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Age and sex determination of Mallards *Anas platyrhynchos* in autumn

Ålders- och könsbestämning av gräsänder Anas platyrhynchos *på hösten*

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Abstract

Male and female mallards *Anas platyrhynchos* are easily told apart, whereas ageing is problematic, due to individual timing of moult and lack of easily defined age criteria. From examination and photographic documentation of mallards caught at Ottenby Bird Observatory (56°12′N, 16°24′E), we describe nine characters of plumage and bare parts to be used for ageing in autumn. The reliability of these characters was tested by letting experienced bird ringers determine putative age of birds from photos. Age determination from any single character proved to be uncertain, as correctly assigned mallard photos of each character was in the range of 51–85% for males and 48–89% for females. For both sexes, the lowest figure represented post-humerals and the highest represented tertials. Rectrices, tertial coverts, and greater coverts had high scores (71–85%). Using all characters, 91% of the males and 95% of the females were correctly aged. As young mallards, with the progress of pre-breeding moult (completed from October onwards), acquire tail and tertials identical to adults, untypical individuals are better not assigned to an age category.

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Background

The mallard *Anas platyrhynchos* is the most numerous and widespread dabbling duck in the world with a Holarctic distribution covering most of the northern hemisphere, including Alaska and southern Greenland. It is only absent in desert areas, the extreme north, and tropical regions. The global population is estimated to number at least 19 million individuals, of which 7.5 million occur within Europe (Wetlands International 2006, 2015). Additionally, millions of mallards are released for hunting each year, primarily in the northern hemisphere (Champagnon et al. 2013). The mallard is an important model species for research on ecological processes (Gunnarsson et al. 2006), harvest management (Nichols et al. 2007), and disease (Wallensten et al. 2007). Correctly assigning birds to age and sex categories are pivotal for research purposes; for example, age can have strong effects on infection susceptibility (Costa et al. 2010, van Dijk et al. 2014) and population dynamics (Hauser et al. 2007). Sex determination based on plumage is simple, except for very young birds. Males display a conspicuous breeding plumage with green head and mainly grey body, while females have a mainly brown plumage speckled with black. Ageing, however, can be far more challenging, partly because of the protracted breeding season, where the difference between early and late clutches can differ with almost five months (Cramp & Simmons 1977), and the individual temporal variation in performance of moult.

A key for age determination is to understand the process of moult (Ginn & Melville 1983). The downy plumage of ducklings is during body growth replaced by juvenile feathers. At the age of 2–4 months, juvenile mallards perform a partial moult of some feathers on the head, neck, mantle, scapulars, breast, and flanks in late summer (mainly July–September, correlated to hatching date) (Cramp & Simmons 1977, Reeber 2015). Both young and adults undergo pre-breeding moult from August–December, but the process may be prolonged during winter. This moult includes most body feathers, scapulars, tertial coverts, tertials, and tail, but very

Table 1. Feather terms and abbreviations used in this article (see also Figures 1–2).
Fjäderterminologi och förkortningar som används i artikeln (se även Figur 1–2)

Abbreviation *Förkortning*	Explanation *Förklaring*
1cy	1st calendar-year, i.e. from hatching until January 1st. *Första kalenderåret, dvs. från kläckning tom. 31 december.*
2cy+	2nd calendar-year and higher, i.e. from January 1st the year after hatching, which means that a bird is 2cy+ from about six months age onwards. *Andra kalenderåret och senare, dvs. från 1 januari året efter kläckningen, vilket innebär en fågel från ungefär sex månaders ålder och äldre.*
Alula *Lillvinge*	The miniature outermost primary (the "thumb") and its coverts. *Förkrympta yttre handpennan ("tummen") och dess täckare.*
Greater coverts (GC) *Större täckare*	The first row of feathers covering the secondaries. Numbering starts from outer to inner, as with secondaries. Mallards usually have 12 GC, occasionally 13. *Första raden av fjädrar som täcker armpennorna. Numreringen startar utifrån och går inåt, liksom för armpennorna själva. Gräsanden har vanligen 12 GC, i undantagsfall 13.*
Median coverts (MC) *Mellersta täckare*	The second row of feathers covering the secondaries. *Andra raden av fjädrar som täcker armpennorna.*
Lesser coverts (LC) *Mindre täckare*	An area of coverts anterior of the median coverts. *Täckarna framför mellersta täckarna.*
Post-humerals (PH) *Posthumeraler*	Feathers placed in between the tertials and the scapulars. *Fjädrar som sitter mellan tertialerna och skulderfjädrarna..*
Primaries (PP) *Handpennor*	The flight feathers of the hand. Mallards have ten PP, excluding the remicle which is the stunted P11. Numbering starts from inner to outer, as with primary coverts. *Handens vingpennor. Gräsanden har tio PP, samt den rudimentära P11. Numreringen startar inifrån och går utåt.*
Primary coverts (PC) *Handtäckare*	The feathers covering the primaries, often mainly referring to the greater primary coverts. Mallards have nine PC and numbering starts from inner to outer, as with primaries. *Fjädrarna som täcker handpennorna, ofta även kallade större handtäckarna.*
Rectrices (RR) *Stjärtpennor*	The main feathers of the tail. Mallards have ten pairs and numbering starts from the central pair (R1 to R10). In male breeding plumage, the central two pairs of RR are small, black, and upcurled, almost blending in with uppertail coverts. *Stjärtens egentliga fjädrar. Gräsanden har tio par och numreringen startar från det centrala paret (R1 till R10). Hos hanen i praktdräkt är de två centrala paren av RR korta, svarta och uppåtsvängda, och blandar sig nästan med de övre stjärttäckarna.*
Scapulars *Skulderfjädrar*	The shoulder feathers (between tertials/coverts and body/back). *Fjädrarna mellan tertialerna/täckarna och ryggen.*
Secondaries (SS) *Armpennor*	The flight feathers of the arm, where the speculum and the white trailing edge is located. Most mallards have 10–11 SS, but some have 12 (excluding the tertials). Numbering starts from outer to inner, as with greater coverts. *Armens vingpennor, där vingspegeln och den vita vingbakkanten sitter. De flesta gräsänder har 10–11 SS, men somliga har 12. Numreringen startar utifrån och inåt, samma som för större täckarna.*
Tertial coverts (TC) *Tertialtäckare*	The (greater) coverts covering the tertials. *De större täckare som täcker tertialerna.*
Tertials (TT) *Tertialer*	The innermost flight feathers of the arm, which on a folded wing generally cover the secondaries. Mallards have four TT and numbering starts from outer (T1) to inner (T4), T2 being longest. *De innersta armpennorna, vilka i allmänhet täcker övriga armpennor när vingen är ihopfälld. Gräsanden har fyra TT och de numreras från den yttre (T1) till den inre (T4), T2 är längst.*

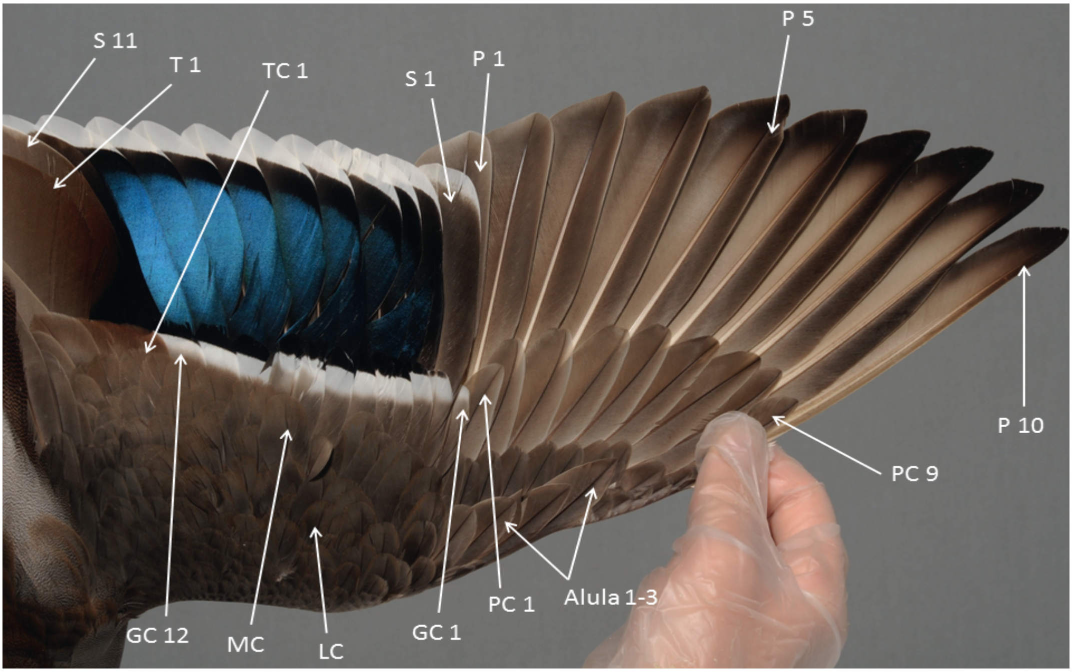

Figure 1. Mallard (male) wing showing location of greater coverts (GC), median coverts (MC), lesser coverts (LC), primary coverts (PC), alula, primaries (PP), secondaries (SS), tertial coverts (TC), and tertials (TT).
Vinge av hane med olika fjädergrupper markerade. Svenska termer i Tabell 1.

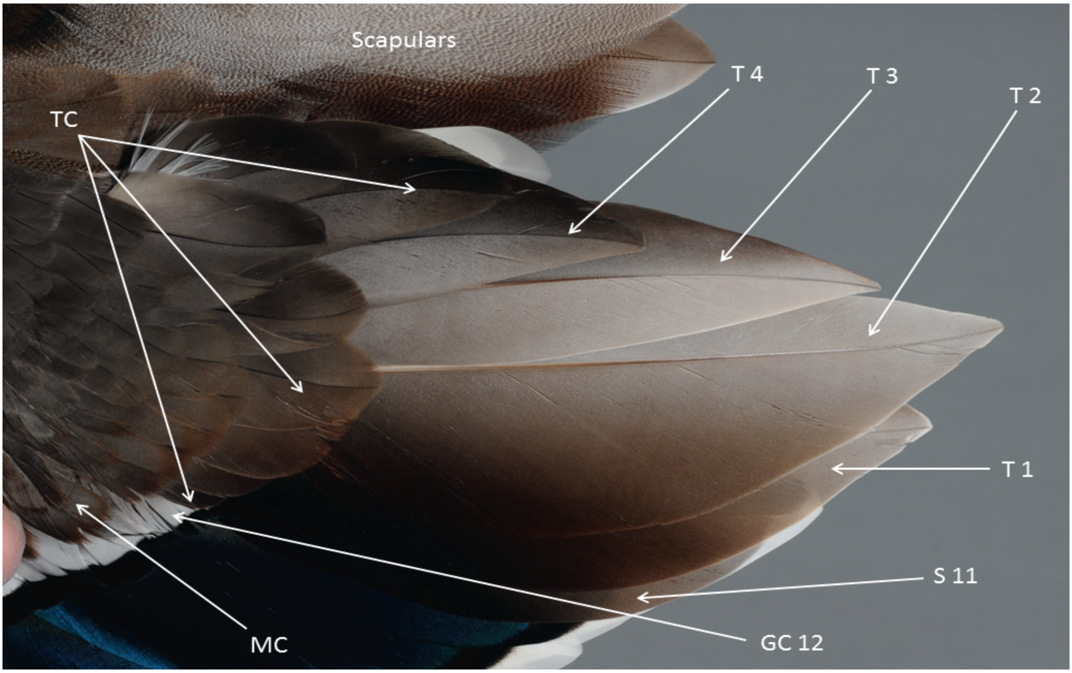

Figure 2. Mallard (male) wing showing location of scapulars, tertial coverts (TC), tertials (TT), median coverts (MC), greater coverts (GC), and secondaries (SS).
Vinge av hane med olika fjädergrupper markerade. Svenska termer i Tabell 1.

few lesser, middle, and greater coverts, and no primaries and secondaries (see Table 1 and Figures 1–2 for location of feather groups). The retained feather groups allow determination of juveniles until replaced during the next year. Young females also retain at least some juvenile tertials and tertial coverts, whereas most males have moulted all tertials by late November (Hopper & Funk 1970). Males are thought to perform more extensive tertial moult due to sexual selection (Ashley et al. 2007), and perhaps is sexual selection also responsible for the "extra" moult of mainly head and neck feathers noted in males in February–March (Reeber 2015).

In January–May, females perform a moult (of similar extent as the preceeding one) to acquire an even more cryptic plumage during nesting, brood-rearing, and moult of flight feathers, while males moult into a female-like eclipse plumage in May–July (Reeber 2015). Both sexes are flightless for about one month when all remiges (primaries and secondaries) are lost simultaneously during the summer (mainly late June–August), latest in successfully breeding females. It has been suggested that this "drastic" moult strategy is an adaption to the fact that for *Anseriformes* birds, due to the morphology of relatively small wing area and heavy body, even the loss of a few remiges would severely affect the ability to fly. Consequently, it might be better to become flightless for one month than to fly weakly for several months, as would be the duration for gradually replacing the remiges (Reeber 2015). Regardless of the strategy's background reason, moulting in aggregations decreases the risk of predation (Beauchamp 2004).

Compared to passerine birds (order *Passeriformes*), less literature is available for age and sex determination of non-passerines. The most widespread reference is the *Identification guide to European non-passerines* by Baker, published by British Trust for Ornithology (BTO) in 1993. However, there is also duck specific literature for Europe, including an analysis of wing characters by Boyd et al. (1975), and an identification manual for age and sex based on hunted ducks from the French hunting organization OFNS (Mouronval 2014). In North America, U.S. Fish and Wildlife Service organizes a project in which hunters contribute detached wings in order to determine species, sex and age composition in the duck harvest. Initialized in 1958, the sampling reached national coverage in 1961, and is still running today. Age and sex identification material based on data from this project was published in 1992 (Carney 1992), and a "pre-study" in mallards was published back in 1960 (Carney & Geis 1960). Moreover, cloacal examination is a commonly used method to sex juvenile waterfowl (Hochbaum 1942). This is, however, a technique most ringers are inexperienced with.

As part of a long-term ringing program of migratory waterfowl in Sweden, we have collected a large number of detailed photographs of the plumage of birds with known age and sex. The aim of this article is to investigate the feasibility of proposed age criteria (regarding plumage and bare parts) and to provide an accessible online photo repository for the use in field situations.

Methods

Ottenby Bird Observatory (56°12′N, 16°24′E) is situated on the southernmost cape of the island of Öland in the Baltic Sea. Just north of the bird observatory, a specially designed duck trap is used for catching ducks for scientific purposes such as ringing and sampling for avian influenza A viruses. The trap is a 30 meters long and 7 meters wide steel construction covered with (soft) nylon mesh. Wild ducks can enter through funnel-shaped entrances on one side and are attracted to the trap by bait grain and semi-domestic mallards kept in a separate compartment. Once a day, ducks that have entered the trap are herded into a separate section where they are caught, placed in individual cardboard boxes, and taken to a nearby field lab. There, a ring of steel with an identification number is closed around the tarsus, and then the age and sex of the bird is determined (if possible). Biometrical data collected for ducks include length of wing (measured from the carpal joint to the tip of the longest primary on the closed wing), "bill-head" (measured from the tip of the bill to the back of the

Table 2. Number of photographically documented autumn mallards in each sex and age category.
Antal gräsänder av olika kön och ålder som dokumenterats fotografiskt under hösten.

Age *Ålder*	1cy	2cy	3cy	4cy	5cy	6cy	7cy	Total
Male *Hane*	37	10	8	6	6	4	1	72
Female *Hona*	36	4	4	3	0	0	0	47

skull), and tarsus (measurement between the right angles of the tibiotarsus and the tarsometatarsus on one end, and the tarsometatarsus and the bent foot on the other). Most birds, including approximately one thousand mallards each year, are caught in the autumn (September–December), when Ottenby is used as a major stopover site for ducks and other birds.

This article is based on experience and pictures gathered by Ottenby Bird Observatory personnel working with the duck ringing project 2002–2015. We focused on characters that had previously been judged relevant for ageing ducks (Baker 1993, Boyd et al. 1975, Carney 1992, Carney & Geis 1960, Mouronval 2014). Characters have been verified by documentation of birds with known age, being ringed as juveniles and recaptured at older ages. The examined photo material consists of 119 mallards of various ages (Table 2).

Reliability test of age characters

To test the reliability of different age characters, ten present or former ringers at Ottenby Bird Observatory took part in a questionnaire. Photographs of aged mallards were placed according to character. In the first set-up, for each sex, ten pictures of each of nine (previously described) age characters (Table 3) were randomly selected from the archive. The selected pictures were presented one by one and the participants were to decide whether each picture referred to a first calendar year (1cy) or adult (2cy+) mallard. In this attempt, we aimed at determining the chance of correctly ageing a mallard from any single character. Therefore, 1cy birds referred to as adults were registered as incorrectly aged, even if they had completed post-juvenile moult and thus were adult according to plumage (not relevant for e.g. lesser, middle and greater coverts not included in the pre-breeding moult). In

Table 3. Summary of nine characters for four mallard age/sex categories. Swedish version below.

Character	1cy male	2cy+ male	1cy female	2cy+ female
Rectrices (RR)	Retained juvenile RR narrow, notched at tip, brown with buff edges and internal patterns.	Broad and mainly whitish-grey. Internal patterns faint, but may be dark grey and/or grizzled.	Narrow, notched at tip. Note ground colour, shape and distribution of internal patterns.	Broad and of good quality, black and warm buff. Extensive and irregular internal patterns.
Tertials (TT)	Retained juvenile TT narrow, worn and dark brownish-grey.	Broad, silvery-grey fading into chestnut and black on T1–T2.	Narrow, uniformly brown and faded, worn and frayed.	Broad and grey, T1–T2 have warm brown edges on outer vanes.
Tertial coverts (TC)	Narrow, worn and frayed, rather uniformly dull brown.	Broad, unfrayed, outer TC grey at base and chestnut at tip.	Narrow and dark brownish-grey with buffish-white tips.	Broad and fairly grey (some warmer brown), broad white tips.
Greater coverts (GC)	Narrow and fairly pointed, weak bands, seldom black on inner vane of GC3.	Broad and blunt-tipped, neat and solid black-and-white band to GC2.	Narrow and fairly pointed, black is fading in GC 3-6, buffish-white tips more common.	Broad and blunt-tipped, distinct black usually present on both vanes out to GC3.
Median and lesser coverts (MC & LC)	Dull grey-brown, comparably more worn, narrower at base and less rounded at tip.	Grey-brown with an obvious silvery hue, organized, good quality, broad at base.	Greyish-brown, some with buff edging, worn, narrow and pointed.	Cold greyish cast, some with buff edging. More likely to have chestnut hue?
Primary coverts and primaries (PC & PP)	PC narrow and pointed, dull grey-brown with grey edge.	PC fairly rounded and uniformly grey. PP not heavily worn.	PC narrow and pointed, dull grey-brown. PP heavily worn.	PC broader and rounder with contrasting grey outer vanes.
Post-humerals (PH)	Worn, narrow, dark brownish-grey.	Good quality, broader and rounder, grey.	Narrow and dark brownish-grey; adult PH similar.	Greyer, broader and rounder than in juveniles.
Bill	Greenish-yellow with blackish area on the ridge.	Bright yellowish except blackish nail at the tip.	Duller orange, indistinct saddle, no (or few) spots.	Bright orange, distinct saddle and black spots.
Feet	Dull orange.	Bright orange.	Dull orange.	Orange.

Tabell 3, forts
Sammanfattning av nio egenskaper för ålders- och könsbestämning av gräsänder. English version above.

Karaktär	1cy hane	2cy+ hane	1cy hona	2cy+ hona
Stjärtpennor (RR)	Kvarvarande juvenila RR smala, urnupna i spetsen, bruna med gulbruna kanter och inre mönster.	Breda och till större delen vitgrå. Inre mönster otydligt, men kan vara mörkgrått och/eller gråmelerat.	Smala, hack i spetsen. Notera grundfärg, form och utbredning av inre mönster.	Breda och av bra kvalitet, svarta och varmt gulbruna. Omfattande och oregelbundet inre mönster.
Tertialer (TT)	Kvarvarande juvenila TT smala, slitna och mörkt brunaktigt grå.	Breda, silvergrå, övergående i kastanjebrunt och svart på T1–T2.	Smala, enfärgat bruna och blekta, slitna och fransiga.	Breda och grå. T1–T2 har varmt bruna kanter på ytterfanen.
Tertialtäckare (TC)	Smala, slitna och fransiga, ganska enfärgat matt bruna.	Breda, ofransade, yttre TC, grå vid basen och kastanjebruna i spetsen.	Smala och mörkt brungrå med gulbruna till vita spetsar.	Breda och tämligen grå (somliga varmt bruna), breda vita spetsar.
Större täckare (GC)	Smala och rätt spetsiga, svaga band, sällan svarta på innefanet av GC3.	Breda och trubbspetsade, tydligt och kraftigt svart och vitt band till GC2.	Smala och rätt spetsiga, svart mattare hos GC 3–6, gulbruna till vita spetsar vanligare.	Breda och trubbspetsade, tydligt svart på båda fanen ut till GC3.
Mellersta och mindre täckare (MC & LC)	Matt gråbruna, jämförelsevis mer slitna, smalare vid basen och mindre rundad spets.	Gråbruna med tydlig silverton, välordnade, god kvalitet, breda vid basen.	Gråbruna, somliga med gulbruna kanter, slitna, smala och spetsiga.	Kyligt gråaktig anstrykning, somliga med gulbruna kanter. Oftare kastanjebrun anstrykning?
Handtäckare och handpennor (PC & PP)	PC smala och spetsiga, matt gråbruna med grå kanter.	PC tämligen rundade och enhetligt grå. PP ej hårt slitna.	PC smala och spetsiga, matt gråbruna. PP slitna.	PC bredare och rundare med kontrasterande grå ytterfan.
Posthumeraler (PH)	Slitna, smala, mörkt brunaktigt grå.	Hög kvalitet, bredare och rundare, grå.	Smala och mörkt brunaktigt grå; adultas PH lika.	Gråare, bredare och rundare än hos juveniler.
Näbb	Grönaktigt gul med svart på näbbryggen.	Lysande gul förutom svart nagel i spetsen.	Mattare orange, otydlig sadel, inga eller få fläckar.	Lysande orange, tydlig sadel och svarta fläckar.
Fötter	Matt orange	Lysande orange.	Matt orange.	Orange.

the second set-up, 20 individuals of each sex were selected and pictures of all the nine characters were presented for each of them. This was done in order to quantify the possibility of ageing mallards correctly with all characters at hand.

Results and Discussion

Sexing

Young mallards are generally possible to sex by field characters already before they have become independent from their mother. Females have an orange bill with a variable blackish pattern, often covering a large part of the upper mandible. In the typical case, the dark area starts close to the base of the bill (often leaving a narrow, clean orange area next to the feathering), covers the nostrils and reaches to about one centimeter short of the blackish bill tip. Adult (i.e. 2cy+) females acquire a more distinct blackish pattern and sometimes extensive blackish spotting. From the age of one month, young males develop a greenish-yellow bill, which often appear plain with a (less extensive) dark area on the central upper ridge. Adult birds are always easy to sex according to bill pattern, although genetically depleted feral birds (and perhaps other?) can deviate from the normal patterns. Males in eclipse plumage may appear superficially similar to females, but differentiate from females by blacker crown and more greyish face and neck.

