercus borealis	HQ608832
Seicercus borealis	L77138
Seicercus borealis	L77143
Seicercus borealis borealis	AB362438
Seicercus borealis borealis	AB362439
Seicercus borealis borealis	AB362440
Seicercus borealis borealis	AB362441
Seicercus borealis borealis	AB362442
Seicercus borealis borealis	AB362443
Seicercus borealis borealis	AB362444
Seicercus borealis borealis	AB362445
Seicercus borealis borealis	AB362446
Seicercus borealis borealis	AB362462
Seicercus borealis borealis	AB530997
Seicercus borealis borealis	AB530998
Seicercus borealis borealis	AB530999
Seicercus borealis borealis	AB531000
Seicercus borealis borealis	AB531001
Seicercus borealis borealis	AB531002
Seicercus borealis borealis	AB531003
Seicercus borealis borealis	AY635052
Seicercus borealis borealis	HQ243658
Seicercus borealis borealis	HQ243659
Seicercus borealis borealis	HQ243660
Seicercus borealis borealis	KP245888
Seicercus borealis borealis	Z73484
Seicercus borealis kennicotti	AB362435
Seicercus borealis kennicotti	AB362436
Seicercus borealis kennicotti	AB362437
Seicercus borealis kennicotti	AB362461
Seicercus burkii	AY635064
Seicercus burkii	AY635065

Phylloscopus fuscatus	DQ174599
Phylloscopus fuscatus	DQ174600
Phylloscopus fuscatus	DQ174601
Phylloscopus fuscatus	DQ174602
Phylloscopus fuscatus	DQ174603
Phylloscopus fuscatus	HQ608823
Phylloscopus fuscatus	Y10729
Phylloscopus goodsoni fokiensis	AY656219
Phylloscopus goodsoni fokiensis	AY656220
Phylloscopus goodsoni fokiensis	AY656221
Phylloscopus goodsoni fokiensis	AY656222
Phylloscopus goodsoni fokiensis	AY656223
Phylloscopus goodsoni goodsoni	AY656225
Phylloscopus goodsoni goodsoni	AY656226
Phylloscopus goodsoni goodsoni	AY656227
Phylloscopus goodsoni goodsoni	AY656228
Phylloscopus griseolus	KJ456393
Phylloscopus hainanus	AY656229
Phylloscopus magnirostris	AY635056
Phylloscopus magnirostris	AY887681
Phylloscopus magnirostris	HQ608822
Phylloscopus magnirostris	L77129
Phylloscopus magnirostris	Y10737
Phylloscopus nigrorum benguetensis	AY656204
Phylloscopus nitidus	EF502039
Phylloscopus nitidus	Z73489
Phylloscopus occipitalis	AY635057
Phylloscopus occipitalis	EU372678
Phylloscopus occipitalis	L77131
Phylloscopus occipitalis	Y10735
Phylloscopus occisinensis	HQ608829
Phylloscopus ogilviegranti ogilviegranti	AY656216
Phylloscopus orientalis	AY887678
Phylloscopus orientalis	Z73490
Phylloscopus plumbeitarsus	AB362468
Phylloscopus plumbeitarsus	AY656230
Phylloscopus plumbeitarsus	Y10740
Phylloscopus poliocephalus giulianetti	AY656224
Phylloscopus pulcher	HQ608826
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Phylloscopus pulcher	KJ567541
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Phylloscopus pulcher	KJ567543
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Phylloscopus pulcher	KJ567546
Phylloscopus pulcher	KJ567547
Phylloscopus pulcher	KJ567548
Phylloscopus pulcher	KJ567549
Phylloscopus pulcher	KJ567550
Phylloscopus pulcher	KJ567551
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Seicercus castaniceps	AY887680
Seicercus castaniceps	HQ608857
Seicercus castaniceps	KJ456461
Seicercus castaniceps castaniceps	AY635067
Seicercus examinandus	AB362424
Seicercus examinandus	AB362425
Seicercus examinandus	AB362426
Seicercus examinandus	AB362427
Seicercus examinandus	AB362428
Seicercus examinandus	AB362429
Seicercus examinandus	AB362430
Seicercus examinandus	AB362431
Seicercus examinandus	AB362432
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Seicercus examinandus	AB362434
Seicercus examinandus	AB362463
Seicercus examinandus	AB362464
Seicercus examinandus	KP245873
Seicercus examinandus	KP245874
Seicercus examinandus	KP245875
Seicercus examinandus	KP245876
Seicercus examinandus	KP245877
Seicercus examinandus	KP245878
Seicercus examinandus	KP245879
Seicercus examinandus	KP245880
Seicercus examinandus	KP245881
Seicercus examinandus	KP245882
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Seicercus examinandus	KP245886
Seicercus examinandus	KP245887
Seicercus examinandus	KP245895
Seicercus examinandus	KP245896
Seicercus examinandus	KP245897
Seicercus examinandus	KP245898
Seicercus grammiceps grammiceps	AY635068
Seicercus ijimae	L77141
Seicercus ijimae	Y10741
Seicercus montis montis	AY635073
Seicercus omeiensis	AY635078
Seicercus poliogenys	AY635079
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Seicercus soror	AY635083
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Phylloscopus pulcher	KJ567552
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Phylloscopus pulcher	KJ567555
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Phylloscopus pulcher	KJ567557
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Phylloscopus pulcher	KJ567561
Phylloscopus pulcher	KJ567562
Phylloscopus pulcher	KJ567563
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Phylloscopus pulcher	KJ567565
Phylloscopus pulcher	KJ567566
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Phylloscopus pulcher	KJ567572
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Phylloscopus pulcher	Y10732
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Phylloscopus reguloides	KM248527
Phylloscopus reguloides	KM248529
Phylloscopus reguloides	Y10736
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Seicercus tephrocephalus	AY635085
Seicercus tephrocephalus	HQ706182
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Seicercus valentini latouchei	AY635072
Seicercus valentini latouchei	AY635086
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Seicercus valentini valentini	AY635087
Seicercus valentini valentini	AY635089
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Seicercus whistleri nemoralis	AY635074
Seicercus whistleri nemoralis	AY635076
Seicercus whistleri whistleri	AY635075
Seicercus whistleri whistleri	AY635077
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Seicercus xanthodryas	AB362448
Seicercus xanthodryas	AB362449
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Seicercus xanthodryas	AB362458
Seicercus xanthodryas	AB362465
Seicercus xanthodryas	AB362466
Seicercus xanthoschistos tephrodiras	AY656246
Seicercus xanthoschistos xanthoschistos	AY635091
Sylvia atricapilla atricapilla	Z73494
Sylvia melanocephala	L77121

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Migration of Greylag Geese *Anser anser* according to recoveries of birds marked with traditional leg-rings in Sweden

Flyttning hos grågäss enligt återfynd av fåglar märkta med traditionella metallringar i Sverige

LEIF NILSSON

Abstract

Traditional recoveries of ringed Greylag Geese *Anser anser* from different regions in Sweden have been analyzed to compare the migration patterns from a number of different areas. During the years up to and including 2012, 7210 Greylag Geese were marked with metal rings from the Swedish Ringing Centre, yielding 1398 recoveries. After exclusion of local recoveries in the ringing area, 924 recoveries were used in the present analysis. The majority of recoveries were from the Western European flyway along the Atlantic coast but some Greylag Geese marked in the province of Södermanland migrated south through Eastern Europe even reaching Northern Africa. A number of records of Greylag Geese marked during the moult on Gotland were probably recruited from Eastern Europe. Later about 25% of these birds migrated south through central Europe. In general, the geese marked in different parts of the country showed the same migration patterns as geese neck-banded in SW Scania and Södermanland.