As the post-juvenile moult progresses, males and females are easily separated by plumage differences. The green head, white necklace, brown breast, grey body, and black rear of males clearly distinguish them from the camouflaged plumage of females, with its buff and tawny-brown background colours, heavily marked with various black patterns. The wing pattern is, however, quite similar between the sexes, especially in 1cy birds. In general, females have browner wing coverts, some with obvious buffish edging (rare in young males, absent in adult males). The black tips to greater coverts are on average broader in males, but the white wingbar on greater coverts is longer in females and reaches the tertial coverts, whereas it barely continues beyond the secondaries in males. Only males attain grey and vermiculated scapulars, and innermost underwing coverts are broadly barred in females, but finely vermiculated in males.

Males are on average larger and heavier than females (Table 4). Within the sexes, adult mallards have on average slightly longer wings and are heavier than 1cy birds (Table 4).

Age characteristics in autumn

Young mallards are most easily recognised by the presence of juvenile tertials and rectrices. These are often noticeably narrow, frayed, and faded, although some late broods may still have quite fresh tertials and tail feathers at least until mid-autumn (October). Further, tertials and rectrices show distinctive character differences between juvenile and adult males and females, respectively. Tertial coverts are usually also quite a useful character for ageing. Juveniles start to moult TT and RR from October onwards, after which ageing gets more complicated and other characters need to be examined more closely. All features are subject to individual variation, so ageing should always be based on a summary of characters.

Males

With the pre-breeding moult, both 1cy and adult mallard males attain their species-distinctive metallic-green head that has earned the mallard its colloquial name “green-headed duck” in several languages (e.g. Chinese and Afrikaans). Although not very useful as a character, young males often retain a few juvenile feathers and thus look less “smashingly” green.

The bill is a somewhat more reliable feature, as young males tend to have a dull greenish-yellow bill with a blackish area on the ridge. In contrast, adults generally have a plain yellowish bill, except for the blackish nail at the tip. However, some young males approach spotless yellowish bills and a few adult males may show black patterns on a greenish-tinged background.

Feet colour is quite variable and should only be used as a supplement to other features. 1cy males often still have dull orange legs by late autumn, while most adults have acquired a richly orange colouration.

Central tail feathers (generally 2–3 pairs) of juvenile males are quite uniformly brownish-black with buff edging (Figure 3). Outer rectrices have slightly lighter centra, being brown or greyish-brown with broken, female-like, internal patterns. They are narrower than corresponding feathers in adults, and often frayed and notched at the tip. By October, many juveniles have moulted and attained a mainly post-juvenile (i.e. adult) tail (Figure 4), although some juvenile rectrices may be kept throughout the winter. In adults, rectrices are broader and predominantly pale grey, some having grey internal patterns (more or less faint). Central 2–3 pairs (actually R3–5 on each side, as R1–2 are black and upcurled) may have blackish-grey centra and can then be quite similar to juvenile tail feath-

Table 4. Mean ± SD values of wing length, bill-head length, tarsus length, and body mass for four different age/sex categories of mallards caught at Ottenby, SE Sweden, in autumn (September–December) 2002–2014.
Medelvärden ± SD för kroppsmått och vikt för olika kön och ålder under hösten vid Ottenby.

Age/sex category *Ålder/kön*	Wing (mm) *Vinglängd*	Bill-head (mm) *Näbblängd*	Tarsus (mm) *Tars*	Body mass (g) *Vikt*
1cy female *hona*	265.4 ± 6.2 (n = 2016)	106.0 ± 2.8 (n = 1477)	54.8 ± 1.8 (n = 1476)	988.0 ± 105.1 (n = 2024)
2cy+ female *hona*	270.1 ± 6,3 (n = 564)	106.8 ± 2.8 (n = 570)	55.2 ± 1,9 (n = 570)	1028.0 ± 114.2 (n = 649)
1cy male *hane*	280.9 ± 6.7 (n = 2674)	113.7 ± 2.9 (n = 2017)	57.6 ± 1.9 (n = 2017)	1147.7 ± 126.5 (n = 2675)
2cy+ male *hane*	287.0 ± 7.3 (n = 1177)	114.4 ± 3.1 (n = 1059)	58,0 ± 2.0 (n = 1058)	1220,0 ± 121.0 (n = 1158)

Figure 3. 1cy male, September. Typical juvenile tail with rectrices that are narrow, worn, notched at the tip, and mainly brownish in colour with buffish edging. All except central 2-3 pairs show broken internal patterns.
Typisk ung hane i september med stjärtpennor smala, urnupna och tandade i spetsen, till större delen bruna med ljusare kanter.

Figure 4. 1cy male, November. The whole tail is post-juvenile and this individual is, therefore, identical to an adult male by this character. Note broader shape, better quality, lack of notching and heavy abrasion, and no brown colouration.
Juvenil hane i november efter ruggning av stjärten. Denna individ är därför identisk med en adult hane i denna karaktär. Notera bredare form, högre kvalitet, inga urnupna spetsar, ingen kraftig förslitning och inget brunt.

Figure 5. 1cy male, September. A quite typical wing of a juvenile male. Lesser and median coverts, as well as primary coverts and primaries, are dull brownish. The latter show heavy signs of wear. Buffish tips to MC and LC do not occur in adults. *Typisk vinge av juvenil hane i september. Mindre och mellersta täckare är liksom handtäckare och handpennor mörkt brunaktiga. Handpennorna kraftigt slitna. Ljusbruna spetsar på MC och LC saknas hos adulta.*

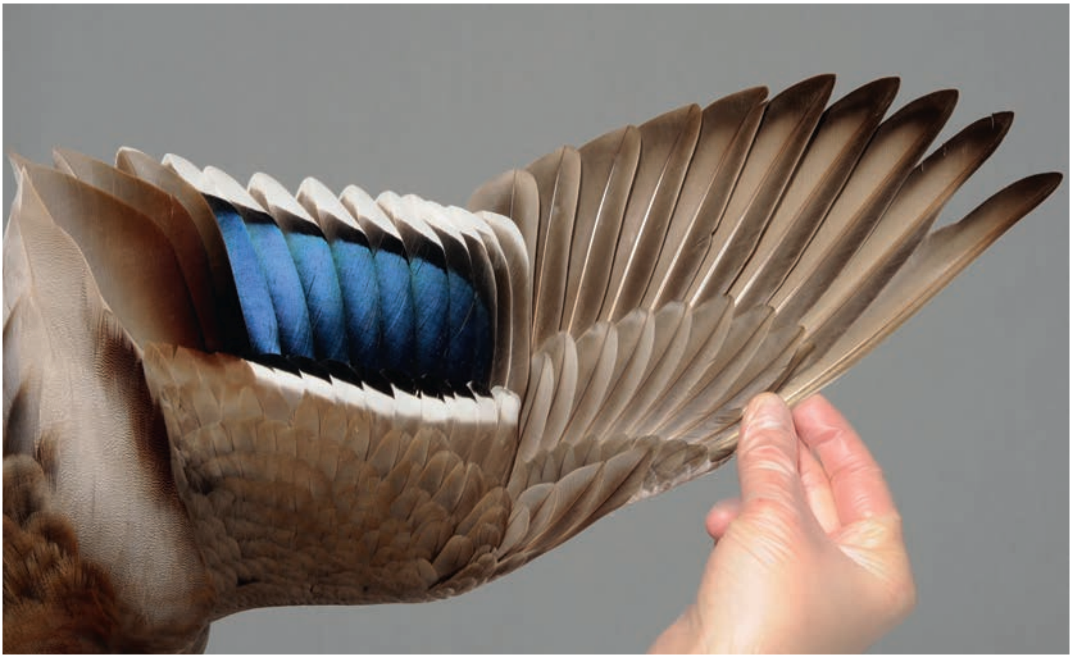

Figure 6. 2cy+ male, October. A typical and easily identified adult, showing a grey cast to the whole wing. Note broad, rounded, quite uniformly silvery-grey PC, as well as broad and blunt-tipped GC with full black tips reaching the second outermost feather. *2cy+ hane i oktober. En typiskt och lätt åldersbestämd hane. Notera breda, rundade och enhetligt silvergrå PC, liksom breda och rundspetsade GC med helt svarta spetsar ut till näst yttersta fjädern.*

Figure 7. 1cy male, October. Juvenile MC and LC are dull brown and often give an unstructured appearance. GC and MC are slightly narrower and more pointed, not widening as much towards the base as in adults. The black GC band gets much reduced in the outer part of the arm and is often not present at all in GC1–3, or present on the outer vane of the feather only.
1cy hane i oktober. MC och LC är matt bruna och ger ofta ett ostrukturerat intryck. GC och MC är något smalare och spetsigare och blir inte bredare mot basen som hos en adult. Det svarta bandet hos GC reduceras i den yttre delen av armen och saknas ofta hos GC1–3 eller finns bara på ytterfanet.

Figure 8. 2cy+ male, December. Adult GC are tipped distinctly black (on both vanes) further out than on juvenile GC, in this case to GC2 (even GC1 has black tip, which is unusual). The black-and-white generally forms a fairly neat line (although slightly irregular in this individual) and adults usually show more sharply demarcated borders to grey base of GC compared to juveniles. Note chestnut-brown LC and MC and also that outer MC are nicely rounded and widely broadening towards the base.
2cy+ hane i december. Spetsarna hos GC är tydligt svarta längre ut på båda fanen än hos juvenil, i detta fall till GC2 (till och med GC1 har svart spets, vilket är ovanligt). Gränsen mellan svart och vitt är vanligen rak men på just denna individ något orgelbunden. Adulta har vanligen skarpare gräns mot den grå basen hos GC än juveniler. Notera kastanjebuna LC och MC samt även att yttre MC är vackert rundade och bredare mot basen.

Figure 9. 1cy male, September. Juvenile tertials are narrower compared to post-juvenile TT and often abraded. Further, they have a more uniform brownish ground colour, lacking the obvious silvery-grey hue of adults. The pale tips and edges may disappear with wear. Juvenile tertial coverts are narrower, more pointed, browner, and usually more frayed compared to adults. TC may be edged buff (as in this individual) and some may even show a blackish subterminal band inside.
1cy hane i september. De juvenila tertialerna är smalare än hos adulta och ofta nerslitna. De är dessutom mera enfärgat bruna och saknar den tydligt silvergrå tonen hos adulta. De ljusa spetsarna och kanterna kan försvinna genom förslitning. De juvenila tertialtäckarna är smalare, spetsigare, brunare och vanligen mer slitna än hos adulta. TC kan ha gulbruna kanter (som hos denna individ) och somliga kan till och med uppvisa ett svartaktigt subterminalt band.

Figure 10. 2cy+ male, October. Adult tertials have a silvery-grey ground colour, fading towards blackish on inner web of T3 and T4, and towards warm brown and blackish on outer web of T1 and T2. Adult tertials are broader and generally show less signs of wear compared to juvenile TT. Adult TC are broad and grey, the outer TC usually broadly tipped chestnut, hence showing much more contrast than TC of juveniles.
2cy+ hane i oktober. Adulta tertialer har silvergrå grundfärg, som övergår i svart på innerfanet av T3 och T4 samt mot varmt brunt och svartaktigt på ytterfanet av T1 och T2. Adulta tertialer är bredare och visar vanligen mindre förslitning än hos juvenila. Adulta TC är breda och grå, och de yttre TC har vanligen breda kastanjebruna spetsar och är därför kontrastrikare än de juvenila TC.

ers. Adult RR are, however, different in quality and shape, much less brown in colour, and much more broadly edged whitish-buff.

In terms of wing colour, juvenile males (until complete wing moult at about one year of age) most often give a rather dull greyish-brown impression (Figure 5), while typical adult wings have a mainly greyish appearance with silvery-grey cast to primary coverts, primaries, and wing coverts (Figure 6). Adult PC are typically quite uniformly coloured and often stand out as the palest area. In juveniles, the centre of each primary covert is duller grey-brown in contrast to grey edge of outer vane, but this is also the case in many adults. Adult PC are more often fairly rounded, whereas PC of juveniles often are narrow and pointed. Adult PP are less often heavily abraded.

Adult median and lesser wing coverts may give a more homogeneous, neat and robust impression, while the wing covert area of juveniles often appears unorganized. This is probably related to the circumstance that juvenile MC generally show heavier signs of wear (due to poorer quality). MC of juveniles are also slightly narrower, less rounded (more angular), and less broadening towards the base compared to adults (Figure 7 and Figure 8, respectively). The ground colour of 1cy birds is dull grey-brown compared to grey-brown with an obvious silvery hue in typical adults (Figure 6). Both juvenile and adult males show some warmer brown MC and LC, warmest in some adults that tend to go towards clear chestnut (Figure 8). Juvenile median coverts may show pale edging, which is never the case in adult males.

As with MC, juvenile greater coverts often appear narrower than subsequent generations. The black pattern at tips of GC varies within and among individuals, so this character should be used with care, but black on both inner and outer vanes generally extends further out in the wing, often reaching GC2, in adult males (Figure 8). Juveniles have more irregular black markings on outer GC, and have quite often no black present on inner vane of GC3 (Figure 7). The white bar on GC is generally sharper and more neatly demarcated in adults, often reaching all the way out to GC1 (Figure 8). Both black and grey borders often appear vague and irregular in juveniles, and the white bar almost always turns diffuse (grey) on GC1-2 (Figure 7).

Juvenile male tertials are rather narrow and dark brownish-grey, lacking crisp grey colouration, and often have a pale buffish tip and edges (Figure 9). Adult tertials are broader and usually show less signs of wear (Figure 10). The ground colour is silvery-grey, fading into warm brown and black on outer vane of T1 and T2 (adjacent to the blue patch, *i.e.* the speculum, on SS). On adult T3 and T4, the grey fades into blackish towards the body (inner vane), although T4 is sometimes almost uniformly blackish-grey.

Moulted (*i.e.* adult) tertial coverts are broader and unfrayed, being of better quality compared to juvenile TC. Ground colour differences between juvenile and adult birds are similar to MC and LC, i.e. juvenile TC are rather homogeneously dull brown (Figure 9), whereas adult TC are greyer (Figure 10). Inner TC are usually duller, darker, and browner in both age categories. Typical outer TC of adults show grey bases contrasting to warm brown or chestnut tips, making them distinct from juvenile coverts. However, some adults have duller TC, and some juveniles show adult-like TC with chestnut tips.

Juvenile male post-humerals are narrow and dark brownish-grey, lacking solid grey colouration. Typical adults show grey, broader, and rounder PH. As with other feather groups (e.g. MC, TT and TC), juvenile PH are of poorer quality than corresponding adult feathers and therefore often show stronger signs of wear.

Scapulars of juvenile males are “female-patterned”, whereas they are silvery-grey with dark vermiculations in adult males, some of which have warm dark-brown tips or outer/inner web (but still vermiculated). In adult eclipse plumage, the scapular area turns female-like again, but there are always some greyish and vermiculated feathers present. It may, however, be difficult to judge whether a bird is a young male that has acquired its first adult scapulars, or an adult eclipse male. Generally, juvenile feathers in the scapular area have darker and more solid centra (similar differences as between juvenile and adult female RR).

Females

The bill patterns of female mallards show much variation, but there are some general features to support other, more reliable, age characters. Many young females have dull orange bills (Figure 11), whereas most adult females have a bright yellow-orange colour to the bill (Figure 12). As aforementioned, females have a blackish saddle, most often reaching from close to the base and falls less than a centimeter short of the equally blackish nail at the tip. The saddle is, however, very variable in both shape and intensity. Some females have diffuse and/or small saddles, whereas others have distinct and/or extensive ones. Adult females often show

Figure 11. 1cy female, September. The female bill pattern is rather variable. Juveniles usually lack dark spots and show a dull orange colour, but these characters should only be used as a supplement to more important features.
1cy hona i september. Honornas näbbmönster varierar. Ungfåglarna saknar vanligen fläckar och är matt orange. Dessa karaktärer ska dock bara användas i kombination med andra viktigare karaktärer.

Figure 12. 2cy+ female, October. Adult females often show distinct blackish spots and a bright yellow-orange colour of the bill.
2cy+ hona i oktober. Adulta honor har ofta tydliga svarta fläckar och en klart gul-orange näbb.

extensive blackish spotting (Figure 12), usually most obvious at the sides of the bill. Typical juveniles have a less distinct blackish saddle and lack obvious spotting (Figure 11).

There is a slight average difference in iris colouration between 1cy and adult females, as some young birds have very dark blackish-brown eyes. However, many 1cy females have already by their first autumn acquired the lighter brown iris usually seen in adults.

Adult females show on average a deeper orange feet colour compared to pale orange in 1cy birds, although this is less distinctive than in males. Young birds with a rich colouration are inseparable from adults.

Juvenile female tail feathers are narrow, usually obviously worn, and have a notched tip. Typically, a blackish (mainly brown when worn) internal pattern covers most of the feather centre and runs all the way to the tip along the shaft (Figure 13). Especially the outer rectrices often present a double internal pattern: basally a narrow dark core along the shaft surrounded by a buff frame, which in turn is enclosed by the main dark area, followed by buff edges. The variation is large, though. Some juvenile females show only a narrow pale core enclosed by a dark area and buff edges, and some are almost entirely dark with just a narrow pale edge. The latter pattern is most common on central pairs of RR.

Adult female tail feathers are broader and of better quality. Pale internal patterns are extensive and quite irregular in shape, often cutting through the whole feather more or less horizontally (Figure 14). Borders to dark areas often appear more diffuse. The dark may (narrowly) reach the tip along the shaft, but RR of many adult females are broadly pale-tipped. When fresh, the ground colour of RR is much blacker and warm buff compared to the brownish-black and pale buff of juveniles. However, this contrast can be surprisingly difficult to detect in some individuals. The central pair of RR may show similarity to the juvenile pattern of al-

Figure 13. 1cy, female October. This tail looks fairly fresh, but retained juvenile feathers are narrow and distinctly notched. The dark internal patterns are distinctly set off, cover most of each feather centre, and run along the shaft all the way to the tip/notch. The post-juvenile moult has started from the central pair, moulted feathers being broader, fresher, and lack notching. This is most easily seen in the third fully grown post-juvenile RR on the right-hand side, also showing a fairly horizontal pale area across the entire feather. The dark colour is obviously blacker compared to brownish in the retained RR. Usually, fresh adult feathers show warmer buff colouration as well.
1cy hona i oktober. Den här stjärten ser fräsch ut, men innehåller två generationer stjärtpennor. De juvenila är smala och tydligt urnupna i spetsen. Vidare är de mörka partierna tydligt avsatta, täcker större delen av fjädercentrum och löper längs spolen hela vägen till spetsen. Den postjuvenila ruggningen har påbörjats från stjärtens mitt. De nya (adulta) pennorna är bredare, fräschare och saknar urnypning i spetsen. Detta ses enklast hos den tredje inruggade pennan på höger sida, som också uppvisar ett horisontellt ljust fält tvärs över hela fjädern. Det mörka på de inruggade pennorna är tydligt svartare jämfört med det brunaktiga hos de juvenila fjädrarna. Nya adulta pennor är också vanligen varmare gulbruna.

most entirely dark feathers with narrow pale edge, but the difference in shape, quality, and colour is usually obvious (Figure 14). Note that young birds with a complete set of post-juvenile RR may be found from October onwards.

Adult females often give a greyer general impression of the wing than the dull brownish-grey colouration of juvenile wings. 1cy females rarely show distinctly contrasting grey outer vanes to primary coverts, which many adult females do. On the other hand, only young females occasionally have pale/whitish tips to outer vane. As in males, adult female PC are on average broader and rounder than juvenile PC. Adult primaries may also be broader and their better quality makes them less often appear heavily worn.

Patterns of female MC and LC appear more varying than in males, so age determination by this character is only possible in very few individuals. Most juveniles have a generally greyish-brown colouration (Figure 15), and some juvenile females show obviously narrow, pointed, and worn coverts not seen in adults. In contrast, some adult females show smoothly rounded MC and LC with a greyish cast that appears distinctive (Figure 16). However, on rare occasions, even young females have a greyer covert area. Both juveniles and adults may have MC and LC edged greyish-buff or warm buff (even white tips to longest MC as in Figure 16). The same is true for a male-like chestnut hue to MC and LC, which are then more uniform and lack obvious edging. This is likely more common in adult females.

As in males, juvenile female greater coverts are generally narrower and more pointed (Figure 15) compared to adult GC (Figure 16), but the black terminal band is on average narrower in females than in males. Pattern differences between age classes are similar within the sexes. Consequently, adult females have broader and more even bands than juvenile females. The black is fading in the 3–6 outer GC in juveniles (Figure 15), whereas distinct black is usually present (on both vanes) out to GC3 in adult females (Figure 16). Buffish-white tips to (mainly outer) GC are more common in juveniles. Adult females generally show more distinct border between

Figure 14. 2cy+ female, September. Sometimes two generations of feathers are present. Feathers from the older generation (R5, R7, R9–10 on the right-hand side) are bleached but still have typical adult shape and patterns, and they are not heavily worn. Note the extensive pale areas, some cutting through the feather almost horizontally, a pattern never observed in juveniles. Except for the dark end of the shaft, most rectrices are broadly tipped buff or buffish-white. Central RR are almost entirely blackish with only a narrow pale edge, a pattern more often present in juveniles, but seen in some adults too.

2cy+ hona i september. Ibland finns två generationer av adulta fjädrar samtidigt. Fjädrar från den äldre generationen (R5, R7, R9–10 på högra sidan) har blekts men har fortfarande typiskt adult utseende och de är inte kraftigt slitna. Observera de stora ljusa fälten, av vilka en del skär genom hela fjädern horisontellt, ett mönster som aldrig ses hos juveniler. Förutom de mörka spolspetsarna har de flesta pennorna breda gulbruna eller vitaktigt gulbruna spetsar. De centrala RR är nästan helt svarta med bara en smal blek kant, ett mönster som oftare ses hos juvenila men också hos vissa adulta.

black and white on GC, whereas the border to grey is often diffuse in adult females too.

Juvenile female tertials are often frayed, faded (from blackish-brown when fresh), and narrower compared to post-juvenile TT, although differences are smaller than in males. The dark brown TT of juveniles often show distinct buffish-white tip and edges (Figure 17). Adult females generally have greyer TT with obvious grey colouration on T1 and T2, especially along the shaft, and warmer brown edges on the outer vanes. Some even mirror the TT pattern of males. On adult T3 and T4, the grey fades into blackish towards the body (same pattern, is often present on T1 and T2, but less obvious and generally hidden behind T3 and T4), although T4 is sometimes almost uniformly blackish-grey (Figure 18).

Tertial coverts of juvenile females are narrower than in adult females, also showing a higher degree of wear and duller dark brownish-grey colouration (Figure 17). Adult TC have either a greyer or warmer brown colouration. The tips of outer juvenile TC have buffish-white tips, but they do not generate a pure white continuum with the white GC wingbar present in adult females (Figure 18). Inner TC may have only a narrow buffish-white tip even in adult females. Also in females, juvenile TT and TC may be replaced as autumn proceeds. New feathers contrast in both shape and colour against retained juvenile feathers.

Female post-humerals show less obvious age-differentiation compared to males, but differences still persist: typical juvenile PH are narrow and dark brownish-grey, whereas typical adult PH are greyer, broader, and rounder. Again, juvenile feathers are of poorer quality, so juvenile PH often show heavier signs of wear compared to adult PH.