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Introduction

Starting in the early 1980s, the migration of Greylag Geese *Anser anser* in Europe has been intensively studied using neck-banded individuals. In Sweden, neck-banding mainly occurred in SW Scania and Öster-Malma in Södermanland with only small numbers elsewhere (Andersson et al. 2001). These data are thus biased to represent a few major marking areas, and a long series is available only from SW Scania (1984–2009; Nilsson & Kampe-Persson in prep.).

Over the years, a large number of Greylag Geese have been ringed at different sites with traditional leg-rings from the Swedish Bird Ringing Centre. These recoveries, up to and including 1995, were analyzed by Fransson & Pettersson (2001). In the present contribution, I expand the analysis to include all leg-ring recoveries up to and including 2012. As the sites of neck-banding and leg-banding are rather different, special emphasis is on whether there is a difference in migration patterns given by the two categories of recoveries

Material

The total number of Greylag Geese ringed in Sweden from the start of the ringing program up to and including 2012 was 7210, with a recovery rate of 19,4% (1398 individuals). This is almost twice as many as in the previous analysis. The main marking districts used in this analysis are shown in Figure 1. Excluding local recoveries, the numbers available for analysis of the migration patterns over major marking areas (Figure 1) is as follows: Scania 350, Gotland 245, Småland 25, Västra Götaland 38, Södermanland 158, Stockholm archipelago 23, Hälsingland 68 and Jämtland 17. For marking places before year 1995, see also Fransson & Pettersson (2001).

Results

Of the 924 recoveries of Greylag Geese available for the present study (excluding local recoveries), 157 were reported from Sweden (Figure 2). Most foreign recoveries were from the Western European flyway following the Eastern Atlantic coast (Andersson et

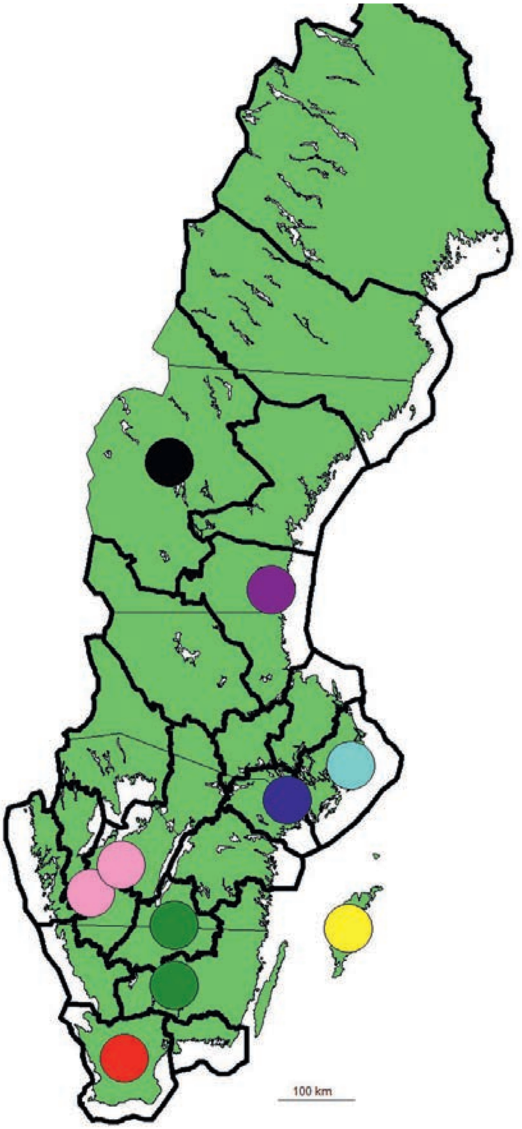


Figure 1. Map of Sweden showing counties where traditional ringing of Greylag Geese *Anser anser* in larger numbers has been undertaken. Colour show the colour used in the recovery maps for different counties.
Karta över Sverige och de län där större antal grågäss märkts. Färgerna visar de färger som använts i återfyndskartorna för olika län.

al. 2001). In addition to recoveries from these countries, 21 recoveries were reported from Poland and between 1 and 8 recoveries came from 15 other countries. Note that there were only small differences in the number of recoveries reported from the different countries along the Western flyway south of Sweden. This is in marked contrast with the geographical pattern of neckband readings, where the Netherlands dominate markedly (Andersson et al. 2001). These differences are related to the number of bird-watchers reading neckbands in the different countries and to differences in hunting pressure.

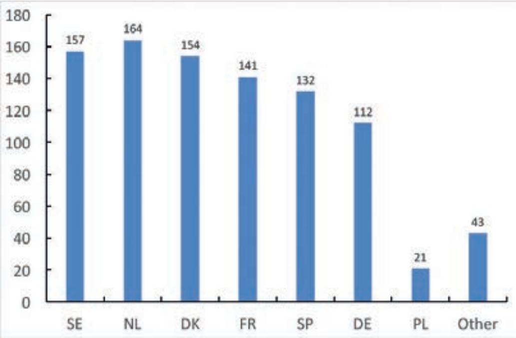


Figure 2. Number of recoveries (excluding local recoveries) of Swedish ringed Greylag Geese Anser anser reported from different countries.
Antal återfynd (exkl. lokala återfynd) av svenskmärkta grågäss från olika länder.

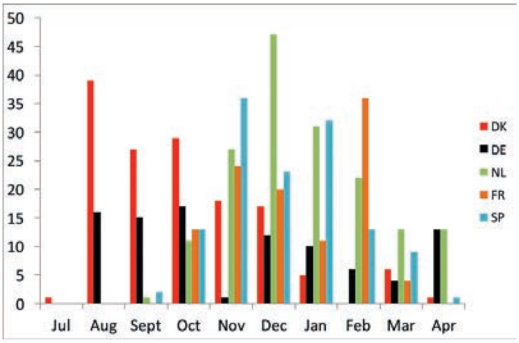


Figure 3. Monthly distribution of recoveries of Greylag Geese *Anser anser* marked in Sweden from some countries.
Månadsfördelning av återfynd av svenskmärkta grågäss från några olika länder.

The temporal pattern of the recoveries show marked variation between different countries, being related to the timing of migration and not least the differences in hunting seasons (Figure 3). In general, the leg-ring recoveries show quite good similarities with the temporal pattern of the migration as shown by the observations of neck-banded geese.