The longest two scapulars look similar to PH, although the former are more pointed, and the differences between the two age classes follow the same pattern as in PH. Feather patterns on the rest of the scapular area are more complex in adult fe-

Figure 15. 1cy female, October. Juvenile LC and MC are generally greyish-brown. The narrower and slightly more pointed shape of juvenile coverts may be present in all coverts shown here, but is usually more obvious in GC. The black tips usually form a rather uneven band that is much reduced in the outer part of the arm, in this case no black in GC1–4 and diffuse black in GC5–6. Note growing inner TC with pure white tip.
1cy hona i oktober. Juvenila LC och MC är vanligen gråbruna. Det smalare och spetsigare utseendet hos juvenila täckare kan finnas hos alla täckare men är vanligen tydligast hos GC. De svarta spetsarna bildar vanligen ett ganska ojämnt band som är starkt reducerat i yttre armen, i detta fall saknas svart hos GC1–4 och är diffust hos GC5–6. Notera den växande inre TC med rent bit spets.

males, having more internal markings (as in RR), and the pale colour is warmer buff. This is, however, a quite unreliable character due to the fact that scapulars are among the first to be moulted.

Reliability test of age characters

Tertials and rectrices show distinctive character differences between juvenile and adult males and females, respectively. Tertial coverts are usually also quite distinguishable, especially in females. These characters have been pointed out in previous publications dealing with ageing of ducks (Baker 1993, Boyd et al. 1975, Carney 1992, Carney & Geis 1960, Mouronval 2014). However, in late autumn (mainly October–December), 1cy birds acquire new rectrices, tertials, tertial coverts, posthumerals, and scapulars, which are identical in appearance to adult feathers. Therefore, already from October some 1cy birds may not be safely identified to age. The other described criteria are generally more subtle and include subjective judgements, except for individuals showing extremely typical features. The last juvenile wing coverts and remiges are replaced during the second summer, i.e. when birds are approximately one year old, and may thus be used for ageing until then.

After TT, RR, and TC, the shape and patterns of GC seem to be the most useful character. In an attempt to propose statistically detectable features for ageing mallards, the black-and-white surface area of GC2 and GC3 was determined the single most reliable character for both males and females (Krapu et al. 1979). The detailed measurement method of that study (executed on feathers removed from birds) is, however, neither suitable nor possible to use on the individual level in field situations.

In the blind test we conducted on experienced ringers, no single character identified all mallards to age correctly (Table 5). For example, only 50% of the pictures of male and 57% of female MC and LC were correctly aged. The corresponding num-

Figure 16. 2cy+ female, October. MC and LC are generally more greyish compared to juveniles. LC, MC and GC are slightly broader with a somewhat blunter tip. The black tips are usually reduced on the outer GC, but are generally present on both vanes to GC3 (GC2 in this individual). There is usually a sharper contrast between the black and white of each adult GC. Note also the broad and fresh TC with pure white tips.

2cy+ hona i oktober. MC och LC är i allmänhet gråare än hos juvenila. LC, MC och GC är något bredare med trubbigare spetsar. De svarta spetsarna är vanligen reducerade på de yttre GC, men finns i allmänhet på båda fanen hos GC3 (GC2 hos denna individ). Kontrasten mellan svart och vitt hos varje adult GC är vanligen skarpare. Observera också de breda och fräscha TC med rent vita spetsar.

bers for PH was 51% and 48%, respectively. As presumed, TT were most correctly identified: 85% of the male and 89% of the female pictures. Given that one 1cy male had acquired complete adult TT, the actual correct feather age was 94% in males. The frequency of correct answers was surprisingly low for male RR (71%), but considering that one young bird was "misidentified" by all participants due to completed moult and the fact that two adult birds looked as if they had retained juvenile RR due to wear and dirt, the result was in the expected range. The individual performance by the participants varied between 59% and 81% for the single character test in males, and between 58% and 87% in females. It deserves to be mentioned that judging age of mallards from a single picture does not mirror a real field situation, when examination includes the collective judgement of several (if not all) criteria at the same time.

In the second set-up, when all age characters were presented for 20 mallard individuals, the frequency of correct answers varied between 80% and 100% (average 91%) in males. The corresponding figures in females were 85–100% (average 95%). The misidentified individuals mainly referred to either 1cy birds that had replaced all of their RR and TT, or adults that, for one reason or another, had juvenile-like rectrices and tertials. The lower frequency of correct answers in males may be explained by a higher number of adult individuals represented among the pictures, namely 12 out of 20 in males compared to 6 out of 20 in females. (This may also include a confirmation bias, as the experienced ringers would expect a higher frequency of juvenile birds, given the situation in the field where juveniles are in excess.) As aforementioned, juveniles are more safely identified to age, since present juvenile feathers are usually easy to detect. In the field, difficult individuals are left unaged. Finally, it should be noted that ageing from pictures is likely to give more incorrect determinations than in a field situation due to e.g. lighting.

Figure 17. 1cy female, October. The juvenile tertials are quite narrow and show obvious signs of wear. The colour is mainly dark brown, often with distinct pale edges or tips (most obvious on the inner TT). The tertial coverts are also slightly narrower and more worn than those of adults. In this female, buffish-white fringes are present on all large tertial coverts, broadest on outer TC producing continuum with the greater coverts wingbar, although less conspicuous than in adult females.
1cy hona i oktober. De juvenila tertialerna är smala och tydligt slitna. De är mörkt bruna med ljusa kanter och spets (tydligast hos de inre TT). Tertialtäckarna är också något smalare och mer slitna än hos adulta. Hos denna hona har alla större tertialtäckarna vitaktigt gulbruna kanter, bredast hos de yttre TC. De bildar en enhet med större vingtäckarnas vingband fast mindre tydligt än hos gamla honor.

Conclusions

Based on our study, we conclude that differences in juvenile tertials and tail feathers are the most easily detectable age characters for both sexes of mallards. Other characters were subject to large variation, and should not be used other than as supportive criteria. Mallards with only post-juvenile TT and RR may preferably be left unaged, if not showing typical juvenile criteria in other features. Judging age of mallards by single characters is often impossible, especially from photos, and some individuals may even be challenging with all characters at hand.

Supporting information

The collective findings have been condensed into a short key and legends of 82 illustrative pictures of mallard characters in Ottenby Bird Observatory's online digital identification guide. This can be found at http://www.ringersdigiguide.ottenby.se/anas-platyrhynchos/OS.

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Sammanfattning

Gräsanden *Anas platyrhynchos* är världens talrikaste simand. Dess utbredning täcker i princip hela norra halvklotet och den saknas egentligen bara allra längst i norr, i ökentrakter samt i tropikerna. Den europeiska populationen uppskattas till 7,5 miljoner individer (Wetlands International 2006, 2015), vartill skall adderas flera miljoner gräsänder som

Figure 18. 2cy+ female, October. Some adult females develop silvery-grey, male-like, tertials, even with a tinge of chestnut on the outer web of T1 and T2. Note distinctly dark inner web of T3 and quite uniformly dark brownish-grey T4. The tips of the outer TC are distinctly and broadly tipped pure white. Also note two generations of adult feathers in the scapular area, older ones being bleached and thus paler.
2cy+ hona i oktober. Vissa adulta honor utvecklar silvergrå, hanliknande tertialer, även med kastanjebrunt på yttre fanen av T1 och T2. Observera det tydligt mörka innerfanet hos T3 och den enfärgat brungrå T4. Spetsarna hos de yttre TC breda och rent vita. Notera också två generationer av adulta fjädrar bland skulderfjädrarna, där de äldre är blekta.

Table 5. Percentage of correctly aged mallards when showing just one character for each individual (n = 100 males and 100 females). 1cy birds with completed moult (in RR, TT, TC or PH) were still considered juvenile and thus counted as incorrectly aged if judged to be adult (although the latter is actually correct according to feather generation).
Procent rätt åldersbestämda gräsänder vid användning av bara en egenskap för varje individ (100 hanar och 100 honor). Individer av ålder 1cy som ruggat RR, TT, TC eller PH betraktades fortfarande som ungfåglar och räknades in bland de felaktigt åldersbestämda om de bestämts till adulta (trots att det senare är rätt baserat på fjädergeneration). Svensk fjäderterminologi i Tabell 1.

Character *Karaktär*	% correctly assigned *% rätt åldersbestämda*	
	Male *Hane*	Female *Hona*
Rectrices (RR)	71	84
Tertials (TT)	85	89
Tertial coverts (TC)	73	78
Greater coverts (GC)	76	85
Median and lesser coverts (MC & LC)	50	57
Primary coverts and primaries (PC & PP)	59	61
Post-humerals (PH)	51	48
Bill *Näbb*	70	70
Feet *Fötter*	74	62
Total	68	70

sätts ut för jakt varje år (Champagnon et al. 2013). Gräsanden är föremål för omfattande studier inom bl.a. ekologi (Gunnarsson et al. 2006), jakt (Nichols et al. 2007) och epidemiologi (Wallensten et al. 2007). I alla dessa avseenden är åldersbestämning mycket betydelsefull för korrekta analyser. Kännedom om ändernas ruggningscykel är avgörande för att kunna åldersbestämma gräsänder.

Med utgångspunkt från 119 fotodokumenterade gräsänder med känd ålder (ringmärkta som 1cy vid Ottenby fågelstation) beskriver vi i denna artikel nio användbara dräktkaraktärer för åldersbestämning av gräsänder på hösten. För att kvantifiera pålitligheten hos respektive karaktär genomfördes ett test där tio representanter ur fågelstationens ringmärkningspersonal fick bedöma ålder på fotograferade fåglar. I en första studie fick deltagarna se tio bilder på var och en av de nio karaktärerna och bedöma huruvida den fotograferade individen var ung eller gammal (totalt 90 bilder på hanar och 90 bilder på honor). I nästa studie skulle tjugo gräsandsindivider av varje kön åldersbestämmas med tillgång till bilder på alla nio karaktärerna.

Resultaten av den första studien visade att när bara en enstaka dräktdetalj kunde studeras blev osäkerheten i åldersbestämningen stor och bara 51–85 % av hanarna respektive 48–89 % av honorna placerades i rätt ålderskategori. (Notera att 1cy-fåglar som ruggat till postjuvenil dräkt bedömdes som felaktigt åldersbestämda utifall de bestämdes till adulta, även om beslutet alltså egentligen var korrekt med avseende på fjädarnas utseende.)

För både hanar och honor var utfallet sämst för posthumeraler, där man i genomsnitt alltså bara bedömde ungefär hälften av bilderna rätt, medan bilderna på tertialer renderade flest korrekta svar (85% respektive 89%). I den andra studien där alla nio karaktärerna kunde studeras samtidigt blev 91% av hanarna och 95% av honorna placerade i rätt åldersgrupp.

Så länge det finns kvarvarande juvenila tertialer eller stjärtpennor är sådana relativt lätta att identifiera och många gräsänder, såväl hanar som honor, kan därmed åldersbestämmas korrekt på hösten. Inom övriga karaktärer förekommer så stor variation att endast mycket typiska individer kan bestämmas med säkerhet. Allteftersom ruggningen fortskrider får även ungfåglar (från oktober och framåt) tertialer och stjärtpennor av samma utseende som äldre gräsänder. Detta komplicerar åldersbestämningsmöjligheterna och individer som ruggat färdigt dessa fjädergrupper bör lämnas obestämda till ålder om det inte föreligger övertygande bevis inom andra karaktärer.

En bestämningsnyckel och ett större bildmaterial av gräsänder finns tillgängligt i Ottenby fågelstations digitala guide för ålders- och könsbestämning av fåglar i handen på webbadressen http://www.ringersdigiguide.ottenby.se/anas-platyrhynchos/OS.

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Bird fauna changes in a small urban park in South Sweden, over a period of 34 years

Förändringar i fågelfaunan i en park i södra Sverige över en tidsperiod om 34 år

ULF OTTOSSON & MAGNUS AHLGREN

Abstract

The density of birds in urban landscapes, including parks, is poorly known. In this study we present surveys of a small city park in south Sweden. The surveys were conducted in April–June 1980 and in May–June 2014. The study plot has an area of 5.1 ha. We found 143 pairs of 22 species in 1980 and 151 pairs of 26 species in 2014 (2800 and 2960 pairs/km$^{2)}$. *Turdus pilaris* was the most common species in 1980 and *Columba palumbus* in 2014. Three species showed significant decline: *T. pilaris* 38 to 15 pairs, *Fringilla coelebs* 12 to 5 pairs and *Carduelis chloris* 18 to 12 pairs, while *Turdus merula* increased from 11 to 15 pairs. Two species, *T. merula* and *Sylvia atricapilla*, nesting both 1980 and 2014, showed increasing numbers that are consistent with these species' population increase in Sweden. The bird densities in this study are considerably higher compared to what is generally observed in southern Sweden. Further study is required to establish whether the high densities are due to chance or edge effect.

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Introduction

There is a general interest among ornithologists, amateurs and professionals alike, to know and understand bird abundance and its variation over time and space. Recent work in Sweden has focused on assessing the population size of all breeding species and the trends in these numbers (e.g. Ottvall et al. 2009, Ottosson et al. 2012, Green & Lindström 2015). One habitat for which the knowledge of bird densities is relatively poor is urban areas, such as city parks. In Sweden urban areas, or "built-up areas", constitute about 3% of the total land area (SCB 2013). This is only a small fraction of Sweden, but it is the habitat in which most people live. In contrast, in the recent book on the number of breeding birds in Sweden (Ottosson et al. 2012), only five of more than 700 references (0.7%) are about birds in urban areas, none of which are dedicated specifically to parks. There is some general work on birds in parks in Sweden (e.g. Wirén 1994, Carlsson 2006) but these works are more qualitative than quantitative (but see Marling 2014). Outside Sweden we find more quantitative work (e.g. Jokimäki 1999 and many references therein), but compared to the total number of publications on bird abundance and population variation in birds, data from urban areas are scanty.

In this study we present bird population densities in a small urban park in South Sweden, surveyed in 1980 and 2014 by the same observers. Over this period the vegetation structure in the park changed relatively little.

In the running text, we use only the briefer English names of birds (e.g. Jackdaw rather than Western Jackdaw); the full English names are given together with the scientific and Swedish names in Table 1.

Method

This study was carried out in April to June 1980 and May to June 2014, with 12 visits in 1980 and ten visits in 2014. Visits were done between 05.00 and 08.00 with one or both authors as observers. Each visit took about two hours.

We used territory mapping (e.g. Bibby et al. 2000), with the objective to estimate population densities for each species. The location of each individual bird was recorded during the consecutive visits and the locations were then combined into species maps to estimate the number of individual territories. Observations of counter-singing males and aggressive interactions were particularly important to distinguish multiple territories of the same species from multiple observations of the same bird, since they help define territory borders. Many observers enjoy this approach because of the intimate knowledge of the local bird community that they develop from repeated visits, and since there are no strict time limits there is freedom to double-check observations and further investigate unusual sightings.

The study area, "Tivoliparken", covers an area of 5.1 ha (Figure 1) and is situated in the central parts of Laholm (56°31'N, 13°2'E), a small city with about 6 000 inhabitants in South Sweden. The park follows a natural ravine at the bottom of which runs a little stream. Edging an open sports ground in the south, it forms a 600 metres long crescent that stretches towards the north-east, with its curve inclining towards the north and then to the north-west. In the south-west it follows a cemetery and in the north it meets the city centre, otherwise the park is surrounded by urban housing, mostly consisting of mature gardens with detached single-family homes.

The difference in altitude from its highest point to its lowest just exceeds 20 meters with the high point along the edge of the graveyard and its lowest point in the north where the stream escapes into a culvert under the city center.

The park mainly consists of beech trees *Fagus sylvatica*, most of which remain since the construction of the park in the late 19th century. The second most frequent tree species is birch *Betula pendula*, which surrounds the clearings to the north and south. Adjacent to the clearings are dense shrubbery of rhododendron *Rododendron sp.* and other exotic species of shrubs, such as thuja *Thuja sp.* and cypress *Cupressus sp.* Along the stream grow black alder *Alnus glutinosa* and smaller shrubs of exotic varieties. The stream's edge also displays a dense growth of herbs, such as butterbur *Petasites hybridus*.

Subject to a few important exceptions, the structure of the park and its vegetation has remained unchanged since 1980. The most striking difference is the removal of the single-track railroad embankment which until 1994 formed the eastern border of the park. Aside from a slight increase of

Figure 1. A satellite image of the park, "Tivoliparken".
Satellitfoto av Tivoliparken.

the area accessible to the public, in biotope terms the removal of the embankment is probably of little or no significance. Another change which is worth mentioning since it may have led to some slight changes of breeding conditions for some bird species, is that in 1980, virtually all the open areas in the south were constituted by mowed lawns. Since then, the local park administration has deliberately left a few patches untouched by the lawn mowers. This has allowed for a relatively dense growth of grass, herbs and lower bushes in these areas.

Results

In total, we recorded 143 pairs of 22 species in 1980 and 151 pairs of 26 species in 2014 (Table 1).

The overall breeding density was 2800 pairs/km^2 in 1980 and 2960 pairs/km^2 in 2014. The highest densities for single species was that of Fieldfare with 745 pairs/km^2 in 1980 and that of Wood Pigeon with 313 pairs/km^2 in 2014 (Table 2).

Eight species were found breeding in 2014 but not in 1980: Mallard, Mew Gull, Collared Dove, Magpie, Rook, Jackdaw, Lesser Whitethroat and

Table 1. The number of breeding pairs of each species for the year 1980 and 2014.
Antal häckande par av varje art åren 1980 och 2014.

	1980			2014		
	min	max	est.	min	max	est.
Mallard *Anas platyrynchus* Gräsand			0			1
Mew Gull *Larus canus* Fiskmås			0			1
Eurasian Collared Dove *Streptopelia decaocto* Turkduva			0			1
Common Woodpigeon *Columba palumbus* Ringduva	18	20	19	15	17	16
White Wagtail *Motacilla alba* Sädesärla			2			0
Dunnock *Prunella modularis* Järnsparv			1			0
Common Starling *Sturnus vulgaris* Stare			11			1
Eurasian Magpie *Pica pica* Skata			0			1
Rook *Corvus frugilegus* Råka			0	35	40	38
Western Jackdaw *Corvus monedula* Kaja			0			1
Eurasian Nuthatch *Sitta europaea* Nötväcka			2	3	4	3
Fieldfare *Turdus pilaris* Björktrast	35	40	38	14	16	15
Common Blackbird *Turdus monedula* Koltrast	10	12	11	14	16	15
European Robin *Erithacus rubecula* Rödhake			1	2	4	3
Common Redstart *Phoenicurus phoenicurus* Rödstjärt			2			4
Lesser Whitethroat *Sylvia curruca* Ärtsångare			0	1	3	2
Eurasian Blackcap *Sylvia atricapilla* Svarthätta			2	4	6	5
Garden Warbler *Sylvia borin* Trädgårdssångare			1			0
Common Chiffchaff *Phylloscopus collybita* Gransångare			0	3	5	4
Willow Warbler *Phylloscopus trochilus* Lövsångare	5	7	6	5	7	6
Icterine Warbler *Hippolais icterina* Härmsångare	3	5	4			2
Pied Flycatcher *Ficedula hypoleuca* Svartvit flugsnappare			2			1
Eurasian Blue Tit *Cyanistes caeruleus* Blåmes			3	3	4	3
Marsh Tit *Poecile palustris* Entita			1			0
Great Tit *Parus major* Talgoxe	3	5	4	4	6	5
Eurasian Tree Sparrow *Passer montanus* Pilfink			1	2	4	2
Common Chaffinch *Fringilla coelebs* Bofink	10	14	12	5	7	5
European Greenfinch *Chloris chloris* Grönfink	16	20	18	11	13	12
European Goldfinch *Carduelis carduelis* Steglits	1	2	1	1	2	1
Hawfinch *Coccothraustes coccothraustes* Stenknäck	1	2	1	2	4	3
Total			143			151

Table 2. Breeding densities of birds in Tivoliparken, Laholm, Sweden. Note that 1 breeding pair automatically leads to a density of 19.6 p/km^2 due to the small size of the park. For many species this is a comparatively high density when extrapolated for larger areas and the densities should therefore be treated with caution.

Häckningstätheter i Tivoliparken, Laholm. Observera att 1 par ger tätheten 19,6 p/km^2 beroende på parkens lilla areal. För många arter blir tätheterna jämförelsevis höga när de räknas upp till större areal och de måste användas med försiktighet.

	Pairs/km^2	
	1980	2014
Anas platyrynchus		19.6
Larus canus		19.6
Streptopelia decaocto		19.6
Columba palumbus	372.5	313.7
Motacilla alba	39.2	
Prunella modularis	19.6	
Sturnus vulgaris	215.7	19.6
Pica pica		19.6
Corvus frugilegus		745.1
Corvus monedula		19.6
Sitta europaea	39.2	58.8
Turdus pilaris	745.1	294.1
Turdus monedula	215.7	294.1
Erithacus rubecula	19.6	58.8
Ph. phoenicurus	39.2	78.4
Sylvia curruca		39.2
Sylvia atricapilla	39.2	98.0
Sylvia borin	19.6	
Phylloscopus collybita		78.4
Phylloscopus trochilus	117.6	117.6
Hippolais icterina	78.4	39.2
Ficedula hypoleuca	39.2	19.6
Cyanistes caeruleus	58.8	58.8
Poecile palustris	19.6	
Parus major	78.4	98.0
Passer montanus	19.6	39.2
Fringilla coelebs	235.3	98.0
Chloris chloris	352.9	235.3
Carduelis carduelis	19.6	19.6
C. coccothraustes	19.6	58.8

Chiffchaff. Four species were breeding in 1980 but not in 2014: White Wagtail, Dunnock, Garden Warbler and Marsh Tit.

Three species showed substantial decreases: Fieldfare from 38 to 15 pairs, Chaffinch from 12 to five pairs and Greenfinch from 18 to 12 pairs. The only substantial increase was that of the Blackbird, 11 to 15 pairs, and the Blackcap, 2 to 5 pairs.

Discussion

Overall, the number of species and the number of breeding pairs was quite similar between the two years, but there was high turnover in the species composition. Eight species, about 30%, were new in 2014 and did not breed in 1980 and four species, 16%, that bred in 1980 did not breed in 2014.

Some, or even most, of these changes are probably due to stochastic effects because the area is small. But for two species, the Rook and the Chiffchaff, the change is due to a true increase of their regional populations. Further, in the case of the Rook, a contributing factor is likely also to be a redistribution of birds from farmland into urban areas (Bengtsson 2014). The southern subspecies of Chiffchaff *Ph. c. collybita* did not even breed regularly in Sweden in 1980 (Ottvall et al. 2009, Ottosson et al. 2012).

For this kind of data set it is slightly ambiguous to draw conclusions about general trends, but the declines of more than 50% of both Fieldfare and Chaffinch seem large enough to indicate that something may have happened on a larger scale. The Fieldfare, as colony breeder, is known to be nomadic in the sense of changing breeding sites from year to year, at least in northern Sweden (Å. Lindström pers. com.). However, the general trend for both species in Sweden over this period is close to zero (Green & Lindström 2015) so the reason for the decline observed in this study is likely to be found in the local environment.

Another species which showed a decline was the Greenfinch and in this case the local change was similar to the national one. The cause of the decline has been suggested to be the parasite *Trichonomas gallinae* (Lehikoinen et al. 2013, Green & Lindström 2015).

Two species, the Blackbird and the Blackcap, showed positive trends that are worth mentioning and both correspond to general positive trends in Sweden. The Blackbird in particular has become relatively more common in urban areas and the Blackcap has doubled its national population in the last 30–40 years (Ottosson et al. 2012, Green & Lindström 2015).