Recoveries of Greylag Geese marked in Scania (Figure 4A) are markedly concentrated to the Western flyway following the east Atlantic coast with recoveries all the way from Sweden to southern Spain, i.e. they show the same general migration pattern as

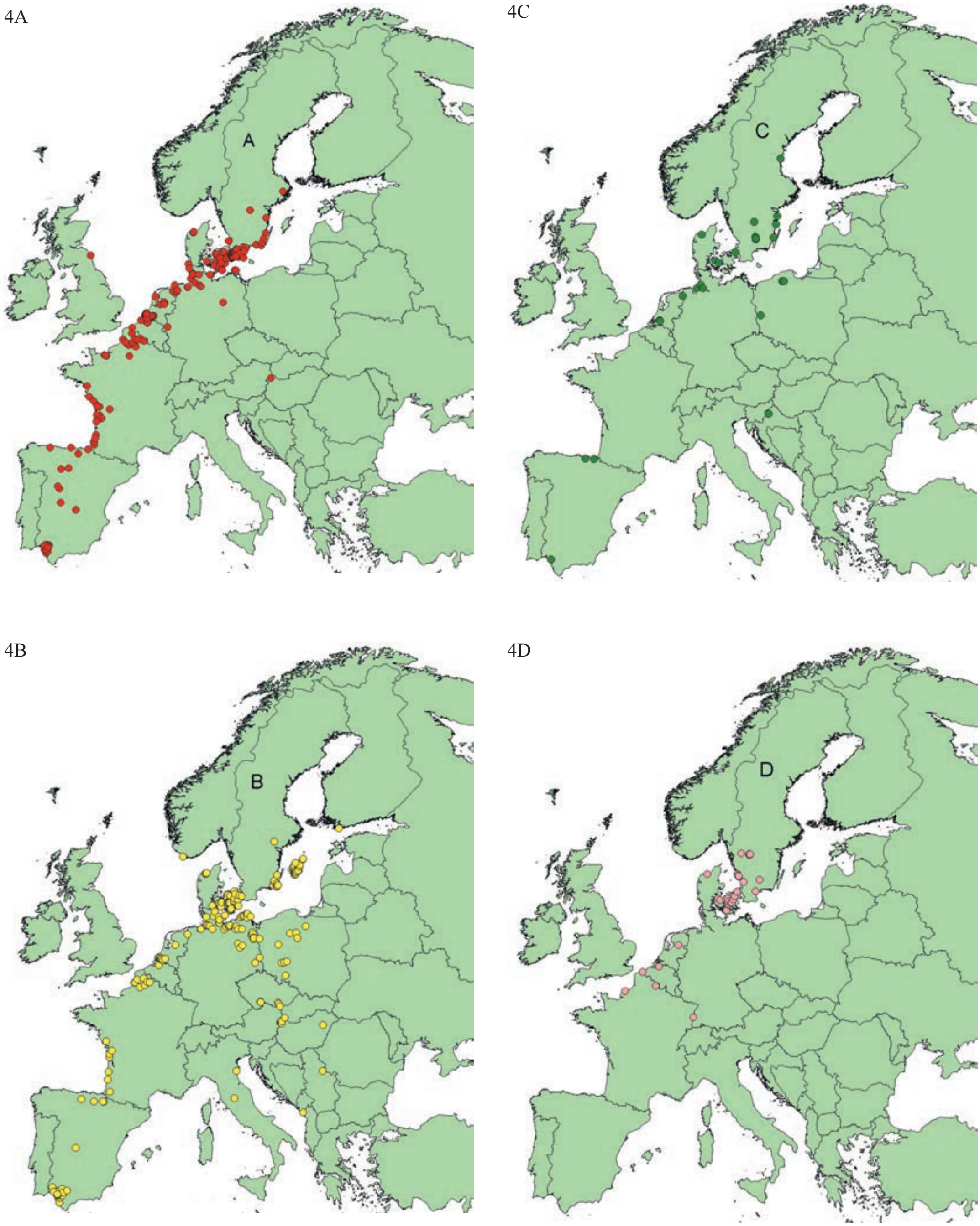
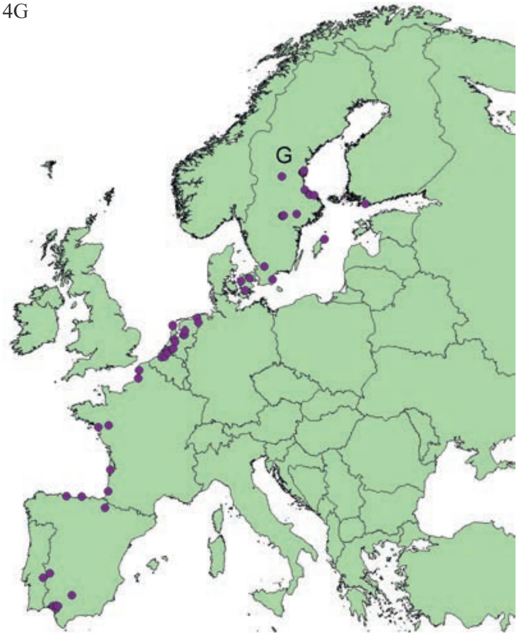


Figure 4. Recoveries of Greylag geese Anser anser marked in different parts of Sweden (see Figure 1). A = Skåne, B = Gotland, C = Småland, D = Västra Götaland, E = Södermanland, F = Stockholm archipelago, G = Hälsingland and H = Jämtland. Not shown on the map are two recoveries of birds from Gotland found in Tunisia and one from Södermanland found in Algeria.

Återfynd av grågäss märkta i olika delar av Sverige (se Figur 1): A = Skåne, B = Gotland, C = Småland, D = Västra Götaland, E = Södermanland, F = Stockholms skärgård, G = Hälsingland and H = Jämtland. Tre fynd saknas på kartorna: två fåglar från Gotland återfanns i Tunisien och en från Södermanland rapporterades från Algeriet

4E

4G



4F

4H

illustrated by the total dataset from the neck-banded Greylag Geese from SW Scania. Comparing the neckband resightings with the traditional recoveries from geese marked in the same area, there are some differences mainly relating to differences in the hunting pressure which makes it more difficult to use the traditional recoveries for an analysis of changes in the migration. Thus 11% of the traditional recoveries of geese marked in Scania were reported from France, whereas about 5% of neck-banded Greylags were re-sighted in France. In the Netherlands the number of resightings of neck-banded Greylag Geese was high, whereas the number of traditional recoveries was lower.

On the island of Gotland, most ringed Greylag Geese were caught during the moult especially as part of a special study during the years 1965–1975 (von Essen 1982). The majority of the ringed geese followed the same route along the east Atlantic coast south to Spain as the geese from Scania (Figure 4B) but a large proportion was apparently of east European origin as they migrated south through eastern Europe. Two recoveries of these birds (not shown on the map) were from Tunisia. In all about 25% of the recoveries were from the Central European Flyway.

Twenty-five recoveries of Greylag Geese ringed in the province of Småland (Figure 4C) were reported. All of them except three (two from Poland and one from Slovenia) were reported from the Western flyway. The Western flyway was also used by all thirty-eight birds from Västra Götaland that were recovered (Figure 4D). In contrast to the recoveries from the other marking areas, all recoveries from Västra Götaland were from the northern part of the flyway with a concentration to Denmark, and the southernmost records being reported from northern France.

The third largest number of recoveries came from the markings in the province of Södermanland (Figure 4E). The material from this province is highly dominated by an introduced population established around Öster-Malma (cf. Andersson et al. 2001). The majority of the Greylag Geese from this group were recovered from the Western flyway with a good number of recoveries from all countries in this flyway. In contrast to the geese from most other marking areas except Småland, a number of recoveries from areas further to the east were reported with recoveries both from Poland, Ukraine, Croatia and Turkey. Whereas the recoveries from the Western flyway mostly were concentrated to the coasts for geese from the other marking areas, a higher proportion of the geese from Södermanland were recovered also in inland France. One important area for the geese from this marking area was Lac du Der in Northeast France. As was also found by observations of neck-banded geese (Andersson et al. 2001), Öster-Malma birds had established a wintering tradition in the Lac Du Der area in northern France yielding a large number of neckband readings.

Twenty-three Greylag Geese were marked in the Stockholm archipelago (Figure 4F), all of these being recovered in the Western flyway with the exception of one recovery from the border between German and Poland.

Quite a large number of Greylag Geese were ringed in the province of Hälsingland (Figure 4G) producing 68 recoveries, all from the Western flyway with the exception of one recovery from the island of Gotland and one from southern Finland. A small sample of geese marked in the inland province of Jämtland (Figure 4H) showed generally the same pattern but with one recovery each from southwest Norway and western Denmark.