The bird density found in the study plot is about ten times higher compared to what is generally observed in southern Sweden. And it exceeds the densities found in several first class woodland habitats, for example a plot in Ottenby Lund (1509 pairs/km^2 on average over 40 years; Bengtsson & Lindström 2012). The fact that Tivoliparken shows a still higher density may be due to chance or because a few border territories have been erroneously included. Just one extra pair will here mean a density increase of 20 pairs/km^2.

The distribution of animals in patchy environments has been a central theme in ecology for a long time (e.g. Fretwell & Lucas 1970, Charnov 1976). Generally, the population size and diversity decrease with patch size (e.g. Robinson et al. 1995) because of so called area sensitive species (Robbins et al. 1989), i.e. species that require territories larger than the patch. But other species may even be more abundant in smaller habitat fragments (e.g. Loman & von Schantz 1991) just because they happen to be in the small patch of study, though they actually utilize or need a larger area to sustain themselves. The high densities shown here for an urban park call for further studies of birdlife in parks and urban areas in general. Are the high densities just due the chance and/or edge effect or is it actually truly high densities due to a good environment or “crowding”.

Our density for the Fieldfare is higher than the highest reported in Ottosson et al. (2012), which was 520 pairs/km^2 (Forslund 2003), also in a very small area of 4.8 ha. The general density for Fieldfare in Sweden is in the range of 5–35 pairs/km^2 (Ottosson et al. 2012). Similarly, our densities for Common Woodpigeon were 370 and 310 pairs/km^2, respectively, which are very high compared to the highest found in Ottosson et al. (2012) which was 56 pairs/km^2, also in a small area of only 10 ha (Fritz 1990). As a comparison, our density for the most common bird in Sweden, the Willow Warbler, 120 pairs/km^2, is well within the range of the commonest densities in Sweden which is 7–170 pairs/km^2 though the general density is within 50–80 pairs/km^2 (Ottosson et al. 2012).

Species like Sparrowhawk *Accipiter nisus,* Common Buzzard *Buteo buteo,* Wryneck *Jynx torquila* and Tree Pipit *Anthus trivialis* were not found in Tivololiparken even though the habitat is right. This is probably a combined effect of small size (area sensitive species) and that the city and the park constitute an island in a large intensively used farmland where these species do not breed and hence there is no pool of these species that can provide the park with recruits.

As studies of birds in urban areas are scarce even though it is a habitat that increases by the day and where many birds spend their lives, more studies are needed to understand what determines the species distribution and abundance in this habitat.

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Sammanfattning

En landskapstyp där kännedomen om täthet hos förekommande fågelarter är förhållandevis dålig är tätbebyggelse, inklusive stadsparker. I Sverige utgör tätbebyggda områden omkring 3% av den totala landytan. Som jämförelse kan nämnas att i den nyligen utkomna boken *Fåglarna i Sverige; antal och förekomst* är det endast fem av fler än 700 referenser (0,7%) som hänvisar till fåglar i bebyggda områden; ingen av dessa handlar specifikt om fåglar i parker. Det finns ett antal allmänna studier om fåglar i parker i Sverige men dessa studier är kvalitativa snarare än kvantitativa. I den här studien presenterar vi två undersökningar av populationstäthet hos fågelarter i en mindre stadspark i södra Sverige, genomförda 1980 och 2014 av samma observatörer. Från tillfälliga besök i mellantiden hade vi sett nya arter, som till exempel gransångare hade börjat häcka i parken, men vi visste inte något om variationer i antalet häckande fåglar eller om några tidigare observerade arter hade försvunnit.

Studien genomfördes i april till juni 1980 och i maj till juni 2014, med 12 besök 1980 och tio besök 2014.

Vi använde revirkartering för att uppskatta populationstätheter för var och en av de förekommande fågelarterna inom det undersökta området. Enskilda fåglars vistelseplatser noteras under upprepade besök varefter de förs över till artkartor så att antalet revir kan uppskattas. Observationer av samtidigt sjungande hanar och revirstrider är särskilt viktiga för att särskilja flera revir av samma art från flerfaldiga observationer av samma individ, eftersom sådana observationer ger underlag för att fastställa revirgränser.

Den studerade ytan "Tivoliparken", har en area på 5,1 ha (Figur 1) och är belägen i centrala Laholm, en liten halländsk stad med ca 6 000 invånare. Parken följer en naturlig bäckravin och domineras av bok där de flesta av träden finns kvar sedan parken grundlades i slutet av 1800-talet. Det näst vanligaste trädet är björk som omger två större öppna ytor i norr och söder. I anslutning till de öppna ytorna finns tjocka buskage av rhododendron och andra exotiska busksorter som exempelvis thuja och cypress. Längs bäcken växer klibbal och lägre buskage av exotiska växtsorter. Längs bäckens brinkar syns även täta bestånd av örter som exempelvis pestskråp. Med ett fåtal undantag är parkens struktur och beväxning oförändrad sedan 1980.

Det sammantagna resultatet var 143 par av 24 arter år 1980 och 151 par av 27 arter år 2014. (Tabell 1).

Den sammanlagda häckningstätheten var 2800 par/km^2 år 1980 och 2960 par/km^2 år 2014, med björktrast på 745 par/km^2 som den högsta tätheten år 1980 och ringduva med 313 par/km^2 år 2014 (Bilaga 1).

2014 häckade åtta arter som inte häckade 1980: fiskmås, turkduva, skata, råka, kaja, ärtsångare och gransångare. Fyra arter häckade 1980 men inte 2014: sädesärla, järnsparv, trädgårdssångare och entita.

Tre arter uppvisade betydande minskningar: björktrast från 38 till 15 par, bofink från 12 till 5 par och grönfink från 18 till 12 par, medan koltrast hade ökat från 11 till 15 par.

Antalet arter och antalet häckande par var relativt lika under de båda åren, men sammansättningen av arter uppvisade större skillnader. Åtta arter, ungefär 30%, var nya 2014 jämfört med 1980 och fyra arter, 16%, som häckade 1980 fanns inte kvar 2014. Några, eller rent av de flesta, av dessa förändringar beror på tillfälligheter; eftersom parkens yta är så liten. Två av arterna; råka och gransångare, har dock tillkommit som en följd av den ökade utbredningen och förekomsten hos dessa två arter. När det gäller råkan är det dessutom troligt att häckningarna har påverkats av att arten är på väg mot nya habitat; från jordbrukslandskap till bebyggelse. När det gäller gransångaren så förekom dess sydliga ras inte ens som regelbunden häckfågel i Sverige 1980.

Med tanke på den begränsade datamängden är det svårt att dra några säkra slutsatser beträffande trender. De observerade minskningarna på över 50% för både björktrast och grönfink är dock tillräckligt stora för att läggas till grund för slutsatsen att något har inträffat. Björktrasten, som kolonihäckare, är känd för att vara nomadisk på så sätt att hela kolonier kan flytta från ett år till ett annat. Redan 1983 noterade en av författarna (MA) att antalet häckande björktrastar i parken hade minskat med cirka 50%. Den allmänna trenden för båda dessa arter är dock stabil, så minskningarna i den här studien beror troligen på förändringar av lokala förhållanden. En annan art som uppvisar en minskning är grönfink. I motsats till de tidigare nämnda arterna minskar den här arten i Sverige som helhet, troligen på grund av parasiten gulknopp.

Två arter, koltrast och svarthätta, häckade både 1980 och 2014 och visar ökande siffror som står i överensstämmelse med dessa arters ökande förekomster i Sverige. Koltrasten har ökat påtagligt i bebyggda områden och antalet svarthättor har fördubblats de senaste 30-40 åren.

Fågeltätheterna i den här studien är ungefär tio gånger högre jämfört med motsvarande siffror tidigare kända från studier i södra Sverige i allmänhet (2800 par/km^2 jämfört med exempelvis 1509 pairs/km^2 i genomsnitt över 40 år i Ottenby Lund). På en liten yta som den här, blir tätheterna lätt uppblåsta på grund av slumpmässiga faktorer och en relativt stor kantzon. Ett enda par innebär en täthet av 20 par/km^2 vilket redan det är en hög siffra för de flesta arter. Fördelningen av djur i oregelbundna miljöer har varit ett centralt tema inom ekologiforskningen under lång tid. I allmänhet minskar populationsstorlek och diversitet med ökande biotopytor för så kallade ytkänsliga arter men även andra arter kan uppvisa relativ sett högre förekomster i små fragment av lämpliga habitat. De höga fågeltätheter som förekommer i stadsparken i den här studien visar på behovet av ytterligare studier av fågelförekomster i tätbebyggelse i allmänhet och i parker i synnerhet.

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Habitat selection of Ortolan Buntings *Emberiza hortulana* on forest clear-cuts in northern Sweden

Biotopval hos ortolansparv Emberiza hortulana *på kalhyggen i nordsvenska skogar*

JULIANNA ANNE PERCIVAL & SVEIN DALE

Abstract

Ortolan Buntings *Emberiza hortulana* in Sweden used to occur mainly in farmland. Nowadays, a large proportion of the remaining population is found on forest clear-cuts in northern Sweden. Few studies have identified the types of clear-cuts that Ortolan Buntings prefer and whether these habitats are used for both breeding and foraging. We recorded presence and abundance of ortolan buntings on clear-cuts in Västerbotten County, northern Sweden. We sampled 123 clear-cuts (present N = 48, absent N = 75; total of 93–100 territories) and our results showed that clear-cut size, the number of remaining trees, bare soil percentage (≥10%) and narrow-leaved grass vegetation had a positive influence on ortolan bunting occupancy. The number of territories on clear-cuts was positively related to clear-cut size and number of remaining trees. Proximity to nearby farmland did not influence occupancy on clear-cuts. Behavioural observations indicated that the forest clear-cuts were used for both nesting and feeding. We discuss these results in relation to forest management policies and conservation of the ortolan bunting.

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Introduction

The Ortolan Bunting *Emberiza hortulana* is a long-distance migratory bird currently experiencing large population declines and range contractions across most of Europe (Menz & Arlettaz 2011). Ortolan Buntings were once common in large parts of Sweden. However, changes in farming practices and agricultural intensification has led to widespread habitat loss and deterioration of suitable breeding habitat for both the Ortolan Bunting and farmland species in general and subsequent population declines (Svensson et al. 1999, Wretenberg et al. 2006, Green & Lindström 2014). Consequently, the Ortolan Bunting is classified as vulnerable on the Swedish red list (ArtDatabanken 2015), and the current population size is only 2600–5000 breeding pairs (Ottosson et al. 2012, Martin Green, pers. comm.).

Ortolan Buntings have almost disappeared in south and central Sweden. However, a large proportion of the remaining population is found in northern Sweden, where they are found mostly on forest clear-cuts (Ottvall et al. 2008). However, little is known about what kind of clear-cuts are preferred by Ortolan Buntings (but see Gustafsson 2014, Lucas 2014), and whether clear-cuts provide both breeding and feeding habitat. Studies of the Ortolan Bunting in Norway have suggested that farmland is an important feeding habitat for buntings breeding in non-farmland habitats such as raised peat bogs, forest burns and clear-cuts, and most territories are therefore located close to farmland (Dale 2000, Dale & Olsen 2002, S. Dale personal observations). Based on data from the Swedish breeding bird survey, Ottvall et al. (2008) found that abundance of Ortolan Buntings on clear-cuts did not depend on distance from farmland. Thus, clear-cuts used by Ortolan Buntings may provide both breeding and feeding habitat in contrast to the situation in Norway, but detailed knowledge of habitat use and feeding behaviour on clear-cuts in Sweden is lacking.

We aimed to identify the main habitat variables influencing presence of Ortolan Buntings on 123 clear-cuts in Västerbotten County in northern

Sweden by comparing clear-cuts with and without Ortolan Buntings. We also analysed the relationship between number of territories in each clear-cut and habitat variables. Furthermore, we analysed habitat selection at a local scale with pairwise comparisons of neighbouring clear-cuts with and without Ortolan Buntings present. Finally, we also collected data on foraging behaviour to assess which kind of clear-cut habitats provided food and whether farmland was used for foraging.

Methods

Study area and study species

Fieldwork was conducted in Västerbotten County, northern Sweden (63.8–64.4°N, 19.6–21.9°E; Figure 1) during the breeding season from mid-May to late June 2013. The study area is located in the northern boreal forest zone where forests are dominated by Norway spruce *Picea abies* and Scots pine *Pinus sylvestris*, and interspersed with deciduous species such as birch *Betula spp.* and aspen *Populus tremula* (Arnborg 1990). Most of the forests in the study area are managed for timber and pulp production and are harvested at an age of 60–100 years.

The Ortolan Bunting is a small (20–25 g) long-distance migratory passerine bird which returns to the breeding areas in May. Males establish territories and sing to attract females, and males often settle in loose groups because of conspecific attraction (Darrud 2006). Later in the season breeding pairs can be located by alarm calls. The species is single-brooded and nestlings fledge from nests on the ground in the middle of June.

Selection of clear-cuts

Clear-cuts were selected based on a map obtained from the Swedish National Forest Agency. In order to obtain a large sample of clear-cuts, we selected

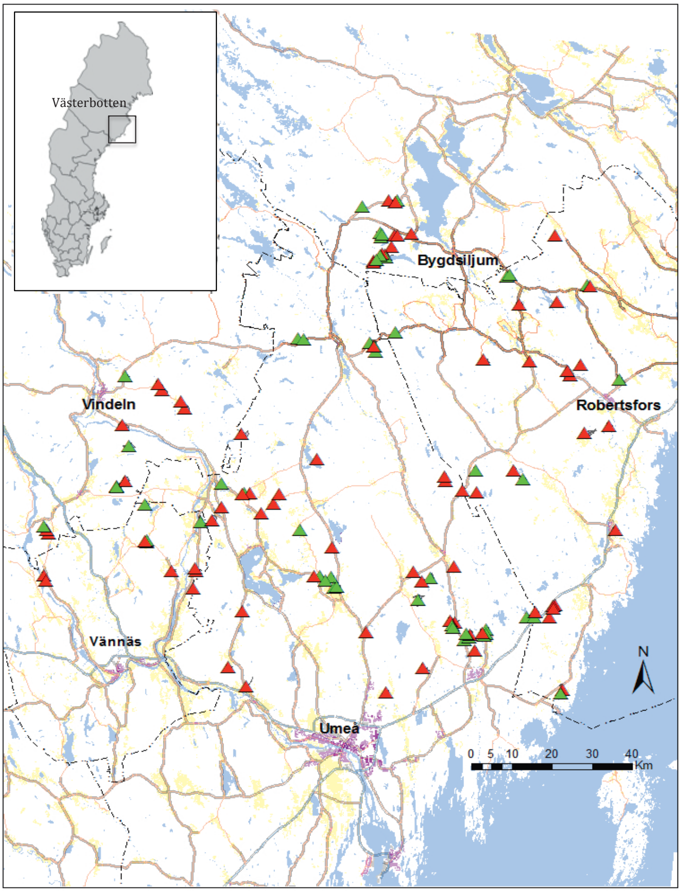

Figure 1. Map of study area showing clear-cuts visited in Västerbotten County, northern Sweden (municipalities included: Robertsfors, Umeå, Vindeln, Vännäs and Skellefteå). Green triangles show clear-cuts where Ortolan Buntings were present, and red triangles show clear-cuts where ortolan buntings were absent.
Kart over studieområdet som viser besøkte hogstfelter i Västerbotten, Nord-Sverige (inkludert følgende kommuner: Robertsfors, Umeå, Vindeln, Vännäs and Skellefteå). Grønne trekanter viser hogstfelter hvor hortulan var tilstede, og røde trekanter viser hogstfelter hvor hortulan var fraværende.

sites that were easily reached from publicly accessible roads. Clear-cuts that would have required access to closed roads, driving on roads in poor condition or walking long distances were not visited. The differences between accessible and inaccessible sites were most likely differences in topography: main roads generally go into valleys, and clear-cuts at higher elevations (e.g. hilltops) may therefore be under-represented. However, because hilltops were not in areas of high elevation (most of the study area was < 300 m a.s.l.), such areas probably do not include important habitat variation that was not present in the selected sites. Thus, despite some potential biases in site selection, the sample included in this study probably contained the full range of habitat variability present in the study area. In addition, our selection ensured that we also obtained a sufficient number of sites close to farmland (65 sites were <500 m from nearest farmland, 83 sites were <1 km from nearest farmland). In total, 123 clear-cuts were visited (see Percival 2014 for a list of geographical coordinates and number of Ortolan Bunting territories in each clear-cut).

At the time of fieldwork, clear-cuts felled early in 2013 were not registered in the Swedish Forestry Database. Clear-cuts less than one year old (post-harvest) at the time of fieldwork were therefore only sampled when they were seen by chance in the field. The database also did not include clear-cuts older than 13 years (post-harvest) and such sites were also not included in the sample. Overgrown clear-cuts with more than 50% regrowth were not sampled, as ortolan buntings are known to prefer sparsely vegetated areas. We did not include burnt clear-cuts in our sample because this was the topic of another study (Lucas 2014).

Field methods

A different part of the study area was visited each day to avoid a time-bias, meaning that clear-cuts in the northern, southern, eastern and western part of the study area were systematically alternated over time. If an Ortolan Bunting was found on a clear-cut, adjoining clear-cuts were also sampled if possible in order to obtain material for paired comparisons of neighbouring clear-cuts with and without Ortolan Buntings. Each clear-cut was visited between 04:00–14:30 hours, and sampling at each clear-cut took between 45 min and 3.5 h, depending on size. We walked around in a loop on each clear-cut, ensuring an approximate equal distance from the centre to the edge of the clear-cut, and on larger clear-cuts we also made cross transects so that no parts of the clear-cuts were >100 m from the walking routes. This was done to minimize the risk of false absences of Ortolan Buntings and in order to assess habitat characteristics of all parts of each clear-cut. Playback was not used, but we made frequent pauses to listen for songs and calls in order to increase chances of detection.

Clear-cuts were classified as occupied (buntings present) if birds were seen or heard. If birds were present, we recorded the number of territories in the clear-cut. Individual territories were distinguished based on singing activity and distance between birds. The position of each Ortolan Bunting and their respective territories were also noted on a sketch of the clear-cut to help determine the total number of territories, in particular on large clear-cuts. In some cases, it was difficult to determine the exact number of territories, particularly on large clear-cuts. In these cases, an approximate number of territories, e.g. 2–3 (indicated as 2.5 in the statistical analyses) was used. Clear-cuts were not visited during heavy rain or wind. Coordinates at each site were recorded with GPS. Each clear-cut was visited once, except to do behavioural observations (see below).

Habitat variables

Habiat variables (Table 1) were collected in the field or retrieved on ArcGIS 10.1 from the shapefile "notification of felling" (in Swedish: Avverkningsanmälningar), which was downloaded from the Swedish National Forest Agency website (http://www.skogsstyrelsen.se/Aga-och-bruka/Skogsbruk/Karttjanster/Skogens-Kalla/).

Vegetation type was classified according to Hägglund & Lundmark (1984) and was based on the abundance of indicator species found in the field-layer. Small, localized variation in vegetation was pooled within the dominant vegetation type(s). However, clear-cuts could have two or more vegetation types when an additional vegetation type was large enough for an Ortolan Bunting territory, or composed more than 10% of the entire clear-cut area.

Regeneration age (age of planted seedlings) was estimated by counting the number of yearly shoots of planted trees. If no planted trees were observed, regeneration age was recorded as zero. Regeneration age differed from post-harvest age (number of years since felling) because planting occurred at variable time intervals after felling, often several years. From the perspective of an Ortolan Bunting, regeneration age may better reflect habitat suitabil-

Table 1. Habitat variables collected for clear-cuts.
Habitatvariabler registrert på hogstfelter. För vegetationstyp både norsk och svensk terminologi för vegetationstyp.

Variable	Type	Categories	Units
Field collected *Samlet i felt*			
Vegetation type *Vegetasjonstype*	Categorical	Broad-leaved grass *Urterik, Bredbladig grästyp* Narrow-leaved grass *Smyle-dominert, Smalbladig grästyp* Sedge-horsetail *Starr-snelle, Starr-fräkentyp* Bilberry *Blåbær, Blåbärstyp* Lingonberry *Tyttebær, Lingontyp* Crowberry-heather *Røsslyng-blokkebær, Kråkbär-ljung-typ* Poor dwarf-shrub *Fattigris, Fattigristyp* Lichen *Lav, Lavmark*	
Regeneration age *Regenerasjonsalder*	Continuous		years *år*
Remaining trees *Gjenværende trær*	Continuous		trees/ha *trær/ha*
Regrowth *Gjenvekst*	Categorical	0, 1–5, ≥ 10%	
Bare soil *Naken jord*	Categorical	0, 1–5, ≥ 10%	
Vegetation litter *Vegetasjonsstrø*	Categorical	0, 1–5, ≥ 10%	
Rockiness *Steiner*	Categorical	None, few, medium, many per ha (for both medium-sized and large rocks) *Ingen, få, middels, mange per ha (for både middels store og store steiner)*	
Soil type *Jordtype*	Categorical	Sand, moraine, peat, rocky *Sand, morene, torv, steinete*	
Topography *Topografi*	Categorical	Bottomland, slope, hill *Flat mark, skråning, ås*	
Aspect *Himmelretning*	Categorical	N, NE, E, SE, S, SW, W, NW	
ArcGIS collected *Data fra ArcGIS*			
Size *Størrelse*	Continuous		ha
Post-harvest age *Tid siden hogst*	Continuous		years *år*
Distance to farmland *Avstand til dyrket mark*	Continuous		m

ity in terms of vegetation structure than post-harvest age because if regeneration age is only a few years the regrowth is still sparse and the site may be attractive to Ortolan Buntings even though the clear-cut may be old according to the post-harvest age.

Remaining trees was based on a visual estimation of the average number of individual isolated trees >2 m that were remaining per hectare. Retention patches (groups of trees) were not included because these patches varied considerably in size from small clusters of individual trees to remnants of intact forest covering several ha. Thus, the variable remaining trees mostly had low values (cf. Figure 2b) and few sites had more than 10 remaining trees/ha.

Regrowth was based on an overall visual estimation of the percentage ground coverage of regenerating vegetation > 2 m and was estimated as 0%, 1%, 3%, 5% and for ≥10% to the closest 5% step. For analyses, regrowth was classified as no regrowth (0%), little regrowth (1–5%) and significant/substantial regrowth (≥10%). The same method applied to the variables *bare soil* and *vegetation litter*. Bare soil was ground coverage of exposed soil from soil disturbance, wheel tracks, or root upheaval. Vegetation litter was ground coverage of freshly fallen or slightly decomposed organic debris such as leaf litter, needles, and in particular cut branches.

Rockiness was measured in the field by counting the number of medium-sized rocks (rocks visible up to 1 m tall) and large-sized rocks (rocks more than 1 m tall) per ha. Medium-sized rocks were categorized into the following groups: none, few (<10 per ha), some (10–50 per ha), many (>50 per ha). Large-sized rocks were categorized into the following groups: none, few (1–2 per ha), some (3–5 per ha), many (>5 per ha). A rockiness index was created to account for both medium and large rocks. Medium-sized rock categories had the following values assigned: 0 (none), 1 (few), 2 (some), and 3 (many). Large-sized rock categories had the following values assigned: 0 (none), 1 (few), 2 (some), 3 (many) and were multiplied by 2. The rockiness index combined the values from the medium-sized rocks and the large-sized rocks to create a scale from 0-9.