Discussion

When comparing the traditional recoveries of Greylag Geese with the observations reported on sightings of neck-banded Greylag Geese in the West European flyway, some marked differences in the distribution of recoveries and resightings between different countries were noted. In the neck-banding data, observations from the Netherlands dominated markedly in the reports, whereas records of neckband sightings from France were much more sparse (Andersson et al. 2001, Nilsson et al. 2013). On the other hand, the number of traditional recoveries of shot birds was only slightly lower in France than in the Netherlands and Denmark. The high number of recoveries from France compared to the other countries reflect the higher hunting pressure on geese here compared to countries further north (cf. also Nilsson et al. 2013).

Another factor to be kept in mind when comparing the traditional recoveries with the observation of neck-banded Greylag Geese is the marked changes in the migration patterns and wintering distribution of the species which has taken place during recent decades (Nilsson 2006, Ramo et al. 2015). In most cases the number of traditional recoveries are too small to make it meaningful to separate recoveries from different time periods, but this change in general migration pattern must be kept in mind when discussing the picture obtained from the traditional recoveries from different regions over a long run of years.

Comparing the general picture of the migration habits of Greylag Geese from Scania obtained from the observations of neck-banded individuals with recoveries from the traditional marking in Scania, they show largely similar patterns. There are however some differences mainly related to differences in hunting pressure between different countries as presented above.

Whereas the general picture from the two datasets are quite similar for Greylag Geese from Scania, there are some differences in details for the geese from Södermanland and Gotland. In the map for recoveries of Greylag Geese from Södermanland there are a few records from Lac du Der (Figure 4F) but the concentration of geese from Södermanland here does not show up so clearly as in the observations of neck-banded Greylag Geese from the same area. This may be an effect of the central parts of the Lac du Der area being protected. Moreover, there were intensive neckband reading operations in the area. The traditional ring recoveries from the Södermanland bird are also fairly well distributed all the way south through France and Spain, whereas relatively few neckband readings of Södermanland birds were obtained from this area (Andersson et al. 2001, Nilsson et al. 2013). In contrast to the neckband readings a number of traditional recoveries were reported from Eastern Europe as far east as Turkey, whereas the neck-banded geese were found in the Western flyway (Andersson et al. 2001).

The samples from Gotland also show differences between the neck-banded birds and the ring-recoveries. Whereas only four individuals neck-banded on Gotland were reported from the Central European Flyway, about 25% of the traditional recoveries of Greylag Geese marked on Gotland were recovered from the Central European Flyway. These differences might be explained by the different time-spans of the datasets and changes in the migration patterns of Greylag Geese during recent decades (cf. Nilsson 2006). Most traditional recoveries were from birds ringed in 1965–1975 (von Essen 1982), whereas neck-banding on Gotland was made during a few years in the eighties (Andersson et al. 2001).

In conclusion, the traditional recoveries show the same general migration pattern for the Greylag Geese as the observations of neck-banded geese even if there are some differences in the distribution of sightings and recoveries such as the higher frequency of recoveries compared to sightings for France related to the higher hunting pressure on geese in France compared to other countries. The Greylag Geese from two areas showed that part of the geese migrated in more easterly directions than the majority of the Swedish Greylag Geese, some birds form Södermanland were spread over Eastern Europe. Moreover several recoveries of Greylag Geese marked on Gotland migrated south through Eastern Europe. As found by von Essen (1982) the moulting sites on Gotland attracted Greylag Geese from Eastern Europe. After moult, these birds probably returned to their areas of origin and migrated south with the local Eastern European birds.

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Sammanfattning

Under senare år har grågåsens flyttningsvanor studerats intensivt i ett flertal europeiska länder med hjälp av märkning av gässen med halsringar. I de nordiska länderna startade detta 1984 (Andersson et al. 2001). Halsmärkningarna av grågäss i Sverige har i huvudsak koncentrerats till tre områden: SW Skåne, Öster-Malma i Södermanland och Gotland. Därutöver har genom åren ett betydande antal grågäss märkts med Ringmärkningscentralens ringar (Fransson & Pettersson 2001). I denna uppsats analyserar jag de traditionella ringåterfynden för grågäss för att komplettera den bild halsmärkningen givit med information om flyttningsvanorna hos grågäss från andra delar av landet.

I min analys har jag använt återfynd rapporterade till och med 2012. Fram till detta år märktes 7210 grågäss som givit 1398 återfynd (19,4%), varav 924 återfynd återstår när lokala fynd uteslutits. Jag har här jämfört fördelningen av återfynd från åtta olika områden i landet, vilka visas på kartan i Figur 1.

Av de 924 återfynden rapporterades 157 från Sverige (Figur 2). De flesta återfynden kommer från västra Europa där gässen flyttar nära Atlantkusten till vinterområdena som tidigare låg i Spanien. Man kan notera förhållandevis små skillnader i antalet rapporterade återfynd från de olika länderna, vilket står i kontrast till rapporteringen av halsmärkta gäss från dessa länder. Förklaringen till detta torde kunna sökas i olika hårt jakttryck på gäss, där speciellt Frankrike ligger högt. Däremot visar den tidsmässiga fördelningen av återfynden betydande likheter med motsvarande bild från observationerna av halsmärkta gäss (Figur 3).

Återfyndens fördelning på olika länder för de olika märkområdena framgår av Figur 4. Majoriteten av återfynden följde den västeuropeiska flyttningskorridoren, men gäss från några märkområden återfanns också från andra delar av Europa, vartill kommer ett återfynd från Algeriet och två från Tunisien. En del av gässen från Södermanland (Figur 4E) gav återfynd spridda över östra Europa, men merparten sågs i västra Europa, där observationerna av halsmärkta grågäss visade att bl.a. ett område, Lac du Der, i norra Frankrike var viktigt för gäss från Öster-Malma (Andersson et al. 2001).

Grågässen från Gotland visar en avvikande bild, men till skillnad från övriga märkta gäss var merparten av dessa märkta som ruggare (von Essen 1982) och de gotländska ruggningslokalerna rekryterade i betydande utsträckning ruggare från östra Europa.

ORNIS SVECICA 27: 139–143, 2017

In the Grasshopper Warbler *Locustella naevia*, males with better nutritional condition at the winter ground arrive earlier than other males at the breeding ground

Hos gräshoppsångare Locustella naevia *anlände hanar med bättre fysisk kondition i vinterkvarteret tidigare än andra hanar till häckningsområdet*

JONAS ENGZELL

Abstract

The aim of this study was to answer the question: Does grasshopper warbler Locustella naevia males with better physical condition in the winter quarter arrive earlier at the breeding ground than other males. This was accomplished by measuring growth bars in tail feathers and then correlate these measurements with different times of arrival at the study area of Björka lertag. The results strongly indicate that early arriving males had better physical fitness (nutritional condition) than later arriving males, at least when their feathers were growing on the wintering grounds in Africa.

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Background

Grasshopper warblers *Locustella naevia* have been monitored in the study area since 1984. As the population over the years increased from one singing male to several, it became apparent that males do not arrive all at once. Some males arrive at the study area in the last days of April or in the first days of May. Other males arrive throughout May. A few turn up as late as in the beginning of June, more or less a month after the first and at a time when the earliest arriving males sing less frequently (indicating that they are breeding).

The aim of the present study was to investigate whether grasshopper warbler males arriving early to the study area were in better physical condition at the time of departure from the winter quarters than males arriving late. As an indicator of condition I used the mean length of growth bars in the tail feathers. One growth bar (one light and one dark bar) corresponds to the growth of the feather during 24 hours.

The validity of using measurements of growth bars as an indicator of condition is summarized by Grubb (2006). The basic assumption is that the greater the average growth bar width, the better the bird's nutritional condition while growing the feather. Grasshopper warblers usually have growth bars in the tail feathers that are visible when holding the bird in the hand, for example during ringing (Figure 1).

Grasshopper warblers nesting in Europe undertake a complete moult in the wintering grounds (Moult -WC) in Africa, before returning to the breeding grounds (Svensson 1992). Kennerley & Pearson (2010) also states "the majority of birds moult completely in tropical Africa". Most birds undergo a complete moult in October to January, but in rare cases some birds continue to moult in February and March (Demongin 2016). Thus the growth bars on tail feathers, seen on returning birds in spring, reflect the nutritional condition of the bird during the tail-growth period at the wintering grounds, although not necessarily the condition just prior to departure. Kennerley and Pearson also states "In the nominate race, some adults have a partial post-breeding moult prior to migration, usually confined to the body and head feathers, but sometimes involving the tertials and central tail feathers" Similar facts are stated by Demongin (2016). This makes the central tail feathers less reliable for growth bar measurement in this study, see under Materials and methods. I measured the

Figure 1. A grasshopper warbler showing the tail with growth bars on the feathers. The tail is moulted during the stay in Africa. The width of one growth bar (one light band grown during night and one dark band during day) represents the growth during 24 hours. Wide growth bars are assumed to be associated with good nutritional status.
En gräshoppsångare demonstrerar stjärten med tillväxtzoner på fjädrarna. Stjärten ruggas under vistelsen i Afrika. Bredden hos en tillväxtzon (ett ljust band under natten och ett mörkt band under dagen) motsvarar tillväxten under 24 timmar. Stor zonbredd anses indikera god näringsstatus.

growth bars on eight grasshopper warblers during 2009 to 2013. This was done as birds were caught in order to answer a different set of questions. The results of these measurements have not been included here, as arrival date was not estimated with the same methodology.

Materials and methods

Trial year

The field season of 2014 was used to determine the catching method, method of growth bar analysis, and how to best use the available field days during spring and early summer in order to establish time of arrival with adequate accuracy to answer the question at hand. Five of nine singing males were caught and studied. I found that song playback was necessary and a permit to do this was applied for and granted by Ringmärkningscentralen (Swedish Bird Ringing Center). I also found that the number of growth bars that I could consistently measure with my intended method (Grubb 2006) was 6–7, not 10, and my method had to be slightly modified to allow for this.

Study area

The study was carried out in the nature reserve Björka lertag. (Natura 2000 sites: SE0240078 Björka lertag, SE0240134 Vissberga lertag. Object number RegDOS: 2000249. Central coordinates (RT90): X 6554548, Y 1460369). Björka lertag is located in Kumla, Närke, in southern Central Sweden. Once a former clay-pit, it has been turned into a reed- and bush-dominated wetland. For pictures see Engzell (2017).

Establishing time of arrival

I monitored and ringed singing grasshopper warbler males during the breeding season of 2015, 2016 and 2017, visiting the study area during the same field periods each year, two periods in May and one in early June. In total I made 64 (20

+24+20) visits to the study area during May and June in 2015–2017 and accumulated 189 h of observation time.

The date when a bird was first heard singing at a location was used to indicate time of arrival. The true time of arrival could be slightly earlier, if for example the weather affects the willingness to sing or if the bird had arrived in between monitoring visits. Hans Waern has kindly provided me with information of the singing males that he noted during monitoring work between my visits to the study area. That means that males could be placed in three groups with a relatively high confidence: males arriving in week 18–19, 20–21 and 22–24.

The singing positions of males were then used to determine the location of each territory, using standard monitoring technics (Lundström et al. 1984). The males were caught using song playback (song of grasshopper warbler played through a speaker close to the net).

Measuring growth bars

In the field I used a slightly modified version of a method originally described by Grubb (2006, Appendix 1, s 160–161). After ringing (and taking the standard measurements) the birds tail was placed on top of a paper index card, onto witch I had stapled a piece of thin black paper. Then I marked the growth bars in the outermost tail feather (generally the right) on the paper/index card with a fine pin (insect-mounting pin size 0) that was placed in a shaft for ease of handling. The pin was pushed perpendicularly through the feather and the underlying paper at the distal edge of each dark growth band (the edge that is closer to the feathers tip). I also marked the tip of the feather. The method allows for quick and accurate measurement of growth bars without a need for pulling out a tail feather, and with little stress and discomfort for the bird.

I then wrote down the information of the bird individual on the index-card, such as ring number, date and place (territory). The distance between the growth bars was then measured to the nearest 0.01 mm, using magnifiers and a pair of digital calipers. Grubb describes measuring the distance between 10 growth bars and divide by 10 to calculate the mean growth rate. The original method requires you to also mark the base of the (pulled) feather, in order to measure between the 10 growth bars centered around the two-thirds point of the feather. I measured between 7, or in a few individuals 6, growth bars, as I found it was often not possible to reliably detect 10 or more growth bars in grasshopper warbler tail feathers, using my field method. If more than 7 bars were noted, I tried to measure the middle 7, using the tip of the feather as a reference. Se Grubb (2006) for more details on the original method. My method is therefore slightly less stringent and probably slightly less accurate. But my method does not require pulling out a feather, for which I do not have a permit (required in Sweden).

Analysis

The results have been analyzed using a one way ANOVA, computed using the Analysis ToolPak in Microsoft Excel (2013). No Tukey Test have been computed, since there was not an equal number of sampling units in all samples. The null hypothesis was that the mean growth rate did not differ between the tree groups (males arriving in week 18–19, 20–21 or 22–24).

Results

In 2015 I caught 9 individuals, 4 arriving in week 18–19, 3 arriving in week 20–21 and 2 arriving in week 22–24 (4, 3, 2). In 2016 I caught 6 individuals (3, 3, 0) and in 2017 I caught 10 individuals (1, 6, 3).

The results on a population level is presented in Figure 2 and in Table 1 and 2.

The difference in mean growth rate (growth per day) of the tail feathers between the three samples, n=8, 12 and 5, is statistically significant since F>Fcrit (F=19,02008>3,443357). The result is significant at the 1% significance level. The null hypothesis is rejected. I conclude that there is strong evidence that the mean growth rate in the tree groups differ.

In Table 3 the results are presented on an individual level. Arrival and mean growth rate of tail feathers of individuals that have been captured (year 1) and recaptured one year later (year 2) are shown. Males ringed/caught in 2014–2017 are included. (Two birds caught in 2014 and re-caught in 2015 are included here, as their time of arrival and tail growth could be determined using the same method as in 2015.)