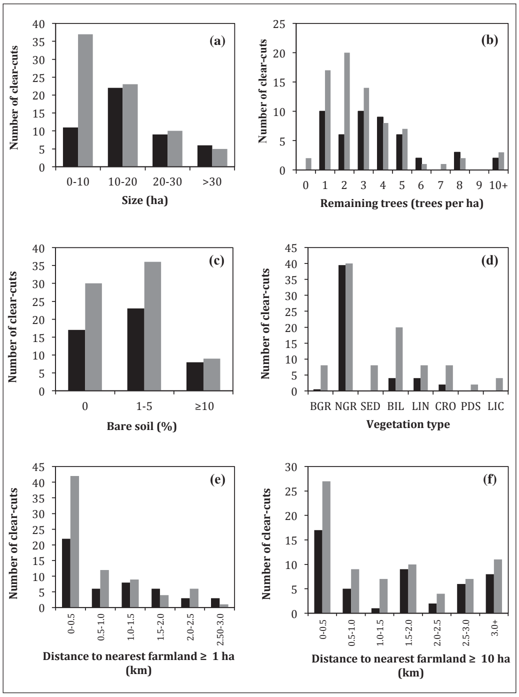

Figure 2. Frequency distributions of main habitat variables at clear-cuts occupied by Ortolan Buntings (N = 48) and unoccupied clear-cuts (N = 75). *Black columns* = occupied clear-cuts; *grey columns* = unoccupied clear-cuts. In (d), vegetation types were abbreviated as follows: BGR = broad-leaved grass, NGR = narrow-leaved grass, SED = sedge-horsetail, BIL = bilberry, LIN = lingonberry, CRO = crowberry-heather, PDS= poor dwarf-shrub, and LIC = lichen). Note that vegetation type has a larger sample size (present N = 50, absent N = 98) because some sites had > 1 vegetation type.
Frekvensfordelinger av de viktigste habitatvariablene på hogstfelter med hortulan tilstede (N = 48) og hogstfelter uten hortulan tilstede (N = 75). Svarte søyler = hogstfelter med hortulan tilstede; grå søyler = hogstfelter uten hortulan tilstede. I (d) ble vegetasjonstyper forkortet som følger: BGR = urterik, NGR = smyle-dominert gressmark, SED = starr-snelle, BIL = blåbær, LIN = tyttebær, CRO = røsslyng-blokkebær, PDS= fattigris, og LIC = lav). Legg merke til at vegetasjonsype har større materialstørrelse (tilstede N = 50, fraværende N = 98) fordi noen steder hadde > 1 vegetasjonstype.

Clear-cut size was taken from the Swedish National Forest Agency website, but if neighbouring and adjoining clear-cuts were not easily distinguished in the field because of a difference in time of felling of only 1–2 years, they were merged into one site in our analyses. In these cases post-harvest age was taken as the average of the two felling sites. Two measures of *distance to farmland* were used. One measured the distance to the nearest farmland of any size above 1 ha, the other the distance to the nearest large farmland (size ≥10 ha).

Behavioural observations

Nineteen focal observations lasting 30 min each were conducted on an opportunistic basis when foraging individuals were active. During the 30-min focal observations, we recorded time periods and positions during singing and foraging, and noted movements within or away from the clear-cut. When possible, detailed information was recorded on foraging activity, such as habitat of foraging sites. If an individual was lost for more than five minutes (unless it was seen leaving the clear-cut to nearby farmland), the sampling period was not included among the 30-min focal observations, but instead included as a casual behavioural observation (N = 4). Together with seven other observations, a total of eleven casual behavioural observations were made in the field of birds that were foraging.

Statistical analyses

Presence and abundance of Ortolan Buntings on clear-cuts were analysed using logistic and linear regression models. Prior to analyses, the number of predictor variables was reduced due to collinearity and lack of variation. *Post-harvest age* was excluded because it was strongly correlated with *regeneration age* ($r_s = 0.88$, $P < 0.0001$). *Soil type* and *topography* were excluded due to small variation in observed categories. Two variables were recoded to reduce the number of degrees of freedom used and to increase the stability of the model: *aspect* was recoded to two categories [north (including east) and south (including west)], and the rockiness index was recoded to three categories (0–1, 2–5, 6–9). *Regeneration age*, *remaining trees*, *clear-cut size* and *distance to farmland* were log-transformed. Two separate models were performed to test for the effect of different farmland sizes: one with distance to nearest farmland of any size above 1 ha, and one with distance to nearest large farmland (size ≥10 ha).

Twenty-three clear-cuts were composed of more than one vegetation type. In clear-cuts that had more than one vegetation type, the dominant vegetation type was used for the analysis, except in two cases where the Ortolan Bunting(s) were found only in the non-dominant vegetation type. In another case, the density of birds was higher in the non-dominant vegetation type, and therefore the non-dominant vegetation type was used to indicate the vegetation type of the clear-cut. Clear-cuts with two different vegetation types that were equally dominant (i.e. 50% coverage each) were excluded from the analyses (N = 3). Analyses were further simplified

Table 2. Habitat selection of Ortolan Buntings on clear-cuts in northern Sweden. Comparisons are made between clear-cuts with Ortolan Buntings present (N = 48) and clear-cuts with buntings absent (N = 75). Values represent means (SE). P-values refer to Mann-Whitney U-tests of each variable separately.
Habitatvalg hos hortulan på hogstfelter i Nord-Sverige. Tabellen viser sammenligninger mellom hogstfelter med hortulan tilstede (N = 48) og hogstfelter uten hortulan tilstede (N = 75). Verdiene representerer gjennomsnitt (standardfeil). P-verdier er fra Mann-Whitney U-tester av hver variabel for seg.

Variable	Present *Tilstede*	Absent *Fraværende*	P
Vegetation type[1] *Vegetasjonstype*[1]	6.4 (0.2)	5.7 (0.2)	0.04
Regeneration age (years) *Regenerasjonsalder (år)*	3.3 (0.4)	3.3 (0.3)	0.82
Remaining trees (trees/ha) *Gjenværende trær (trær/ha)*	3.7 (0.4)	3.3 (0.4)	0.08
Regrowth (%) *Gjenvekst (%)*	3.6 (1.1)	4.2 (1.2)	0.76
Bare soil (%) *Naken jord (%)*	3.4 (0.7)	3.2 (0.8)	0.42
Vegetation litter (%) *Vegetasjonsstrø (%)*	2.7 (0.6)	3.6 (0.9)	0.99
Rockiness index (0–9) *Steinindeks (0–9)*	3.6 (0.4)	3.6 (0.3)	0.95
Aspect (1 = south, 2 = north) *Himmelretning (1 = sør, 2 = nord)*	1.4 (0.1)	1.5 (0.1)	0.53
Size (ha) *Størrelse (ha)*	17.2 (1.3)	13.4 (1.2)	0.005
Post-harvest age (years) *Tid siden hogst (år)*	6.4 (0.4)	6.3 (0.4)	0.84
Distance to farmland of any size (m) *Avstand til dyrket mark uansett størrelse (m)*	854 (122)	643 (85)	0.24
Distance to large farmland (m) *Avstand til større areal dyrket mark (m)*	1618 (218)	1489 (176)	0.64

[1] Vegetation type was ranked from most nutrient-poor (lichen = 1) to most nutrient-rich (broad-leaved grass = 8).
[1] Vegetasjonstype rangert fra mest næringsfattig (lav = 1) til mest næringsrik (urterik = 8).

by removing clear-cuts with vegetation types that only had a few observations [broad-leaved grass (N = 3), sedge-horsetail (N = 4), lichen (N = 4); poor dwarf-shrub had no observations, analyses were therefore based on four vegetation types]. The total sample size for the logistic and linear regression models was therefore reduced from 123 to 109 clear-cuts (47 with buntings present).

Regression analyses were done using stepwise backward elimination of non-significant variables. The final reduced models corresponded well with the full models. In the Results, the full model output is reported because this shows the relative importance of all variables included. Analyses of Ortolan Bunting abundance (number of territories) were performed both with all clear-cuts (N = 109) included, and also using only clear-cuts with buntings present (N = 46, the only occupied clear-cut in crowberry-heather vegetation type was excluded). Statistical analyses were performed with JMP software (version 10.0, SAS Institute Inc., Cary, North Carolina).

Results

Presence/absence on clear-cuts

Ortolan Buntings were found on 48 of the 123 clear-cuts. Clear-cuts that had buntings present were on average larger and tended to have more remaining trees per ha (Table 2, Figure 2). A majority of occupied clear-cuts had narrow-leaved

Figure 3. Photographs showing examples of clear-cuts used by Ortolan Buntings in Västerbotten County, northern Sweden. (a) Clear-cut with 3–4 male territories, showing narrow-leaved grass vegetation type, 0% bare soil, and individual trees used as song posts. (b) More recent clear-cut with one male territory, showing narrow-leaved grass vegetation, >10% bare soil.
Fotografier som viser eksempler på hogstfelter brukt av hortulan i Västerbotten, Nord-Sverige. (a) Hogstfelt med 3–4 territorier og smyle-dominert gressmark, 0% naken jord, og enkelttrær brukt som sangplasser. (b) Ferskere hogstfelt med ett territorium og smyle-dominert gressmark, >10% naken jord.

Table 3. Logistic regression (likelihood-ratio tests) of the relationship between habitat variables and presence/absence of Ortolan Buntings on clear-cuts in northern Sweden. Model with distance to nearest large farmland ($N = 109$, $R^2 = 0.29$). Significant results are in bold.
Logistisk regresjon (likelihood-ratio test) av sammenhengen mellom habitatvariabler og tilstedeværelse (tilstede/fraværende) av hortulan på hogstfelter i Nord-Sverige. Modell med avstand til nærmeste større areal dyrket mark (N = 109, $R^2 = 0.29$). Signifikante resultater er vist med fet skrift.

Variable	df	χ^2	P
Vegetation type *Vegetasjonstype*	**3**	**10.75**	**0.014**
Regeneration age *Regenerasjonsalder*	1	0.20	0.66
Remaining trees *Gjenværende trær*	**1**	**17.76**	**< 0.001**
Regrowth *Gjenvekst*	2	0.42	0.81
Bare soil *Naken jord*	**2**	**8.52**	**0.014**
Vegetation litter *Vegetasjonsstrø*	2	1.89	0.39
Rockiness *Steiner*	2	2.84	0.24
Aspect *Himmelretning*	1	0.70	0.40
Size *Størrelse*	**1**	**22.69**	**< 0.001**
Distance to large farmland *Avstand til større areal dyrket mark*	1	1.40	0.24

grass vegetation type (Table 2, Figures 2 and 3). Other habitat variables did not differ substantially between occupied and unoccupied clear-cuts (Table 2). Occupied clear-cuts had bare soil in 65% of cases, and 42% of occupied clear-cuts were ≥1 km from nearest farmland of any size above 1 ha and 54% were ≥1 km from nearest large farmland (size ≥10 ha; Table 2, Figure 2).

Logistic regression analysis of the relationship between habitat variables and presence/absence of Ortolan Buntings indicated that the probability of presence increased with clear-cut size and number of remaining trees (Table 3, model with distance to nearest large farmland). Furthermore, the results indicated that buntings were more often present when clear-cuts had ≥10% bare soil and had narrow-leaved vegetation type (Table 3). Results were almost identical in the model using distance to nearest farmland of any size above 1 ha (results not shown).

Table 4. Linear regression (effect tests) of the relationship between habitat variables and number of Ortolan Bunting territories on clear-cuts in northern Sweden. Model including only clear-cuts with buntings present, and distance to nearest large farmland ($N = 46$, $R^2 = 0.47$). Significant results are in bold.
Lineær regresjon (effekt test) av sammenhengen mellom habitatvariabler og antall hortulanterritorier på hogstfelter i Nord-Sverige. Modellen inkluderer bare hogstfelter med hortulan tilstede, og avstand til nærmeste større areal dyrket mark (N = 46, $R^2 = 0.47$). Signifikante resultater er vist med fet skrift.

Variable	df	F-ratio	P
Vegetation type *Vegetasjonstype*	2	2.02	0.15
Regeneration age *Regenerasjonsalder*	1	0.17	0.69
Remaining trees *Gjenværende trær*	**1**	**5.11**	**0.031**
Regrowth *Gjenvekst*	2	0.27	0.77
Bare soil *Naken jord*	2	1.32	0.28
Vegetation litter *Vegetasjonsstrø*	2	0.24	0.79
Rockiness *Steiner*	2	2.86	0.07
Aspect *Himmelretning*	1	0.33	0.57
Size *Størrelse*	**1**	**13.20**	**< 0.001**
Distance to large farmland *Avstand til større areal dyrket mark*	1	0.02	0.90

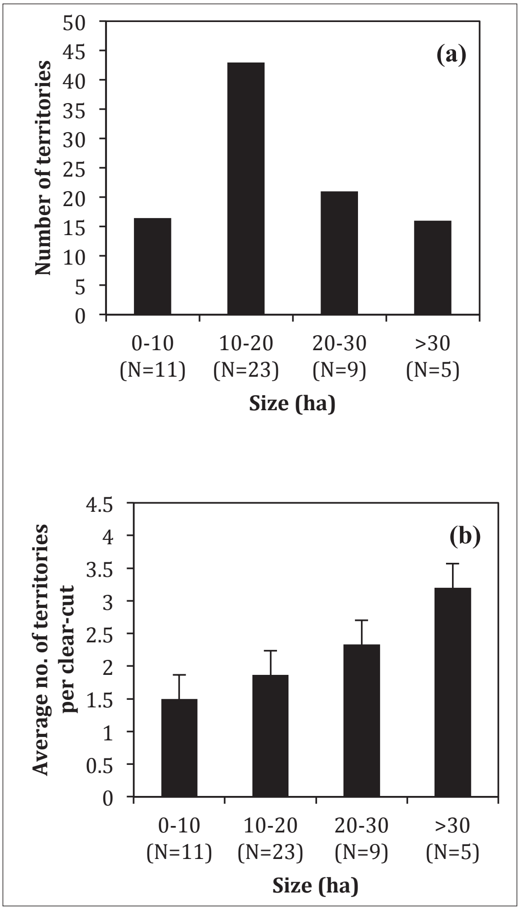

Figure 4. Frequency distribution of number of territories, and mean number of territories (± SE) in relation to clear-cut size at clear-cuts occupied by Ortolan Buntings (N = 48).
Frekvensfordeling av totalt antall territorier, og gjennomsnittlig antall territorier (± standardfeil) i forhold til størrelsen på hogstfeltene for hogstfelter med tilstedeværelse av hortulan (N = 48).

Number of territories on clear-cuts

In total, 93–100 territories were found on the 48 clear-cuts that had Ortolan Buntings present (range 1–4 territories, median 2). Twenty-nine clear-cuts had more than one territory. Linear regression analysis of the relationship between habitat variables and number of Ortolan Bunting territories indicated that the number of territories increased with clear-cut size and number of remaining trees (Table 4, model including only clear-cuts with Ortolan Buntings present and distance to nearest large farmland). The results remained similar when using a model that included all clear-cuts (results not shown) or models using distance to nearest farmland of any size above 1 ha (results not shown).

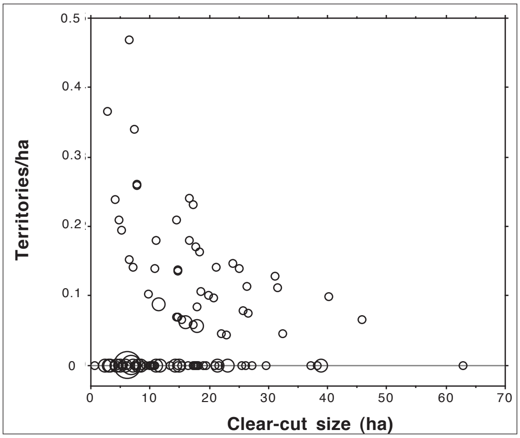

Figure 5. Relationship between clear-cut size (ha) and number of Ortolan Bunting territories per ha. Larger symbols indicate overlapping data points.
Sammenheng mellom størrelsen på hogstfeltene (ha) og antall hortulanterritorier per ha. Større symboler viser overlappende datapunkter.

Most territories were found on clear-cuts that were between 10 and 20 ha (Figure 4a), however, the largest clear-cuts (>30 ha) had the highest average number of territories (Figure 4b). Although larger clear-cuts had a higher total number of territories, analyses showed that territory density (i.e. number of territories per ha) did not increase significantly with clear-cut size (r_s = 0.16, N = 123, P = 0.08; Figure 5), and even declined among occupied clear-cuts (r_s = -0.55, N = 48, P <0.001). Overall, clear-cuts that were smaller than 20 ha had higher territory density [0–10 ha: total of 16.5 territories on a total area of 286 ha (0.058 territories/ha); 10–20 ha: 43 territories on 694 ha (0.062 territories/ha)] than clear-cuts that were larger than 20 ha [20–30 ha: 21 territories on 455 ha (0.046 territories/ha); >30 ha: 16 territories on 397 ha (0.040 territories/ha)].

Paired comparisons of neighbouring clear-cuts

Comparisons of neighbouring clear-cuts with and without Ortolan Buntings did not reveal significant differences in habitat, perhaps due to moderate sample sizes. Clear-cut size showed the largest contrast in which buntings were present on the largest of the two neighbouring clear-cuts in 14 out of 20 cases (two-tailed binomial test: P = 0.12). Other variables were not close to significance (narrow-leaved grass vegetation type chosen in 8/12 cases, present on clear-cuts of older regeneration age in 12/19 cases, with more remaining trees in 11/17 cases, more regrowth in 8/15 cases, more bare soil in 10/17 cases, and more vegetation litter in 5/10 cases). A comparison within clear-cuts that had two different vegetation types present, but Ortolan Buntings present in only one of the vegetation types, indicated a preference for narrow-leaved grass (chosen in 10/11 cases, expected frequency based on coverage of each vegetation type: 6.1/11; $\chi^2 = 5.60$, $P = 0.018$).

Behavioural observations

Ten of the nineteen focal observations occurred at clear-cuts within 500 m from nearby farmland, but in only three cases were Ortolan Buntings seen flying toward farmland. In two cases, nearby farmland was directly adjoining the clear-cut and birds were away from the clear-cut for 16-20 minutes. In the third case, the clear-cut was 252 m from nearby farmland, and the individual was away from the clear-cut for 26 minutes. In the other focal observations birds were only seen foraging within the clear-cut, and individuals were seen making 1–3 foraging attempts on the ground during the 30-min focal period. Each foraging attempt lasted between 30 seconds and 9 minutes (total number of foraging attempts observed = 27, mean foraging time = 3.8 min).

Seven of the eleven casual behavioural observations occurred at clear-cuts within 500 m from

Figure 6. Photographs showing examples of observed foraging sites of Ortolan Buntings in Västerbotten County, northern Sweden. (a) One male was observed foraging in a patch dominated by wavy hairgrass *Deschampsia flexuosa* and taking seeds from mountain melick *Melica nutans* (narrow-leaved grass vegetation type, 0% bare soil). (b) One male was observed foraging in a patch of bare soil (lingonberry vegetation type, 1–5% bare soil). (c) One male was observed in old wheel tracks in a site dominated by wavy hairgrass and patches of fireweed *Chamerion angustifolium* (narrow-leaved grass vegetation type, ≥10% bare soil) (d) One male was observed with an insect in his bill in an area dominated by fireweed (narrow-leaved grass vegetation type, 0% bare soil overall on clear-cut).

Fotografier som viser eksempler på observerte furasjeringssteder for hortulaner i Västerbotten, Nord-Sverige. (a) En hann lette etter mat på et sted dominert av smyle Deschampsia flexuosa *og han tok frø fra hengeaks* Melica nutans *(smyle-dominert gressmark, 0% naken jord). (b) En hann lette etter mat på et sted med naken jord (tyttebær-vegetasjonsype, 1–5% naken jord). (c) En hann lette etter mat i gamle hjulspor på et sted dominert av smyle og partier med geitrams* Chamerion angustifolium *(smyle-dominert gressmark, ≥10% naken jord) (d) En hann ble observert med et insekt i nebbet på et sted dominert av geitrams (smyle-dominert gressmark, 0% naken jord totalt sett på hogstfeltet).*

nearby farmland (five of these were less than 100 m from farmland), and only one individual was seen flying toward nearby farmland. In all other casual observations, individuals were seen engaging in foraging activities on the clear-cut, even when farmland was nearby. Foraging on the ground lasted 1–10 min (total number of foraging attempts observed = 12, mean foraging time = 2.9 min).

Common vegetation of foraging areas included a high proportion of wavy hairgrass *Deschampsia flexuosa*, fireweed *Chamerion angustifolium*, and some moss (Figure 6a,b). Individuals were also observed on the ground pecking at seeds from grasses (*Deschampsia flexuosa* and *Melica nutans*) and spore capsules from haircap moss *Polytrichum spp*. Foraging areas included those with exposed bare soil, quite often in old wheel tracks, but also in areas nearly or completely void of exposed bare soil (Figure 6c,d). Individuals were also observed with insects in their bill (beetles, caterpillars) in foraging areas without exposed bare soil.

Discussion

Habitat selection

In this study, the four most important variables positively influencing presence of Ortolan Buntings on forest clear-cuts in Västerbotten, northern Sweden were clear-cut size, the number of remaining trees per ha (sites with at least 4–5 trees/ha had Ortolan Buntings present most often), percentage of bare soil (≥10%) and narrow-leaved grass vegetation. The first two variables were also related to abundance of Ortolan Buntings (number of territories). Further, proximity to farmland did not influence presence or abundance of Ortolan Buntings, which suggests that forest clear-cuts may provide both suitable nesting and foraging habitat.

Ortolan Bunting occupancy and abundance on clear-cuts was most strongly influenced by clear-cut size, as also indicated in the studies by Gustafsson (2014) and Lucas (2014). Larger clear-cuts can be expected to have higher habitat heterogeneity and could also be more attractive to the Ortolan Bunting simply because they provide large open spaces which is attractive the species (Cramp & Perrins 1994). However, we also found that the density of Ortolan Buntings (i.e. number of territories per ha) actually *declined* with clear-cut size (among occupied sites), which indicates that larger clear-cuts did not attract more buntings at the same rate as clear-cut size increased (see further below under *Management implications*).

We found that a larger number of remaining trees on clear-cuts was positively related to Ortolan Bunting presence and abundance. Ortolan Buntings are known to use single large trees, large shrubs, large rocks, electricity wires and other similar features as song posts and perching sites (Cramp & Perrins 1994, Tryjanowski 2001, Vepsäläinen et al. 2005, 2007). Thus, such structural features appear to be important for making a site attractive to Ortolan Buntings, and our results indicate that current practice of leaving retention trees on clear-cuts should be continued (Gustafsson et al. 2010, Kruys et al. 2013). Note, however, that the differences found were related to a higher probability of presence on clear-cuts with at least 4–5 remaining trees/ha than on clear-cuts with only 1–2 remaining trees/ha.

We found that presence of Ortolan Buntings on clear-cuts was related to ≥ 10% bare soil, although we did not find that bare soil increased number of territories. Our finding that bare soil was attractive to Ortolan Buntings is in line with a number of other studies of the species across Europe (Berg 2008, Menz et al. 2009a, Menz et al. 2009b, Morelli 2012; see also Schaub et al. 2010). Surprisingly, a concurrent study in our study area found an opposite pattern, i.e. Ortolan Buntings were more frequent in areas with low coverage of bare soil (Lucas 2014). We have no clear explanation for this discrepancy, but we suggest that the preference for bare soil may be stronger than indicated by survey data because of a combination of (1) bare soil disappearing gradually during vegetation succession on clear-cuts, (2) male Ortolan Buntings having a high breeding site fidelity when older despite habitat changes (Dale et al. 2005, S. Dale personal observations), and (3) younger males using older males as a conspecific cue for habitat selection (Darrud 2006). Thus, bunting presence on clear-cuts without bare soil may be a legacy of initial clear-cut conditions with bare soil present which stimulated buntings to settle. We also note that our findings were backed by behavioral observations showing that bare soil was used frequently for foraging. Our behavioural data are not amenable for statistical analyses, but our subjective impression from the field is that bare soil was clearly overrepresented as foraging habitat. Our conclusion is therefore that bare soil is beneficial for Ortolan Buntings on forest clear-cuts in northern Sweden.