Discussion

The results strongly indicate that the earliest arriving males had a better nutritional condition than later arriving males when their feathers grew at the wintering grounds in Africa. The males that arrived late had been, in general, in less good condition at

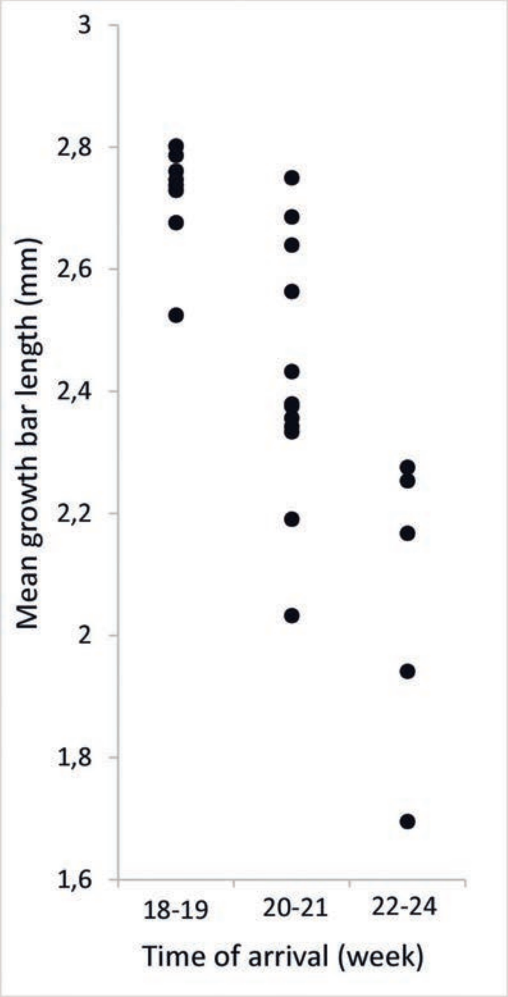

Figure 2. Mean tail growth rate for Grashopper Warbler males arriving in week 18–19, 20–21 and 22–24 during 2015–2017. *Medelvärdet av stjärttillväxten för hanar av gräshoppsångare som ankom under vecka 18–19, 20–21 och 22–24 under år 2015–2017.*

the wintering grounds than the males that arrived before them. The data also suggests that there is less variance in the mean tail growth in the group of early arriving males and that this variance increases in the groups arriving later.

Even if too few individuals have been recaptured for statistical analysis to be meaningful, the result on an individual level seems to support the findings on a population level. Individual males such as CK16785 and CK16786, that had a markedly higher mean growth rate year 2 (+0,345-0,621 mm), also arrived earlier that year. Individuals with only a slight difference in mean growth rate (+/- 0,014-0,054 mm) did not change their time of arrival. At least not as much as to be detectable in this study.

It seems that males with better nutritional condition on the wintering grounds arrive earliest to Björka lertag and that they therefore (theoretically) can claim the best territories there. On the other hand, males arriving early to Björka lertag risk periods of cold weather and a lack of food to a higher degree than later arriving individuals. Probably these are two opposing evolutionary forces working against each other.

Acknowledgements

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Sammanfattning

I Björka lertag, Närke, anländer gräshoppsångarhanar under en relativt lång period. De tidigaste anländer under de sista dagarna i april eller de första dagarna i maj. Därefter anländer hanar under maj fram till i början av juni – när de tidigast anländande hanarna inte längre sjunger lika regelbundet (vilket indikerar påbörjad häckning).

Frågan som jag har försökt besvara är om tidigt anländande hanar är i bättre kondition än sent anländande hanar. Detta undersöktes genom att mäta den genomsnittliga tillväxten på stjärtpennorna och korrelera detta mot ankomstdatum.

Under 2015–2017 inventerades/revirkarterades sjungande hanar. Första gången de hördes på en plats räknades som ankomstdatum. Hanarna fån-

Table 1. Summary from the ANOVA calculation of tail growth rate and arrival of grasshopper warblers.
Sammanfattning från ANOVA beräkningen av stjärttillväxt och ankomsttid hos gräshoppsångare.

Groups (Arrival)	Numbers	Sum	Mean value	Variance
Sample 1 (Week 18-19)	8	21,767	2,720875	0,007702125
Sample 2 (Week 20-21)	12	29,087	2,42391667	0,042892447
Sample 3 (Week 22-24)	5	2,0672	2,0672	0,0605292

Table 2. One Way ANOVA for tail growth rate and week of arrival in grasshopper warbler.
Envägs ANOVA för stjärttillväxt och ankomsttid hos gräshoppsångare.

Source of variation	KvS	fg	MKv	F	p-value	F-crit
Between samples	1,327685	2	0,6638427	19,0200772	1,6E-05	3,443357
Within samples	0767849		0,03490221			
Total	2,095534					

Table 3. Change in mean tail growth rate of the outer tail feather between two years for five individual males, and their different times of arrival.
Medelförändring i tillväxthastighet hos den yttre stjärtpennan mellan två år för fem hanar och deras olika ankomsttider.

Ring number	Tail growth year 1 (mm)	Tail growth year 2 (mm)	Change (mm)	Arrival year 1	Arrival year 2
CK16869	2,787	2,802	+0,015	W. 18-19	W. 18-19
CK16826	2,761	2,747	-0,014	W. 18-19	W. 18-19
CK16875	2,334	2,388	-0,054	W. 20-21	W. 20-21
CK16785	2,109	2,730	+0,621	W. 20-21	W. 18-19
CK16786	2,295	2,640	+0,345	W. 22-24	W. 20-21

gades sedan för ringmärkning. I samband med det mättes stjärttillväxten genom att avståndet mellan de tillväxtzoner man kan se i stjärtfjädern mättes. Genom att mäta avståndet mellan 7, eller i vissa fall 6, tillväxtzoner i den yttre stjärtfjädern, erhölls ett medelvärde. Detta medelvärde kunde sedan korreleras mot ankomstdatum, där hanarna delades in i tre grupper. En grupp som anlände vecka 18–19, en grupp som anlände v. 20–21 och en sista grupp som anlände v. 22–24.

Beräkningar visade sedan att det fanns en statistiskt säkerställd skillnad i stjärttillväxten mellan dessa tre grupper. Stjärttillväxten speglar fågelns ”näringsstatus” när fjädern växer ut. Då gräshoppsångare byter sina fjädrar på övervintringsplatsen i Afrika, slår jag fast att resultaten från denna studie starkt indikerar att tidigt anländande hanar är i bättre kondition på övervintringsområdet i Afrika än sent anländande hanar. Resultat får även stöd i att individuella hanar, som fångats två år efter varandra och där den genomsnittliga stjärttillväxten ökat markant det andra året, även anlänt tidigare år två. Hanar med måttlig förändring i tillväxten har däremot inte nämnvärt ändrat ankomsttid till studieområdet.

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Phloem sap in fire-damaged Scots pine trees provides instant foraging opportunities for Three-toed Woodpeckers *Picoides tridactylus*

Sav i floemet hos brandskadade tallar ger omedelbart tillgång till föda för tretåiga hackspettar Picoides tridactylus

TIMO PAKKALA, JARI KOUKI, MARKUS PIHA & JUHA TIAINEN

Abstract

Three-toed Woodpeckers *Picoides tridactylus* are known to use phloem sap of conifer trees as a food resource mostly in springtime. A local pair instantly began to forage sap of Scots pine *Pinus sylvestris* trees that were damaged in a prescribed forest burning; before the fire they had used phloem sap elsewhere in their territory. During three weeks after the fire, the pair intensively used sap of Scots pines which were exposed to fire. The woodpeckers were probably attracted by nutrients induced by damage reaction of the burned pines. Rapid sap use of newly burned trees has not been described before, and it indicates behavioural plasticity how this woodpecker species can use resources in disturbance driven, dynamic forest environments.

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Introduction

Three-toed Woodpeckers *Picoides tridactylus* predominantly feed on arthropods, but especially in springtime they also use phloem sap of conifer trees (Ruge 1968, Glutz & Bauer 1980, Cramp 1985, Pechacek 2006). Phloem sap is energy-rich and nutritionally valuable containing sugars, amino acids and minerals (Douglas 2006). Three-toed Woodpeckers can gain phloem sap by excavating often horizontal rows of small holes into the bark of living trees; these may be used during several years (Glutz & Bauer 1980, Cramp 1985).

Three-toed Woodpeckers and some other woodpecker species favour areas with burned trees (see Fayt et al. 2005), but known situations are linked to increased amounts of insects gathered to the burned areas (Muona & Rutanen 1994, Hyvärinen et al. 2005). Therefore, the woodpecker responses are generally detected not until the increase of local insect populations (Fayt et al. 2005).

Here we report a quick reaction of Three-toed Woodpeckers to move to a burned area and use the sap of the partially burned and damaged Scots pines *Pinus sylvestris*. We describe this previously undocumented phenomenon and discuss possible mechanisms and reasons for the observed patterns.

Material and methods

Study area

A prescribed burning was conducted on 10 May in 2016 in a forest area of ca. 4 ha within the southern boreal vegetation zone in, southern Finland (61° 12’ N; 25° 09’ E). Most of the trees were harvested from the area prior to the burning, but a group of Scots pines and scattered silver birches *Betula pendula* and Norway spruces *Picea abies* were left standing in the area that was mostly surrounded by coniferous dominated forests.

Three-toed Woodpeckers and their sap trees in the area

The burned area was situated in the middle of a long-term territory of the Three-toed Woodpecker (Pakkala et al. 2017). Breeding and foraging activities of this pair were observed already earlier in the spring before the burning. Intensive mapping of sap trees within the territory was carried out by the author TP in 2015 and 2016. No old sap trees from the pre-burn time were situated in the newly burned area.

The size (diameter at breast height, DBH) of the sap trees in the burned area and the height of the charred zone on their bark from the ground were measured. The numbers, heights, and compass points of sap rows were monitored during field visits of 1–5 hours 1, 4, 11, 15, 23, and 43 days after the burning. The foraging behaviour of the Three-toed Woodpeckers and the time used to sap feeding were observed at the visits.

Results

The sap tree use after burning

The group of Scots pines in the burned area included 37 trees of the age of ca. 40 years within an area of 0.5 ha. The bark of several of the trees was charred, although usually only in the base to less than one meter above the ground (Figure 1). However, the charred surface reached a height of 2–3 meters but mostly on the southern sides of some trunks. The Three-toed Woodpeckers used a total of 11 trees to sap feeding during the period of 11 May to 22 June (Table 1). The DBH of selected trees varied between 20–28 cm and they had various amounts of charred surface in their trunks (Table 1, Figure 1). The Three-toed Woodpeckers used the southern surfaces of the trunks in making the sap rows (Table 1, Figure 1) and generally pecked new rows above old ones.

The Three-toed Woodpecker pair was present in the area already in the next day after the burning, and the birds examined potential sap trees by scaling small areas of the bark of the pines, and some sap holes were also pecked to at least five of the trees (Table 2). Four days after the fire, the woodpeckers were detected to use several hours of foraging time pecking new sap rows and feeding on sap. The sap use was intensive until early June, and 23 days after the fire a total of 215 sap rows were made. The sap trees were visited also later in June, but the number of additional new rows was only 27 during the period 3–22 June (Table 2).

Figure 1 a) The group of Scots pines in the prescribed burning area; b) sap rows of the Three-toed Woodpecker in partially charred trunks of Scots pines. Photographs taken by the author JT.
(a) Tallgruppen på den forstliga brandytan i Evo i södra Finland; b) savrader på stammar av delvis förkolnade tallar.

Feeding behaviour

The feeding behaviour of the woodpeckers was restricted to typical patterns of sap use with scaling narrow horizontal bands into the outermost layer of the trees, pecking small sap holes in the middle of these bands, and then drinking sap with their bills. The trunks of the partially charred pines were intact around the sap rows and there was some resin flow from the sap holes.

During the two weeks after the burning, the male and female were often observed together in the burning area, but mostly feeding at separate trees. In the later periods male and female were most often detected sap-feeding at separate time periods. Feeding behaviour connected to gathering insects (scaling irregular areas of bark, tapping, pecking larger irregular holes, probing, gleaning, etc.; see Pechacek 2006) was not observed, and no signs of this kind of behaviour were detected in the trunks of the pines in the burning areas. Neither were potential food item insects observed in the trunks or sap holes during the observation period.

Discussion

The Three-toed Woodpeckers instantly responded to burning and started to exploit damaged trees by feeding on the sap. This kind of pattern has not been described before. Before and at the time of the prescribed burning, the local pair was actively using the sap of Norway spruce trees in nearby forest areas, but they also searched trees for arthropod food. The area of the prescribed burning was not observed to be used for feeding prior to the burning. After the burning, the pair still occasionally used spruce sap trees, but the birds were observed to use substantial part of foraging time in sap feeding at the burned Scots pines.

Phloem sap is rich in nutrients and contains high concentrations of sugars that provide a good source of carbon and energy, nitrogen (mostly in the form of amino acids), and various minerals (e.g. Pate et al. 1998, Douglas 2006). Woodpeckers are known to select sap trees based on the individual properties of trees, e.g. sap amount and quality (Eberhard 2000, Núñes Montellano & Blendinger 2016). Compared with insect larvae, the nitrogen of the phloem sap is, however, considerably lower quality because of low concentrations of several essential amino acids. The amounts of minerals, e.g. calcium, are also an order of magnitude smaller in phloem sap than in insects (Bukkens 1997, Pate et al. 1998, Douglas 2006).

The sap trees with increased stress levels or visible damages are likely to have higher amounts of nitrogen, amino acids or proteins in their phloem sap than healthy trees (see White 1984). In a forest fire, the trees are exposed to high temperatures that likely affect the composition of phloem sap. Alexou & Dimitrakopoulos (2014) studied the shock and acclimation reactions of the Brutian pine *Pinus brutia* in a simulation of forest fire. They found a clear increase of non-soluble proteins in phloem already after two hours but particularly one day after the fire. The levels of these proteins were significantly higher still one week after the fire compared with the pre-fire situation. Phloem soluble sugars and amino acids also tended to accumulate one day after the fire, but their concentrations had significantly decreased a week after the fire. The phloem transport velocity also increased significantly after the fire, and it was still higher one day after the fire in comparison with the pre-fire situation. It is probable that the Three-toed Woodpeckers reacted to similar changes in the phloem of the burned Scots pines. The Three-toed Woodpeckers have been observed to favour partially burned pines for sap feeding several years after the fire (T. Pakkala, pers. obs.) indicating that also some long-term effects of fire exposure may be important.

Woodpeckers can also themselves induce increased sap flow by their feeding technique: new sap rows are often pecked above the old sap holes (e.g. Cramp 1985, Eberhard 2000) that is thought to be linked to the accumulation of sap in tree tissues above the old rows (Kilham 1964, Eberhard 2000). The Three-toed Woodpeckers used this technique in the burned study area, but it is also possible that the fire injured the tissue structures of the trees in a way that nutrients were blocked to be usable by the woodpeckers. Pecked sap rows were on the southern surfaces of the trees (Table 1) that corresponds the direction of the highest burned zones visible in the trunks and thus probably indicates the surfaces that experienced the highest temperatures during the fire. However, most of the sap rows of the Three-toed Woodpeckers in general are located on the southern surfaces of trees, probably for their beneficial thermal conditions (T. Pakkala, pers. obs.), and we do not know if the observed directionality of the sap rows in the burned area was related to the severity and damages that fire caused on trees.