Ortolan Buntings were mostly present on clear-cuts that had narrow-leaved grass vegetation type. This was supported both by the presence/absence analysis, and by territory locations on clear-cuts that also had another type of vegetation present. Narrow-leaved grass was the dominant vegetation type and is fairly nutrient-rich. Poorer vegetation types (bilberry, lingonberry and crowberry-heather) were used less often than expected. This is in contrast to the situation in Norway where Ortolan Buntings mostly nest on forest clear-cuts that are nutrient-poor (in particular lingonberry-type, Percival 2014). In Sweden, foraging appeared to take place to a large degree on the clear-cuts, whereas in Norway clear-cuts are used for nesting while feeding takes place mostly on farmland (see further below). Thus, the preference for narrow-leaved grass vegetation type in northern Sweden may be related in some way to resource availability, e.g. potentially richer supply of invertebrates.

Availability of food resources on clear-cuts may be correlated with the availability of nutrients for plant growth, which in turn may be related to forestry practices. Before clear-felling, much of the forest in the study area is composed of bilberry, lingonberry and crowberry vegetation types (Arnborg 1990). After clear-cutting, mechanical soil scarification increases mineral nutrient availability and decreases the abundance of late successional dwarf shrubs such as bilberry, and increases the abundance of fast-growing, early-successional species like grasses and forbs (Bergstedt & Milberg 2001). In particular, wavy hairgrass *Deschampsia flexuosa* increases in abundance with increased intensity of soil preparation and increased light (Bergstedt & Milberg 2001, Strengbom et al. 2004), and clear-cuts thereby often develop into narrow-leaved grass vegetation type. Thus, occurrence of Ortolan Buntings on clear-cuts in northern Sweden may be dependent on mechanical soil scarification, and, interestingly, this forestry practice is uncommon in Norway (Stokland et al. 2003).

Distance to farmland

We did not find any evidence that distance to farmland influenced presence or abundance of Ortolan Buntings on clear-cuts. This is in line with other studies conducted in northern Sweden (Ottvall et al. 2008, Gustafsson 2014, Lucas 2014). We found that 42% of all occupied clear-cuts were > 1 km from farmland which makes it unlikely that birds on these clear-cuts had the option to utilize farmland for foraging. Ottvall et al. (2008) found that 61% of occupied clear-cuts had no farmland within a distance of 400 m. Furthermore, our behavioural observations indicated that even those Ortolan Buntings that occurred on clear-cuts close to farmland only occasionally used farmland for foraging. In contrast, Dale (2000) found that 75% of Ortolan Bunting territories on raised peat bogs in Norway were ≤100 m from farmland and he made many observations of birds flying back and forth between the raised peat bogs and farmland. The situation is similar for buntings breeding on a forest burn and on forest clear-cuts in Norway (Dale & Olsen 2002, S. Dale personal observations). These results support our conclusion above that clear-cuts in northern Sweden apparently have enough resources to permit foraging within the clear-cuts. Thus, clear-cuts with narrow-leaved grass vegetation may provide both suitable nesting and foraging habitat, and nearby farmland is therefore not needed for foraging.

Management implications and conservation

The results of the present study have several implications for how forestry practices can help maintain a viable population of Ortolan Buntings in northern Sweden. Habitat preferences of the Ortolan Bunting imply (1) that the practice of leaving retention trees on clear-cuts should be continued, (2) that there is no need to have very large clear-cuts, and (3) that soil disturbance to create patches of bare soil is important. However, one should bear in mind that these measures may conflict with the interests of conservation-dependent forest species. Such a conflict arises partly because the Ortolan Bunting is an open-country species which in northern Sweden occupies a short-lived early-successional forest habitat that is dependent on modern forestry practices. However, clear-cuts provide important habitat also for other conservation-dependent species (e.g. Red-backed Shrike *Lanius collurio*; Söderström & Karlsson 2010).

We found that presence of Ortolan Buntings on clear-cuts increased with number of remaining trees, but it is important to be aware that very few of the clear-cuts had more than 10 remaining trees per hectare. Thus, even the most attractive clear-cuts were fairly open. However, in a study with a larger variation in retention tree densities than in our study (up to 20–30% of original tree density), Söderström (2009) found that open-country species were negatively affected by increasing green-tree retention, whereas forest species were positively affected. This shows that clear-cuts cannot be managed for all species simultaneously, hence, a diversity of clear-cuts may be needed to provide habitat for a wide range of species (see also further below).

Larger clear-cuts had Ortolan Buntings present more often than smaller clear-cuts, and the number of territories increased with clear-cut size, similar to results for other open-country species breeding on forest clear-cuts in Sweden (Söderström 2009). Despite this, *territory density* did not increase with clear-cut size and actually declined among occupied clear-cuts (see Figure 5). This indicates that larger clear-cuts did not attract more buntings at the same rate as clear-cut size increased. Hence, the value of a clear-cut depends on two opposing processes; larger size makes it more likely that Ortolan Buntings are present, but given that a clear-cut is occupied, territory density declines with size. The data on territory density for different classes of clear-cut size (0–10 ha, 10–20 ha, 20–30 ha, >30 ha) presented in the Results suggested that if there are plans to harvest e.g. 150 ha forest, approximately 50% more Ortolan Buntings may be attracted if one makes ten separate clear-cuts of 15 ha each instead of three clear-cuts of 50 ha each (expected number of territories: 10 × 15 ha × 0.062 territories/ha = 9.3, respectively 3 × 50 ha × 0.040 territories/ha = 6.0). Thus, large clear-cuts do not maximize the number of Ortolan Buntings, and they may also have negative consequences for forest interior species because of forest fragmentation and loss of forest cover. Thus, we suggest that clear-cut sizes of 10–20 ha may be optimal for the Ortolan Bunting.

The Ortolan Bunting, as well as a number of other ground-foraging species of open habitats, benefit from patches of bare soil (Schaub et al. 2010). In Sweden, mechanical soil scarification is the most common method of site preparation after clear-cutting, and is practiced in 92% of Sweden's forested areas (Swedish Forest Agency 2013). Soil scarification is intended to increase the survival and growth of seedlings by exposing the mineral soil underneath and increasing soil temperatures (Örlander et al. 1990). There are also other methods of soil scarification with varying degrees of intensity, e.g. disc trenching and mounding. For the Ortolan Bunting it appeared that more than 10% bare soil was most attractive, but it should be noted that we had few sites with more than 20% bare soil, and among these buntings were present on only 1 of 6 sites (sites that had between 10% and 20% bare soil had buntings present on 7 out of 11 sites, Fisher exact test, P = 0.13). Thus, some site preparation may be favourable to the Ortolan Buntings, but too much may be unfavourable. Disturbances from mechanical soil scarification may also create suitable habitats for species that previously benefited from fire-disturbed habitats (Granström 2001). However, soil disturbance is likely to have negative impacts on a number of organisms and is at odds with conservation goals of preserving intact ecosystems. Because Ortolan Bunting territories rarely occupied entire clear-cuts, one option is to continue current soil disturbance practices in one part of a clear-cut, but leave other parts undisturbed.

In conclusion, this study has identified several factors that influence habitat selection of Ortolan Buntings on clear-cuts in northern Sweden. The species has declined rapidly in many parts of Europe, in particular in farmland habitats. In Sweden, the population on clear-cuts is the last stronghold and efficient management of these breeding sites is crucial for long-term survival of the species. Our suggestions provide a basis for management, and should be followed up with detailed studies of breeding success and individual survival in relation to habitat characteristics to refine management.

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Sammendrag

I Sverige pleide hortulanen *Emberiza hortulana* først og fremst å forekomme i kulturlandskapet. I våre dager finnes en stor del av den gjenværende bestanden på hogstfelter i Nord-Sverige. Få studier har undersøkt hva slags hogstfelter hortulanen foretrekker, og om slike hogstfelter brukes til både hekking og næringssøk. Vi registrerte tilstedeværelse og antall hortulaner på hogstfelter i Västerbotten i Nord-Sverige. Vi undersøkte 123 hogstfelter (hortulan tilstede N = 48, fraværende N = 75, totalt antall territorier var 93–100) og fant at størrelsen på hogsfeltet, antall gjenværende trær, prosent naken jord (≥10%) og smyle-dominert vegetasjon hadde positiv effekt på tilstedeværelse av hortulan. Antall

territorier på hogstfeltene økte med størrelsen på hogstfeltet og antall gjenværende trær. Avstand til nærmeste jordbruksmark påvirket ikke forekomsten av hortulan på hogstfelter. Atferdsobservasjoner tydet på at hogstfeltene ble brukt til både hekking og næringssøk. Vi diskuterer disse resultatene i forhold til skogbruksmetoder og vern og forvaltning av bestanden av hortulan.

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Is early grass harvest for silage an overlooked reason for skylark *Alauda arvensis* population decline in Sweden?

Är tidig höskörd för ensilering en förbisedd orsak till sånglärkans Alauda arvensis *beståndsnedgång i Sverige?*

JAN SONDELL, JULIE MURRAY & MAGNUS PERSSON

Abstract

In 2015 we studied the relative importance of silage and cereal crops as breeding habitat for the skylark *Alauda arvensis*. In 2014 we had found that skylarks failed to breed successfully in grass silage fields. We compared skylark density between crops in one organic and one conventional farm, c. 100 ha each, at Kvismaren valley in south Sweden (approx. 59.2°N; 15.4°E). The densities were similar in all crops: 83 territories/km^2 in silage and 75 (spring sown) or 80 (autumn sown) in cereal. However, silage harvest in early June and July destroyed, as in the previous year, almost all nests, effectively preventing skylarks from reproducing successfully in that habitat. Cereal fields are not harvested until after the young are fledged. Approximately 45% of the farmland area in Sweden is grass for silage, normally harvested in late May or early June. We suggest that this early harvest is an important and overlooked driver for population decline of birds nesting in such fields.

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Introduction

The skylark *Alauda arvensis* is abundant all over Europe on intensively used farmland, natural pasture and coastal meadows. It is the only passerine breeding directly on the ground in open fields away from scrub and tree which may be used as observation posts for predators. In recent years the population trend in Europe has been classified as "decreasing". The causes are not fully known, but it is probable that there is a combination of factors behind the decline (BirdLife International). Intensive farming is a major threat, along with reduction of suitable habitat, and predation is also a limiting factor. In England small mammals are major predators (Morris et al. 2008, Buckingham et al. 2015) whilst in other parts of Europe raptors and corvids predominate (Praus & Weidinger 2010).

The skylark is still the twentieth most common bird species in Sweden (Ottosson et al. 2012). It is found on open grassland almost all over the country. However, the Swedish Bird Survey (Green et al. 2016) shows a decrease in recent decades. Since 2015 the species has been classified as NT (Near Threatened) in the Swedish Red List (ArtDatabanken 2015). Possible reasons for this are the declining farming area and the increasingly more intensive use of grassland, where the first harvest nowadays is done at the end of May or early June in central Sweden. This early cut, that will have a detrimental impact on all species dwelling in the grass, is little discussed in Sweden today and may be an overlooked driver for skylark population decrease in Sweden, despite the phenomenon being reported from many other parts of Europe (Buckingham et al. 2015, Donald 2004, Grüebler et al. 2012, Kuiper et al. 2015, Jenny 1990, Vickery 2001).

The study presented here was conducted on arable land in the Kvismaren valley (approx. 59.2°N; 15.4°E). The population is relatively dense and the species is one of the most common in the Kvismaren area. Another similarly ground nesting bird in the area is the ortolan bunting *Emberiza hourtulana,* but unlike the skylark it is one of the rarest breeding birds in the valley. Both species share the same nesting habitats in grassland or cereal fields. Research looking into explanations for the ortolan decline (Sondell et al. 2011) found that problems caused by the use of pesticides may be one of several possibilities. Analysis of blood samples from young birds is a method that can be used to test this theory. However, the ortolan bunting is a highly vulnerable species and ground disturbance caused by searching for their nests can lead to an increased risk of stress and predation. Blood tests on skylark chicks may provide an alternative benchmark for assessing the levels of pesticides in passerine species living on farmland in the area.

When searching for skylark nests in 2014 to obtain blood samples, we observed that all nests on a large grass field used for silage production were destroyed by the first harvest, taking place on 27 May. To learn more about the situation, we decided to carry out a survey of skylarks in 2015.

Objectives

The aim of this study was to assess the effects of farming techniques on breeding skylarks in farmland at Kvismaren. The common crops in the area were represented: grassland (harvested for silage), and autumn and spring sown cereals. Conventional and organic farmland were compared in order to find out whether there were any significant differences in population densities.

Methods

Two large farms were chosen with similar location and ground conditions, essentially humus soil created by drained marshland. Most of the fields in the plain landscape are sown in spring because of the risk for ice lift of the roots of small growing plants sown in the autumn. The conventional farm, using pesticides, is Bärsta and the organic farm is Sörby. Only Sörby has silage fields, as a breeder of cattle for milk production. All fields within the study area

Figure 1. Part of the Kvismaren valley with survey plots on fields belonging to the Bärsta (top NE) and Sörby estates (bottom SW). (From Google maps.)
Del av Kvismardalen med provytor på fält som tillhör Bärsta (i NO) och Sörby (i SV) gårdar.

Table 1. Number of survey plots 2015 at Kvismaren in different kinds of crop and approximate plot and field areas in hectares (ha).
Antal provytor 2015 i Kvismaren i olika grödor och ungefärliga arealer på provytor och åkerfält i hektar (ha).

Crop *Gröda*	Bärsta estate (conventional)			Sörby estate (organic)		
	Number of plots *Antal provytor*	Total plot area, ≈ha *Total provyta*	Total field area, ≈ha *Total fältarea*	Number of plots *Antal provytor*	Total plot area, ≈ha *Total provyta*	Total field area, ≈ha *Total fältarea*
Autumn grain *Höstsäd*	3	9	20	3	9	20
Spring grain *Vårsäd*	6	18	70	6	18	40
Grassland *Vall*	-	-	-	6	18	50
Sum	9	27	90	15	45	110

were large and bordered other fields. The total area is some 200 hectares. Few trees or tree islets were present in the neighborhood (Figure 1).

In total 24 circular plots (Table 1) of 100 metre radius (3.14 ha) were marked out on a map of the fields at the two farms (Figure 1). Each plot was surveyed regularly throughout the season (11 May, 26 May, 10 June, 25 June, 10 July), including pre- and post- silage harvest. Each plot was visited for 15 minutes, including 5 minutes at the beginning to allow the birds to settle after the surveyor had walked up to the centre point (see Photo 1). Thus no activity was recorded in these first 5 minutes. During the following 10 minutes, all observations of singing skylarks were recorded on a plan of the plot, including flight lines if possible – the birds were sometimes singing so high up that mapping their exact movements was difficult. Birds holding territories on the borders of the plots were counted as 0.5 territories. The fieldwork was conducted by Elisabeth Kopp (EKP), Julie Murray (JMY) and Magnus Persson (MPN). Before the start of the survey it was checked that all fieldworkers were counting and recording in a similar manner. This was done by each surveying the same plot and comparing results. The height of the vegetation was measured using a 1 meter long stick held horizontally at the 'mean' top, judged by eye, of the actual stalks. The distance to the ground was then measured.

It was desirable to know a little about the nesting period, firstly to check the breeding stage and secondly to collect blood samples for analyses of pesticides. Therefore, we carefully searched for nests during and immediately after harvest in 2014 and 2015 and also recorded potential predators as well as studying their behavior. Furthermore, in 2015 we randomly searched the fields for replacement clutches in the new growth of grass, during the post-harvest period.

To get information of the breeding period for skylarks in the part of Sweden where Kvismaren is located (Svealand; 58–61°N), accessible ringing data from 1962–2001 at the Swedish Bird Ringing Centre was analysed together with ringing data from Kvismaren 2014 and 2015.

Results

Vegetation height

The mean vegetation height at different dates during the survey period is presented in Figure 2 and Appendix 1. On 22 May the autumn crop (wheat-rye hybrid *triticale* at both farms) was 35 cm high while the spring crop (wheat at Bärsta, oats at Sörby) had not yet reached 10 cm. By mid-May the autumn sown cereals were already taller than the grass, which did not gain much more height by late May–early June. The grassland was harvested for the first time on the 5 and 9 June (harvester breakdown in between), the vegetation being cut down to a height of around 10 cm. The grass had reached

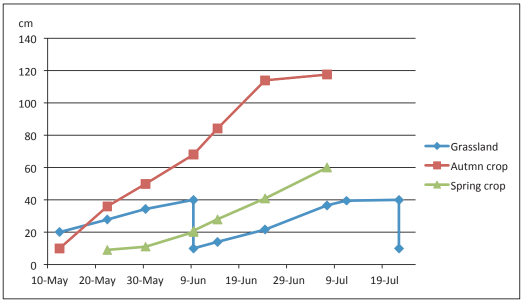

Figure 2. Mean vegetation heights in the various crops of fields included in the skylark study May–July 2015.
Medelhöjd på vegetationen i olika grödor som ingick i studien av sånglärka maj–juli 2015.

Table 2. Compilation of survey result 2015 at Kvismaren in different kinds of crop. The result is based on two inventory rounds per crop in May for autumn seed and silage and two rounds in late May early June for spring crop. Territories per plot including standard deviation and territories per hectares are given including mean number of territories per type of crop.
Inventeringsresultat i olika grödor baserat på två inventeringsomgångar. Antal revir per provyta med standardavvikelse per hektar redovisas, även revir i medeltal per gröda.

Crop *Gröda*	Inventory dates *Inventerings-dagar*	Territories per plot *Revir per provyta*	Standard deviation	Territories per hectare *Revir per hektar*	Mean per type of crop *Medeltal per typ av gröda*
Autumn grain *Höstsäd*					
Sörby	12+22 May	2.75	1.35	0.92	0.80
Bärsta	15+24 May	2.00	1.05	0.67	
Spring grain *Vårsäd*					
Sörby	31 May+14 June	2.08	1.61	0.69	0.75
Bärsta	31 May+15 June	2.44	0.53	0.81	
Silage *Vallodling*					
Sörby	12+22 May	2.50	1.31	0.83	0.83
Average *Medeltal*				0.80	0.79

40 cm again by 11 July when the final survey round was completed. The second cut of the silage field was done 22 July, delayed by roughly a week due to wet weather. By the end of June both autumn and spring seed were higher than the grass. Later in the season a third harvest of silage was carried out on 23 September.

Survey of skylark territories and timing of breeding in Sweden

In Table 2 the survey result is summarized (see also Appendix 1 for the full dataset). There was no significant difference in skylark numbers between the conventional and organic farms (t-test, autumn seed t=0.76, df=6, p>0.2 and spring seed t=0.52, df=6, p>0.2). The survey result shows almost the same density of territories in different types of crop at the end of May (p>0.2 for all combinations of grass and grain). A mean of 0.75–0.83 territories per hectare (autumn seed 0.80, spring seed 0.75 and grassland 0.83) or 75–83 territories per km^2 was registered based on the two rounds showing the highest number of singing males. In the spring grain at Sörby however the variation was high (mean 2.04, std. dev. 1.61 territories per plot, Table

Photo 1. Julie Murray is counting the singing skylarks at a survey plot in spring seed. Kvismaren 30 May 2015.
Julie Murray räknar sjungande sånglärkor på en inventeringspunkt den 30 maj 2015. Foto Jan Sondell.

Photo 2. Newly cut silage field at Sörby estate, Kvismaren in the beginning of June 2016.
Nyingen skördat ensilagefält på Sörby gård, Kvismaren i början av juni 2016. Foto Magnus Persson.

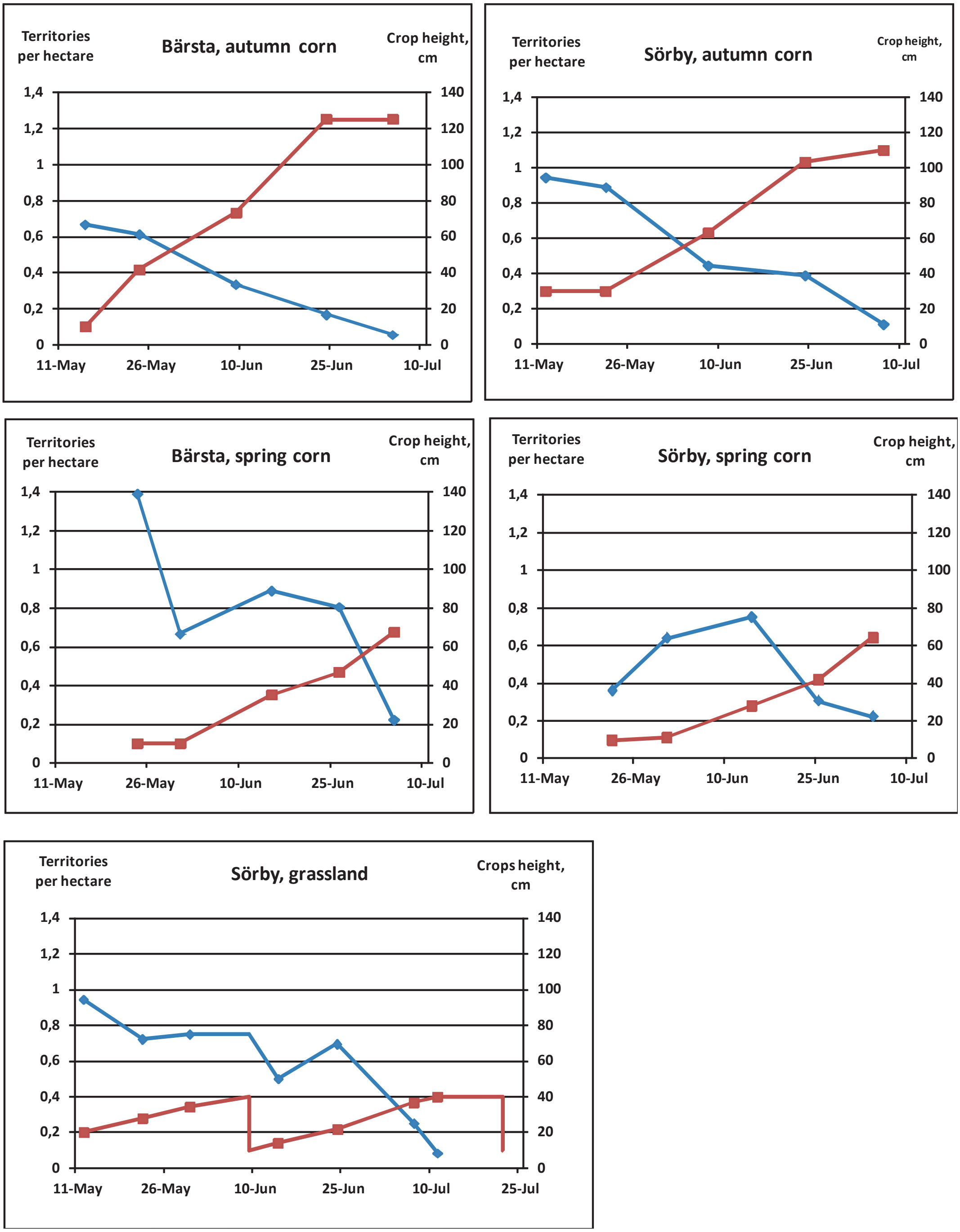

Figure 3. Skylark territories (blue) at different survey date and crop height (red) in different crops. In grassland there are two dips in crop height indicating the two harvests, on 5 or 9 June, and 22 July (note that data for 9 and 22 June are approximations). The second harvest was delayed by one week due to rain.