The Three-toed Woodpeckers use phloem sap generally prior to nesting in spring (Ruge 1968, Glutz & Bauer 1980, Cramp 1985, Pechacek 2006). The woodpeckers used the pine sap trees

Table 1. The Scots pine trees of the burned area used by the Three-toed Woodpeckers in sap feeding. The tree number indicates the approximate order in which the trees were taken to sap use. Sap row information describes the situation at the end of the observation period on the 22 June.
Brandytans tallar, som ett par av tretåig hackspett använde för savkonsumtion. Trädets nummer hänvisar till den approximativa ordningen, i vilken hackspettarna började utnyttja trädet. Informationen om savraderna avser situationen på slutet av observationsperioden den 22 Juni.

Tree number *Trädets nummer*	Diameter at breast height *Diameter vid brösthöjd*	Height of the charred bark from ground *Förkolnade barkens höjd från marken*	Number of sap rows pecked *Antal gjorda savrader*	Height zone of sap rows *Höjdbälte för savraderna*	Direction of sap rows *Riktning för savraderna*
1	24 cm	ca. 2 m	26	1.5–8 m	SW–S
2	22 cm	ca. 3 m	33	3–8 m	SW–S
3	26 cm	not charred *oförkolnad*	38	7–10 m	WSW–SE
4	24 cm	< 1 m	16	1–6 m	S–SE
5	25 cm	< 1 m	25	1–6 m	SW
6	25 cm	ca. 2 m	22	1–7 m	SW–ESE
7	27 cm	not charred *oförkolnad*	26	3–8 m	SW–ESE
8	26 cm	not charred *oförkolnad*	18	2–6 m	SW–SE
9	28 cm	ca. 2 m	21	3–6 m	SW
10	22 cm	< 1 m	2	3.5–5 m	SSW
11	20 cm	< 1 m	15	2–3 m	SSW–S

actively during three weeks after the fire to early June, but then their use clearly decreased. The activity period matches the pre-nesting season of the local pair; which was forced to delay its nesting attempt because the nest cavity was taken over by the Great Spotted Woodpecker *Dendrocopos major*, and they were not able to start nesting until in early June.

The reported case shows that a fire-related damage to conifer trees may be advantageous for the woodpeckers also due to the increased sap provision. Thus, in addition to the previously documented positive effects via the increased availability of bark beetles after fire, the Three-toed Woodpecker shows remarkable flexibility in taking advantage of disturbance-driven dynamic forest landscapes.

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Table 2. The activity of the Three-toed Woodpeckers at the sap trees of the burned area.
De tretåiga hackspettarnas aktiviteter på savträden i brandområdet.

Observation time (Date; number of days after burning; length of observation time) *Observationtid (Datum; antal dagar efter branden; längden av observationen)*	Three-toed Woodpecker activity *Aktiviteten av tretåiga hackspettar*	The amount of sap rows *Mängden av savrader*
11.5.; 1 day; 2 h (afternoon) *11.5.; 1 dag; 2 h (eftermiddag)*	Male and female at sap trees ca. half of the observation time *Hanen och honan vid savtallarna omkring hälften av observationstiden*	ca. 15 rows started in 5 trees *ca. 15 påbörjade rader på 5 träd*
14.5.; 4 days; 5 h (morning) *14.5.; 4 dagar; 5 h (morgon)*	Male and female actively at sap rows most of the observation time *Hanen och honan aktivt vid savraderna mestadelen av observationstiden*	ca. 70 rows in 9 trees, part of the rows unfinished *ca. 70 rader på 9 träd, några av dem halvgjorda*
21.5.; 11 days; 4 h (morning) *21.5.; 11 dagar; 4 h (morgon)*	Male and female at sap rows ca. half of the observation time *Hanen och honan vid savraderna omkring hälften av observationstiden*	130 rows in 11 trees, part of the rows unfinished *130 rader på 11 träd, några av dem halvgjorda*
25.5.; 15 days; 2 h (morning) *25.5.; 15 dagar; 2 h (morgon)*	Male and female mostly at separate times at sap rows ca. 30 % of observation time *Hanen och honan mestadels separat vid savraderna ca. 30 % av observationstiden*	160 rows in 11 trees, part of the rows unfinished *160 rader på 11 träd, några av dem halvgjorda*
2.6.; 23 days; 2 + 1 h (morning, afternoon) *2.6.; 23 dagar; 2 + 1 h (morgon, eftermiddag)*	Male occasionally at sap rows in the morning, no observations in the afternoon *Hanen sporadiskt vid savraderna på morgonen, inga observationer på eftermiddagen*	215 rows in 11 trees *215 rader på 11 träd*
22.6.; 43 days; 1 + 1 h (morning, afternoon) *22.6.; 43 dagar; 1 + 1 h (morgon, eftermiddag)*	No woodpeckers observed at sap trees *Inga hackspettar vid savträd*	242 rows in 11 trees *242 rader på 11 träd*

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Sammanfattning

Den tretåiga hackspetten *Picoides tridactylus* lever av insekter och allehanda andra artropoder men särskilt från förvåren till början av häckningen använder den också sav som föda, särskilt från gran och tall. Saven är rik på energi och näring i form av sockerarter, aminosyror och mineraler. Saven lagras i parenkymceller i trädens floem och hackspetten kommer åt saven genom små hål, som den hackar, ofta i rader på stammens solsida (så kallad savrad), och sådana träd kan användas under flera år. Det är känt att tretåiga hackspettar, och även andra hackspettar, lockas till områden som drabbats av skogsbrand. Den vanliga tolkningen är att det är ökad förekomst av insekter efter en brand som lockar till sig hackspettarna. Men denna effekt kan normalt inte upptäckas förrän efter någon tid. I denna uppsats visar vi att det också kan vara saven som attraherar och att man då får en omedelbar effekt.

I samband med en långtidsstudie av savanvändning observerades i Evo i södra Finland våren 2016 hur ett lokalt par av tretåig hackspett omedelbart började använda sav från brandskadade tallar i en liten grupp (37 ca. 40-åriga tallar) som lämnats vid en hyggesbränning. Branden passerade genom det sparade tallbeståndet och många tallars bark förkolnade till en höjd av 2–3 meter på den sida från vilken branden kom. Hyggesbränningen genomfördes den 10 maj 2016 och användningen av sav började genast dagen efter branden och fortsatte intensivt under tre veckor. Från fyra dagar efter bränningen och framåt kunde hackspettarna tillbringa flera timmar i talldungen med att hacka nya hål och dricka sav. Hackspettarna använde elva av de trettiosju tallarna, som hade en brösthöjddiameter på 20–28 cm. Savhålen hackades på sydsidan av stammen, vilket var den kraftigast brända sidan. Vanligen hackades de nya hålen ovanför gamla hål.

Det aktuella hackspettparet var redan före bränningen i färd med att använda sav från granar utanför brandhygget men hade inte observerats använda tallarna i den sparade dungen. Antagligen lockades hackspettarna av de brända tallarnas fysiologiska reaktion. Hettan är en stressfaktor som observerats förorsaka förändringar i savens sammansättning, till exempel ökat innehåll av kväve, aminosyror, protein och sockerarter samt även ökat savflöde. Att spettarna hackade nya hål ovanför gamla kan förklaras av att sav eller värdefulla komponenter i saven ackumuleras ovanför de skadade partierna av barken.

Man har inte tidigare observerat att den tretåiga hackspetten reagerar så omedelbart att utnyttja brandskadade träd. Den snabba övergången till att använda tallsav på brandytan visar på beteendets flexibilitet, som är en del av anpassningen till den boreala skogens störningsdynamik.

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