Antal revir (blå) av sånglärka vid olika stråhöjd (röd) i olika grödor vid olika inventeringstillfällen. I vallodlingen indikerar det två nedgångarna skördetillfällena den 5 eller 9 juni respektive 22 juli (notera att data för 9 och 22 juni är uppskattningar). Den andra skörden var försenad på grund av regn.

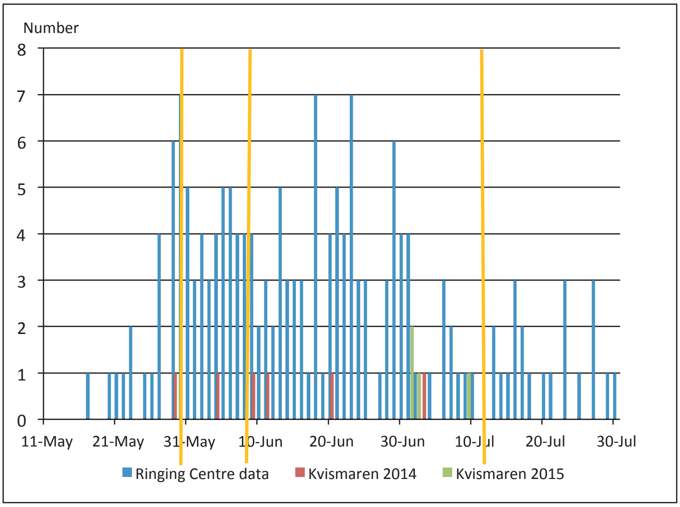

Figure 4. Ringing dates for skylark clutches 1962–2001 in Svealand from Swedish Bird Ringing Centre. Yellow vertical bars show in order (1) early to normal first harvest of silage 2014, (2) late first harvest in 2015 and (3) late second harvest in 2015. Clutches spontaneously ringed at Kvismaren in 2014 and 2015 are also indicated.
Datum för ringmärkning av kullar av sånglärka 1961–2001 i Svealand enligt Ringmärkningscentralen. Gula vertikala streck visar i ordning tidigt till normalt skördetillfälle 2014, sen första skörd 2015 och sen andra skörd 2015. Kullar som tillfälligtvis har märkts vid Kvismare fågelstation 2014–2015 visas också.

2). This was probably partly due to the islets with tall trees in close proximity and partly due to the bordering silage field (Figure 1).

Number of skylark territories in grassland cut for silage at Sörby at different height of crop is also shown in Figure 3. The first and second harvests are indicated by sudden drops in height curves. In May the number of territories varied from 0.94 per hectare to 0.72 until the first harvest. Five days later the number had dropped to 0.5. It recovered shortly afterwards almost to its former level but fell close to zero in the middle of July. Although many skylarks were singing and recorded as holding territories on 24 June, it is probable that only a small proportion of pairs laid a replacement clutch, judging from our observations. Only 0.25 territories per hectare were recorded on 8 July in the silage field.

Figure 4 shows that the main ringing period in Svealand 1962–2001 is the whole month of June. The young are estimated to be about 6 days of age when ringed and the main breeding period counted from the first egg laid is thus normally approximately between 5 May and 5 June in central Sweden.

Effect of silage harvest

During the silage harvest careful observations of skylark behaviour were made. Systematic searches for nests were carried out 5, 6 and 9 June. The complete field notes from these occasions are attached (Appendix 2). No nests were found in the stubble between the lying grass strips. The lying grass cov-

Table 3. Breeding cycle for the skylark after Donald (2004).
Häckningscykel för sånglärka efter Donald (2004).

Activity *Aktivitet*	Time in days *Tid i dagar*	Comments *Kommentarer*
Restart after failure *Tid att starta omläggning*	ca 5	Uncertain *Osäker*
Nest building *Bobyggnad*	ca 5	Uncertain *Osäker*
Laying of eggs *Äggläggning*	3–5	Varies with the number of eggs, 1 egg per day *Varierar med antal ägg, 1 ägg per dag*
Incubating *Ruvning*	11–12	
Feeding young in nest *Matning av ungar i bo*	8–9	
Feeding young outside nest *Matning av ungar utanför bo*	8–11	
Sum	40–47	

ered some 75% of the field area after cut (Photo 2). Many predators (mainly harriers, corvids and gulls) were also searching for living creatures in the field. Observations by field staff suggested that no nests survived the cut and the subsequent predator search. Confused behavior of adult skylarks was also observed (see Appendix 2). A pair of ortolan buntings showed signs of having had a nest in the silage field and this also appeared to have been destroyed by the harvest (the male changed his song behaviour after the grass harvest).

Also in 2014 another silage field of the same size as that at Sörby estate was cut, this year on 27 May. The observations on that occasion were similar to those in the main study year, 2015. The same species of predators were present and no surviving skylark nests were found. However, a nest with known approximate position before the cut was seen to be predated in the stubble by a crow *Corvus corone.*

Search for nests

Intensive feeding of young in the cereal fields was not observed by the staff until Midsummer but it had probably been going on for some time. The weather was very bad before Midsummer and prevented detailed observations. However, on 30 June and 1 July a search for nests was carried out in order to get blood samples from nestlings. We located approximate positions for six nests in spring seed, three at each farm. Most chicks by this time had left the nest and were being fed by the parents in the area surrounding the nest. Four pairs were observed to feed in this manner, whilst two nests still had young in the nest cup. These nests were visited. The nestlings were around eight to nine days old, and almost ready to leave the nest.

One replacement nest with skylarks feeding three young was found in the silage field on 9 July. The chicks were estimated to be around five days old. This indicates an incubation start date of 23 June, which agrees with a breeding cycle beginning directly after harvest on 9 June (see also Table 3). In the large silage field additional replacement nests were searched for but no more were located.

Discussion

Skylark breeding period in central Sweden

It is important to state that no systematic search for nests was made, except after the first harvest of the silage field. Therefore, we do not know the relationship between singing territories and nests or the exact timing of nesting in our study plots. Our previous experience of visiting nests in homogeneous fields has demonstrated a negative impact on breeding success; it is not possible to fully avoid a track in the crop, which may guide predators to the nest. Three ortolan and two skylark nests have probably been predated for this reason in recent years at Kvismaren.

The skylark breeding cycle is presented in Table 3. The duration of the breeding cycle is at a minimum 40 days including restart after failure (after Donald 2004). It will take some days to restart the breeding, so this is an uncertain estimate. Also the amount of time spent on nest building is uncertain, but is estimated to another five days. The figures

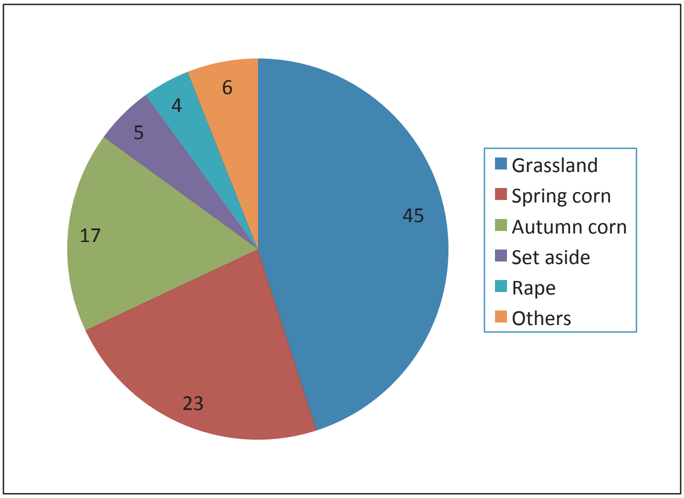

Figure 5. Use of arable land in Sweden 2014 in percent. Total area 2.6 million hetares. (Data from Jordbruksverket).
Åkermarkens användning i Sverige i procent 2014. Grödorna är ordning vall, vårsäd, höstsäd, träda, raps och övrigt. Total area 2,6 miljoner hektar.

for egg laying, incubation and feeding of young are more reliable, summing up to 30–37 days (after Donald 2004). The skylark breeding period is rather long (Figure 4) and probably influenced by the height of different crops and replacements due to predation and harvest failures. It is thus uncertain if the replacement nest we found on 9 July was successful. Time between harvests one and two was 43 days in 2015, as the second cut was delayed by a week due to rainy weather. Normally the two successive cuts in late May and early July within some 35 days would totally wipe out the skylark production in the grassland fields of the Kvismaren valley. Furthermore, only a small proportion of the larks laid a replacement clutch. By the middle of July silence prevailed in the study area. A second brood is also unlikely in Sweden due to the time demand for moult (Ginn et al. 1983).

The significance of different types of farms and crop for the reproduction of skylarks at Kvismaren

We found no significant difference in skylark numbers between organic and conventional farming at Kvismaren. The average number of territories were similar at both farms, and in different types of crops.

The same density of skylarks as in Kvismaren (some 75 pairs per km^2) was recorded in a Swedish study on an organic farm in Uppland (Berg & Kvarnbäck 2011). Compared to other studies in Europe (compiled by Donald 2004) this occurrence is very high and may well be related to the very high proportion of spring seed in the Kvismaren valley. Only about 10–15% of the farmland at larger estates in this part of Närke is used as grassland (Markus Grenestam, Örebro County Administrative Board, pers. com.) and autumn seed is avoided in large areas due to potential for root damage.

Skylark males compete in spring for nesting territories within their home area. The birds are already at their breeding grounds in March. They are very faithful to the territory held the previous year (Delius 1965). Then they wait for around two months for adequate conditions to be able to start breeding; most importantly for vegetation which is high enough to hide the nest. As the farmers rotate the crops in a 3–5 year cycle, the larks may either wait for the vegetation to grow high enough, or move to adjacent fields. The males probably use both strategies. The start of the nesting period in a certain crop may then be fairly synchronized. The grassland is probably a favorable breeding habitat (Kuiper et al. 2015). The even distribution in different crops (75–83 pairs km^2) at Kvismaren can probably be explained by the lark's faithfulness to a particular area in combination with rotation of crops in the actual fields from year to year.

In Switzerland Jenny (1990) found in a limited area that intensive cutting of grass (every month) destroyed all nests, mirroring the results presented here. In areas largely comprised of grassland, such a farming technique may eliminate the entire skylark population. In the interior of northern Sweden the grassland share of the arable land nowadays is very high (some 90%, Jordbruksverket 2014). In this part of the country the skylark decrease is most rapid (Green et al. 2016). The early harvest is probably the main reason why very low figures are reported in density comparisons and production of young when it comes to intensively used grassland all over Europe (Buckingham et al. 2015, Donald et al. 2002, Wakeham-Dawson & Smith 2000, Poulsen 1993, Jenny 1990). In Kvismaren spring seed is fortunately dominant.

The number of territories in the autumn crops during the middle of May is as high as in the other types of crops, but possibly the skylarks breeding there are arrested by the fast growing crop. High vegetation is not optimal for searching of food (Donald 2004). However, at Kvismaren there is plenty of ground with lower vegetation around, in fields recently sown with spring seed or other late crops (potatoes, carrots, etc.). Therefore, it may be easy for the larks to find sufficient feeding areas at moderate distances if the nest is laid in autumn seed. The carrot field (Figure 1) is a good example of this. It was also utilized by many feeding larks from the surrounding fields of spring seed. A feeding distance of up to 150 m is normal for this species (Donald 1999) and probably it can be extended if necessary. Donald (2004) gives an example of a pair of skylarks nesting in autumn seed searching for food in a set aside area 500 m away from the nest.

In spring sown cereals the breeding cannot start until the vegetation is high enough to hide the nest. This year it happened at the beginning of June (Figure 4, see also Photo 1). Most of the fields in Kvismaren are sown with spring seed because of the risk for ice lift of the roots of small growing plants sown in the autumn. This means that the skylark population at Kvismaren is comparatively strong. What is the situation in other parts of the country?

The significance of different grain for the reproduction of skylarks in Sweden

Figure 5 shows the proportions of different crops in Sweden in 2014. Hay, silage and other animal forage cover 45% (excluding semi-natural pastures) and cereals some 40% of the arable land area. The remaining part is mainly occupied by set aside areas and oil seed rape but also sugar beets, potatoes and leguminous plants. The cereal area is divided into autumn seed, some 17% (in 2013 only 10%) and spring seed 23%.

In this context it is also important to be aware that the agricultural area in Sweden has decreased since 1975 by around 400 000 hectares (13%). This also of course, has an impact on the number of skylarks present. The proportion of grassland has been fairly constant over the years (Wretenberg et al. 2006), but the cultivation technique has changed dramatically. Up to the 1980s and beginning of 1990s the harvest output was *dry hay*. To harvest that kind of material, the straws needed cellulose content for the handling, which generally prevented cut before the middle of June. In the 1990s the harvest gradually changed from hay to *soggy silage* and earlier cuts, in which better nutrient content were possible to achieve. In Örebro county for example the dry hay share was 86% and the silage 13% in 1992 (SCB 1993). Today the proportion of silage is over 90% and the intensity in cultivation of grassland has increased, generating successively earlier and more harvest rounds in a season.

Monitoring shows that the skylark has decreased in Sweden in recent decades (Wretenberg et al. 2007, Green et al. 2016). However, different methods for collecting data show different results. During the period 1975–2014 a severe decrease of 72% was calculated based on observers' free-choice of sample sites. In 1998 a more reliable system was introduced, namely fixed sites evenly covering the whole country (Green et al. 2016). During the period 1998–2014 the new scheme estimated a decline of 21% compared to 45% during the same period for the free-choice scheme. The skylark has obviously decreased in number in Sweden but it is uncertain how big that decrease is.

In total some 800 000 skylark pairs breed in Sweden today (actually 2008, Ottosson et al. 2012). Out of these 680 000 breed on cultivated farmland, and the remaining 120 000 pairs nest on natural grassland, mainly on the islands of Öland and Gotland. Our study in Kvismaren indicates that the change to grass silage cropping, besides the decrease in farmland area, may be an important and overlooked driver of population declines of skylarks and other field nesting species. Skylarks breeding in cereal crops are normally not seriously affected by farming methods. Only in areas where autumn seed strongly dominates may there be a risk for lack of feeding habitats because of the high vegetation. Autumn seed areas are mainly situated in the counties of Skåne, Västra Götaland, Östergötland and Uppland where the autumn crop covers one quarter of the farmland area. Despite that, these counties keep two thirds (66%) of the skylark population on farmland in Sweden (Ottosson et al. 2012).

In 2012 SOF BirdLife Sverige introduced the program *Rädda Sånglärkan (*http://www.raddasanglarkan.se/; transl.: Save the Skylark) for creating unsown patches in autumn-sown cereal fields (Skylark plots; 1–2 per hectare, 16–20 m2/plot). These have been shown to improve the quality of breeding habitat by increasing food availability in dense vegetation in England (Morris et al. 2004, RSPB leaflet), where the autumn or winter seed is totally dominant. Studies in Sweden have not been able to verify such benefit (Berg & Kvarnbäck 2011, Hiron et al. 2012). It is possible that the main reason for the skylark setback in Sweden is not the height and density of the autumn seed but, alongside the shrinking total farming area, the successively lower reproduction rate in grasslands because of the increasing intensity in harvesting over recent decades. A more successful way to support the larks in autumn seed areas would probably be to depart homogenous areas of autumn seed and breed other crops in between (Chamberlain et.al. 1999). Rotation of crop is a natural element in the farmer´s planning.

Is it possible to improve the skylark outcome in grassland fields?

The repeated harvest of silage several times per season is today a standardised method to optimise quality and volume of the yield from grassland. This optimisation has been refined during many decades. A delay of the first, and for the skylark, the most disastrous harvest would affect the quality of the silage the most; the early harvested high quality grass is required to get maximal milk production and thus a good economic return for the farmers. There is obviously no simple solution to the time schedule problem. A three to four weeks delay (until after Midsummer) of the harvest would spare many broods (Figure 4) but the quality of the silage would in general decrease too much (Jordbruksverket 2014).

What can we do to address this? We know that the skylarks avoid parts of the fields bordering tall trees. Oelke (1968) estimated a distance from about 100 to 200 m dependent of the height of the adjacent forest. These areas of the fields are usually possible to harvest on time without causing any harm to the larks. Also smaller fields, less than around 10 hectares, surrounded by trees are possible to harvest as they are not utilised by the larks (Piha et al. 2003). However, in the few ortolan bunting breeding areas these are not good solutions as the species often nests close to smaller wooded islets within the fields.

Areas in the central part of the field might also be left for the skylark 3–4 further weeks, and this food could be reserved for recruits to the milk stock and cows not producing milk for the moment. Also sucker cows demand less nutritious food (Nilla Nilsdotter-Linde, pers. com.). With such a strategy a system for compensation to farmers for delaying harvest in order to protect the skylark nests (and other ground breeding birds such as partridge, pheasant, corncrake, quail, curlew, lapwing, corn bunting, etc.) is probably necessary to introduce. Also Montagu's harrier nesting on farmland on Öland suffers from the early cut (Rodebrand 2016). To leave set-asides more or less covered with vegetation during the breeding period is another good option.

A new possibility is available in some primary agricultural areas because grass is a good basis for producing biogas. Instead of producing silage for cows, the grass may be transported to a plant and fermented for biogas production. There are such plants in Västerås and Örebro. In a case study Dahlgren (2013) calculated on a possible expansion of biogas until 2030 (medium case) to make use of 5% of the agricultural area in Sweden. The possibility of expansion is however uncertain and very much dependent on oil price and on political decisions. The advantage with gas production in this context would be that it is possible to harvest the grass somewhat later. How much later is today unknown and must be studied.

Further studies focusing on the skylark nest distribution in different fields in Sweden are desirable. With such local knowledge, development of an adapted harvest of the grasslands to decrease losses of skylark nests and other animals dwelling in the grass may be possible.

Conclusions

A survey of skylarks at Kvismaren, central Sweden, in 2015 showed that the abundance was 75–83 pairs per km$^{2.}$ No significant differences due to crop and cultivation system in the study area of 200 hectares could be identified. Both in 2014 and 2015 the first harvest of grass for silage likely destroyed all nests. A few pairs laid a replacement clutch but there is normally not time enough to allow these young to fledge before the next cut. There are no such major threats in the grain fields. The best nesting habitat at Kvismaren is probably the large proportion of spring seed where the vegetation is shorter than in the autumn seed during the breeding period of the skylarks. Autumn *triticale* also grows higher than the spring cereals crops wheat and oats.

The program for creating skylark plots in autumn grain to improve the breeding habitats for skylarks in Sweden ought to be evaluated. An option would be to use resources earmarked for skylarks to delay part of the harvest for silage in certain areas or get a better mixture between fields with autumn seed and other crops. Further studies focusing on ways and means for this are needed.

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Sammanfattning

År 2014 genomfördes studier av ortolansparv i Kvismaren och i samband med detta togs blodprov på bl.a. lärkungar för att se om växtskyddsmedel anrikades i åkerhäckande tättingar. Därvid upptäcktes att vallodlingarna skördades långt innan ungarna i lärkbona var utflugna. Alla lärkbon förstördes. Därför genomfördes under 2015 en inventering av sånglärka med syfte att undersöka hur odlingsmetoderna i jordbruket påverkade sånglärkans revirtäthet i olika grödor och om det var någon skillnad på ekologisk och konventionell odling. Odling av vall, höstsäd och vårsäd ingick i studien.

Resultat

Totalt inventerades ungefär 200 hektar jordbruksmark på två stora gårdar i Kvismardalen; Sörby och Bärsta. Fördelning på grödor och antal provytor framgår av Tabell 1. Studieområdet med provytor redovisas i Figur1. Alla insamlade studiedata redovisas i Appendix 1.

Vegetationens utveckling har stor betydelse för när lärkan kan börja häcka. Stråhöjden i olika grödor redovisas vid olika tidpunkter i Figur 2. I Figur 3 presenteras revir av sånglärka i olika grödor på

Sörby och Bärsta i relation till grödans höjd vid olika tidpunkter under våren–försommaren. Antalet revir är lägre där vegetationen är högre. Antalet revir är ungefär detsamma vid samma vegetationshöjd på de två gårdarna. Den lägre tätheten av lärkrevir i vårsäd på Sörby kan kanske förklaras av närheten till träddungar (Figur 1) eller till vallodlingen, som erbjuder optimala förutsättningar. Vallar saknas på Bärsta.

Skörd 1 och 2 i vallodling på Sörby indikeras av en momentan nedgång i vegetationens höjd. På våren registrerades mellan 0,92 och 0,72 revir per hektar. Antalet sjönk till 0,5 efter första skörd. Det ökade sedan igen men föll till nära noll i mitten av juli.

Trots noggrant sök efter slåttern hittades varken skadade eller hela lärkbon (Appendix 2). Den första slåttern förstörde uppenbarligen alla bon eftersom fältet antingen var penetrerat av hjulspår eller täckt av hösträngar på ca 75% av arealen. Den kvarvarande stubben patrullerades av kråkor och kärrhökar och flera andra predatorer. År 2014 bevittnades även hur ett frilagt lärkbo plundrades på sina ungar av kråka. Ett par ortolansparvar fick sannolikt också sitt bo förstört av slåttern.

Sök efter lärkbon för blodprovtagning skedde inte förrän i månadsskiftet juni–juli. Vädret veckorna innan hade varit mycket regnigt och kallt. Fyra bon där ungarna matades efter att ha lämnat boet noterade i månadsskiftet och två där ungarna fortfarande var i boet, 8–9 dagar gamla, alla i vårsäd jämnt fördelade på Bärsta och Sörby. I vallodlingen hittades den 9 juli en omlagd kull med lärkungar som var ca 5 dagar gamla. Det är osäkert om denna kull hann bli flygg innan nästa skörd, som något försenad på grund av regnigt väder, ägde rum den 22 juli, se sånglärkans häckningscykel i Tabell 3. En tredje skörd togs 23 september.

Diskussion

I Figur 4 redovisas 137 kullar av sånglärka märkta i mellersta Sverige 1962–2001, data från Ringmärkningscentralen, tillsammans med de slumpvis funna kullar som märkts i Kvismaren 2014 och 2015. Om ungarna vid märkningen är ca 6 dagar kan man beräkna att den huvudsakliga häckningstiden startar i perioden 5 maj till 5 juni i mellersta Sverige.

Häckningsperioden är relativt lång och styrs av höjden på olika grödor och av de omläggningar som sker på grund av predation och skador på bona vid skörd. Med gällande skördeintervaller får sånglärkorna inte alls några ungar på vingarna i vallodlingarna. Dessutom lägger få par om, åtminstone var det så i Kvismaren 2015. Tidsåtgången för ruggning efter häckningen begränsar också föräldrarnas möjligheter till omläggning.

Inventeringsresultatet i Kvismaren visar på ungefär samma täthet, 75–83 revir per kvadratkilometer, oberoende av gröda. Detta är ett relativt högt värde jämfört med andra studieresultat i Europa. Att sånglärkan har en så stark stam i Kvismaren beror troligen på att andelen vallodling är liten.

Sånglärkan är starkt hemortstrogen. Den anländer till hemmaåkern i mars och väntar sedan på att vegetationen ska bli så hög att den kan börja häcka. Jordbruket tillämpar en växtföljd som gör att lärkan måste häcka i olika grödor olika år. I höstsäd och vallodling kan den starta tidigare än i vårsäd. Om vegetationen blir för tät för födosök finns andra grödor i omgivningen att besöka (Figur 1).

Figur 5 visar fördelningen av olika grödor i Sverige år 2014. Vallodling (exklusive naturbeten) utgör 45% av åkerarealen. Höstsäd utgjorde 17% (en relativt hög siffra, år 2013 var andelen bara 10%) och vårsäd 23%. När man diskuterar arealer i förhållande till sånglärkans förekomst är det också viktigt att veta att 400 000 hektar jordbruksmark har lagts ner sedan 1975. Det innebar 13% av arealen, som nu är ca 2,6 miljoner hektar. Andelen vallodling har varit ungefär lika genom åren men skördetekniken har ändrats dramatiskt från torrt hö till fuktigt ensilage. Höskörden skedde i regel omkring midsommar medan det första ensilaget tas redan i slutet av maj när lärkan har nykläckta ungar i bona.

Inventeringar har visat att sånglärkan minskat i antal i Sverige under senare decennier. Under perioden 1975–2014 var minskningen hela 72% enligt sommarpunktrutterna i Svensk fågeltaxering. De objektivt utlagda standardrutterna visar en nedgång på 21% under åren 1998–2014. Motsvarande värde för sommarpunktrutterna var 48%. Sånglärkan har uppenbart minskat men hur mycket och orsakerna kan diskuteras. Dels har den minskade åkerarealen haft betydelse men i övrigt är det troligt att det successivt allt effektivare utnyttjandet av vallarna med flera och tidigare skördar är den största orsaken till minskningen. De områden som har mest höstsäd har också den största populationen sånglärka. Skåne, Västra Götaland, Östergötland och Uppland hyser 66% av populationen sånglärka på åkermark i Sverige.

År 2012 introducerade SOF-Birdlife Sverige programmet Rädda Sånglärkan med syfte att skapa lärkrutor (1–2 stycken per hektar, 16–20 m^2) för att öka sånglärkornas möjligheter att skaffa föda. Idén kom från England där höst- eller vintersådd är helt dominerande. Om huvudorsaken till sånglärkans tillbakagång, vid sidan av arealminskningen, är den dåliga reproduktionen på vallarna, kan nyttan av denna satsning ifrågasättas. En satsning på 2 400 lärkrutor per år för att gynna en lärkpopulation på 680 000 par på åkermark kan i bästa fall ge en marginell förbättring. Från England rapporteras dessutom att lärkan kan flyga upp till 500 m för att födosöka på ett omtyckt näringsställe, även om så stort avstånd är undantag.

Det är uppenbart att man inte kan senarelägga skörden av vallarna av naturskyddsskäl utan att det får konsekvenser för lantbrukarnas ekonomi. Det finns därför ingen enkel lösning för att skydda lärkbona från förstörelse. Lärkan häckar dock inte på mindre fält (<10 hektar) och inte närmare åkerkanter med höga träd än 100–200 m. På sådana delar av arealen kan man skörda utan problem för sånglärkan. Vissa typer av boskap behöver heller inte det mest fullvärdiga fodret vilket betyder att vissa lärktäta fält kanske kan sparas ungefär de 3–4 veckor till efter midsommar som behövs för att ungarna ska bli flygga före skörd. Att lämna delvis ogrästäckta trädor är ett annat bra alternativ.

Ytterligare studier är önskvärda på åkermarker i Sverige. Med lokal kunskap kan man eventuellt utveckla nya skördemodeller med syfte att minska skadan så mycket som möjligt. I sammanhanget bör kanske också ett ersättningssystem till lantbrukarna utvecklas.

Slutsatser

Sånglärkan har en stark stam i Kvismaren, det finns 75–83 revir per kvadratkilometer oberoende av gröda och typ av gård. Både 2014 och 2015 förstördes sannolikt alla bon i vallodlingar inom studieområdet vid den första skörden. Eventuella omläggningar förstördes med största sannolikhet också i samband med efterföljande skördar. Det finns inga sådana hot på sädesfälten. Den nuvarande satsningen på lärkrutor ter sig mot denna bakgrund tveksam, och projektupplägget bör därför utvärderas. Kanske kan medel avsedda för sånglärkan användas på ett bättre sätt genom att lämna ekonomiska bidrag till senareläggning av vallskörden på vissa fält eller delar av fält.

Appendix 1

Data from all survey plots and visits in 2015.
Data för alla provytor och besök 2015.

Plot no. *Yta nr*	Visit no. *Besök nr*	Date *Datum*	Start time *Start-tid*	Singing males *Sjungande hanar*	Height of crop (cm) *Grödans höjd (cm)*	Surv-eyor *Inven-terare*
Sörby, autum crop ***vårsäd***						
1	1	12-5-15	0621	3.0	30	JMY
1	2	22-5-15	0812	2.5	30	EKP
1	3	6-6-15	0934	1.5	62	EKP
1	4	24-6-15	0647	1.5	100	JMY
1	5	7-7-15	0801	0.5	120	JMY
2	3	12-5-15	0642	4.0	30	DWE
2	4	22-5-15	0812	2.0	30	JMY
2	5	10-6-15	0909	1.0	65	EKP
2	6	24-6-15	0710	0.5	120	JMY
2	7	4-7-15	0742	0.0	110	JMY
3	1	12-5-15	0622	1.5	30	DWE
3	2	22-5-15	0850	3.5	30	EKP
3	3	9-6-15	0934	1.5	62	EKP
3	4	24-6-15	0623	1.5	90	JMY
3	5	4-7-15	0721	1.0	100	JMY
Sörby, hay ***hö***						
4	3	12-5-15	0700	2.5	no data	DWE
4	4	22-5-15	0832	3.0	32	EKP
4	5	30-5-15	0800	2.0	40	JMY
4	6	14-6-15	0822	1.0	13	MPN
4	7	24-6-15	0815	3.5	20	MPN
4	8	7-7-15	0820	1.0	40	MPN
4	9	11-7-15	0730	1.0	50	MPN
5	1	12-5-15	0641	1.0	?	JMY
5	2	22-5-15	0753	0.0	30	JMY
5	3	30-5-15	1042	1.0	40	JMY
5	4	14-6-15	0905	0.0	13	MPN
5	5	24-6-15	0855	2.5	20	MPN
5	6	7-7-15	0740	0.0	40	MPN
5	7	11-7-15	0817	0.5	50	MPN
6	1	12-5-12	0700	2.0	no data	JMY
6	2	22-5-15	0759	3.5	30	EKP
6	3	30-5-15	0820	2.0	38	JMY
6	4	14-6-15	0845	2.0	13	MPN
6	5	24-6-15	0835	2.0	20	MPN
6	6	7-7-15	0800	1.0	40	MPN
6	7	7-11-15	0755	0.0	50	MPN
7	1	12-5-15	0723	4.0	no data	DWE
7	2	22-5-15	0730	2.5	30	EKP
7	3	31-5-15	0830	1.5	33	EKP
7	4	14-6-15	0855	1.0	15	EKP
7	5	24-6-15	0846	1.5	25	JMY
7	6	7-7-15	0812	0.5	35	JMY
7	7	11-7-15	0755	0.0	27	JMY
8	1	12-5-15	0726	2.5	no data	JMY
8	2	22-5-15	0726	2.0	15	JMY
8	3	31-5-15	0809	5.0	25	EKP
8	4	14-6-15	0837	3.5	15	EKP
8	5	24-6-15	0825	2.5	25	JMY
8	6	7-7-15	0751	2.0	35	JMY
8	7	11-7-15	0734	0.0	30	JMY
9	1	12-5-15	0748	5.0	no data	JMY
9	2	22-5-15	0705	2.0	30	EKP
9	3	31-5-15	0747	2.0	30	EKP
9	4	14-6-15	0812	1.5	15	EKP
9	5	24-6-15	0804	0.5	20	JMY
9	6	7-7-15	0731	0.0	30	JMY
9	7	11-7-15	0714	0.0	30	JMY
Sörby, spring crop ***vårsäd***						
10	1	22-5-15	0635	0.0	10	EKP
10	2	30-5-15	1104	0.0	12	JMY
10	3	14-6-15	0815	1.0	30	JMY
10	4	25-6-15	0605	0.5	40	JMY
10	5	7-4-15	0836	0.0	65	JMY
11	1	22-5-15	0644	0.0	0	JMY
11	2	31-5-15	0657	1.0	8	JMY
11	3	14-6-15	0835	0.0	30	JMY
11	4	25-6-15	0625	1.0	45	JMY
11	5	4-7-15	0857	1.0	75	JMY
12	1	22-5-15	0703	0.0	8	JMY
12	2	31-5-15	0713	0.5	10	EKP
12	3	14-6-15	0855	1.5	30	JMY
12	4	25-6-15	0645	1.5	45	JMY
12	5	4-7-15	0918	0.5	65	JMY
Bärsta, autum crop ***höstsäd***						
13	1	15-5-15	0732	1.0	10	JMY
13	2	24-5-15	0750	0.5	45	EKP
13	3	10-6-15	0848	1.0	80	JMY
13	4	24-6-15	0630	0.5	125	MPN
13	5	5-7-15	0713	0.0	125	JMY
14	1	15-5-15	0736	2.0	10	EKP
14	2	24-5-15	0755	3.0	45	MPN
14	3	9-6-15	0939	1.0	70	JMY
14	4	24-6-15	0655	0.0	125	MPN
14	5	5-7-15	0653	0.0	125	JMY

Plot no. *Yta nr*	Visit no. *Besök nr*	Date *Datum*	Start time *Start-tid*	Singing males *Sjungande hanar*	Height of crop (cm) *Grödans höjd (cm)*	Surv-eyor *Inven-terare*
15	1	15-5-15	0736	3.0	10	MPN
15	2	24-5-15	0752	2.5	35	JMY
15	3	9-6-15	0959	1.0	70	JMY
15	4	24-6-15	0717	1.0	125	MPN
15	5	5-7-15	0635	0.5	125	JMY
16	1	24-5-15	0820	4.0	no data	MPN
16	2	31-5-15	0806	2.5	no data	JMY
16	3	15-6-15	0645	3.0	37	EKP
16	4	26-6-15	0840	2.5	50	MPN
16	5	5-7-15	0713	1.0	65	JMY
17	1	24-5-15	0825	4.0	15	JMY
17	2	31-5-15	0726	1.5	15	JMY
17	3	15-6-15	0650	2.5	37	JMY
17	4	26-6-15	0805	2.0	50	MPN
17	5	5-7-15	0759	1.0	65	JMY
18	1	24-5-15	0825	4.5	15	EKP
18	2	31-5-15	0744	2.0	15	JMY
18	3	15-6-15	0650	3.0	37	MPN
18	4	26-6-15	0750	3.0	50	MPN
18	5	5-7-15	0817	2.0	65	JMY
19	1	23-5-15	0755	2.0	10	JMY
19	2	30-5-15	0955	2.5	12	EKP
19	3	14-6-15	0939	3.0	28	JMY
19	4	25-6-15	0804	1.5	40	JMY
19	5	4-7-15	0605	1.0	60	JMY
Sörby, spring crop *vårsäd*						
20	1	23-5-15	0813	2.5	10	JMY
20	2	30-5-15	1015	3.5	12	EKP
20	3	14-6-15	0942	4.5	23	EKP
20	4	25-6-15	0722	0.0	40	JMY
20	5	4-7-15	0624	1.0	60	JMY
21	1	23-5-15	0831	2.0	10	JMY
21	2	30-5-15	1032	4.0	12	EKP
21	3	14-6-15	0942	3.5	23	MPN
21	4	25-6-15	0742	1.0	40	JMY
21	5	4-7-15	0642	1.0	60	JMY
Bärsta, spring crop *vårsäd*						
22	1	16-6-15	0910	2.0	35	JMY
22	2	26-6-15	0727	2.0	50	MPN
22	3	4-7-15	0839	0.0	70	JMY
23	1	16-6-15	0912	3.0	35	MPN
23	2	26-6-15	0649	3.0	50	MPN
23	3	5-7-15	0859	0.0	70	JMY
24	1	17-6-15	0805	2.5	30	MPN
24	2	26-6-15	0628	2.0	30	MPN
24	3	5-7-15	0922	0.0	70	JMY

Appendix 2

Skylark observations and counting of possible predators during and after harvest on a surveyed silage field 2015, with an area of 50 hectares at Sörby estate, Kvismaren. (See also Photo 2.)

Observers: JMY= June Murray, EKP= Elisabeth Kopp, MPN= Magnus Persson.

5 June

Harvest northern part. Weather: dry, sunny (~17 degrees), wind from SW (8 m/s at first, dropping to almost 0 by the end); start: 15.45 end: about 19.00, with pause from 16.00 to 17.00.

The farmers first cut the edges of the field and then drove away for about an hour. During this cutting skylarks were displaying in the neighbouring uncut field. In the pause between the cutting skylarks displayed over the still uncut part as well as over the cut part. Two skylarks landed in the cut part on top of the grass lying on the ground. They were not carrying food (probably). Also during the pause, three skylarks flew very quickly and flat above the ground over the still uncut part, crossing the cut part, flying into the neighbouring field where they met two more skylarks; they were chasing each other a little and went down to the ground.

While the harvest was going on (two machines simultaneously) gulls gathered, most of them staying close behind the machines, probably looking for insects. They only stayed longer on a spot further from the machines where a dead fawn was found.

Gulls and jackdaws were the first to arrive, foraging on the ground. At the very beginning of the harvest, one raven fought with the marsh harrier. The ravens meanwhile went on circling the field in the air and kept some distance. At one point one raven suddenly flew into the middle of the gulls, stealing a field mouse from them. Two hooded crows walked between jackdaws, too far away to see what they fed on. No predator was seen picking up or carrying away skylark chicks or other birds.

After the harvest the gulls were slowly leaving, just the jackdaws, crows and ravens stayed till later evening as well as the marsh harrier. After the harvest, one or two (could be double counted) skylarks were displaying completely over the harvested field, "ignoring" the corvids and gulls (EKP).

Areas where crows/gulls gathered immediately after cutting were checked, the first two of these on ridges where the blades had scraped vegetation away to expose soil. No evidence of nests/chicks destroyed or otherwise was found at these locations. At the third location a dead fawn was found.

Whilst cutting was still taking place a single skylark flew low and purposefully over the cut hay behind the tractor and landed in the still uncut area (it was not observed again). This is similar to observations made by EKP above.

One skylark recorded singing well after the harvest, whilst another sung in broken spells. (JMY)

Predators: Black headed gulls: 88. Common gulls: 2; herring gulls: 2; (gulls seemed more interested in insects and "small stuff"), about 30 jackdaws (same behaviour); one male Marsh harrier patrolling across the cut grass, hasn't been seen picking up birds though. 4 ravens circling, one is stealing a field mouse off the gulls. One raptor (probably black kite patrolling high up shortly over neighbour field but left quickly; Hooded crows: 2; Fox 1(evening) (EKP).

6 June

9.30–11.30. Overcast, dry, wind 0–2 m/s. Farmer was collecting the grass on neighbouring land. Observing from island in middle of field, three skylarks were heard and observed displaying, despite the grass having been cut (average height of grass now: 10 cm). This was surprising in comparison to the previous year's study, when the field fell absolutely silent after the hay harvest. Two roe deer fawns found dead as result of harvest machines going through. Ground searched for evidence of destroyed skylark nests or chicks with areas where gulls and crows seen gathering searched with particular thoroughness. (MPN, JMY)

Predators seen at arrival: raven 1, marsh harrier 1, crow 5, black headed gulls 2. All of them flew as we approached, except the marsh harrier. This continued hunting throughout the period of observation. Marsh harrier observed eating small rodent.

9 June

Second southern part of harvest. Start: 10.00 hrs. End: between 12.30 and 13.00. This time it was only one machine harvesting. No skylarks were singing when we came to the field which is strange because the harvest had just started on one far off end of the field.

We could not find any nests even though we could see one skylark carrying food (caterpillar, probably Noctuidae) and obviously searching for its nest (12.02). It walked around slowly on the pile of hay and next to it, dropping the caterpillar a few times until it dropped it completely. After that we went out to look for its nest, turning around all the hay in this area, but we could not find it.

One to 3 skylarks were singing over the uncut part in the south (that strange clover-sheperd's purse field) during almost the whole harvest from 10:57 on until the machine was halfway finished with that part. Another one was singing over another part of the still uncut field. One skylark was singing partially over the already harvested field and partially over the not yet harvested field (11:48) until the machine approached it, then it quit. Two skylarks were observed flying out of the still uncut grass onto the harvested line closest by, sitting there shortly, flying very low back into the high grass whilst the harvest was still going on (no panic). Some skylarks (up to 8) were observed sitting around in the harvested parts (without food in the beak) looking around, not moving or moving very slowly, some of them randomly picking on the ground (foraging?). They seemed confused.

After the harvest was completed we stayed another 2 hours but no more skylarks could be heard anymore (may also be because they were never very active around that time of the day). Only two skylarks could be observed flying up flushed in front of or around the harvest machine. We guess that many skylarks flee by foot before the machine approaches or have flown off a long time before that as we couldn't see more fleeing (feel vibrations?).

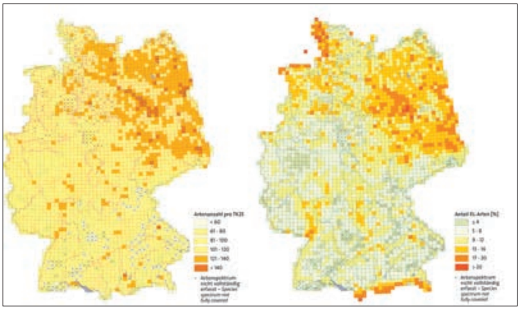
Predators: 2 Marsh harriers after harvest, 1 during harvest (arrived at 11:33), 26 black headed gulls. Around 40 Jackdaws, 3 ravens (first one came in around 40 minutes after start of harvest when ¼ of field was harvested, second one came after about 1 hour),2 herring gulls, 3 hooded crows, 1 kestrel (male 11:14), 4 buzzards (first two of them came around 10:45 o clock, the other two showed up at 11),1-2 common gulls fighting over a mouse or bird (close to the tree line, unlikely to be a skylark?) (11:51, JMY).Two ravens were picking up a mouse each (Arvicolinae, one of them for sure common vole because it was huge and fat), one of them at 11:20 o' clock (EKP+MPN).Black headed gull tried to carry of a vole but it was too heavy and it dropped it. The gull was followed by 10 other gulls but they didn't seem to be interested in the vole. One marsh harrier picked up another vole. No hunting success for kestrel or buzzards could be observed. Marsh harrier flew in between the gulls in the most freshly cut hay (MPN).

Nya böcker – *New books*

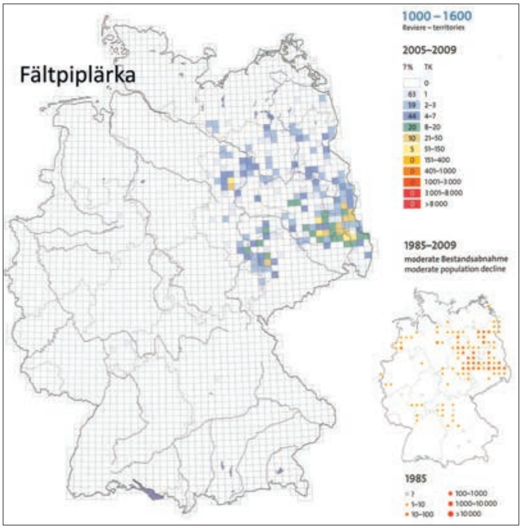
Kai Gedeon, Christoph Sudfeldt & Christoph Grüneberg (redaktörer och författare) samt sexton ytterligare författare, 2014. **Atlas Deutscher Brutvogelarten.** (Atlas of German Breeding Birds, engelska sammanfattningar). Stiftung Vogelmonitoring Deutschland und Dachverband Deutscher Avifaunisten, Münster. 800 sidor, 23x32 cm. Pris 990 SEK i Naturbokhandeln.

Denna tyska häckfågelatlas är ett mästerverk. Planer och inventeringsregler fastställdes och publicerades i maj 2005 och fältarbetet genomfördes 2005–2009. Bearbetningen av materialet startade omgående och under 2010 fanns artkartorna tillgängliga online för rättning, kommentarer och komplettering. Texterna till respektive art låg på samma sätt tillgängliga online fram till den slutliga avstämningen av verket 2013.

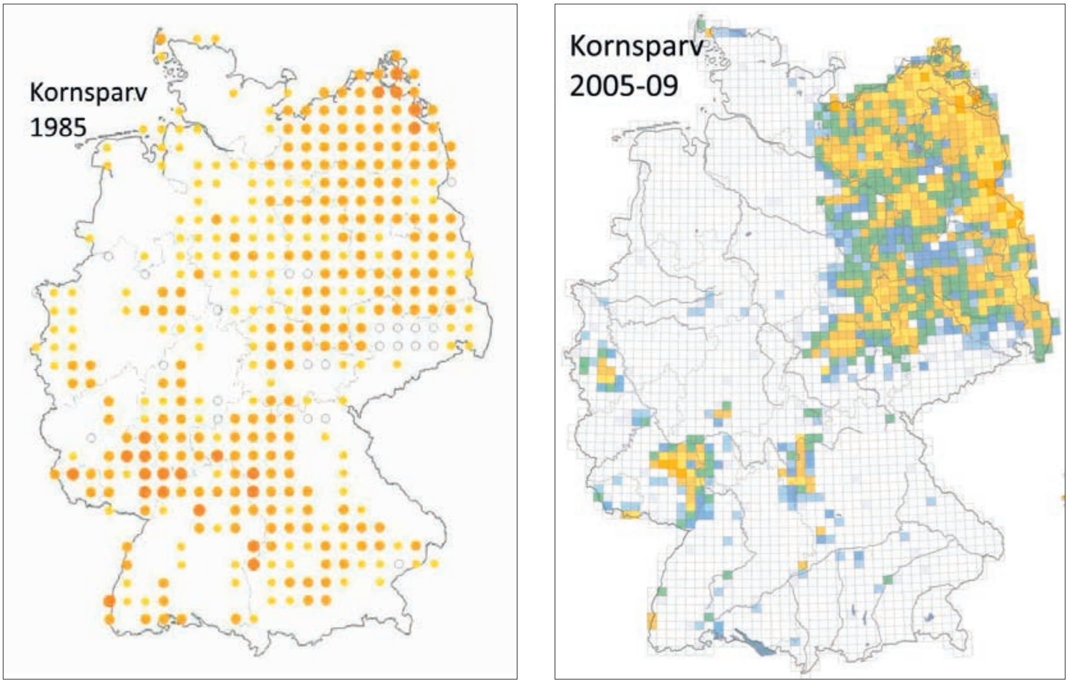
Till en del är boken en traditionell atlas men till en annan del nyskapande. Alla arter redovisas med hjälp av rutor om ungefär 11 gånger 11 kilometer (10 minuter longitud och 6 minuter latitud). Men som det måste vara i en modern atlas redovisas antalet par för varje ruta. Det sker i en skala från 0, 1, 2–3, 4–7 och vidare upp till 1001–3000, 3001–8000 och >8000 par. Dessa skattningar emanerar främst från de skattningar som inventerarna gjort i fält. De hade nämligen i uppgift att skatta antalet par i rutan i just dessa intervall. Summaresultatet för alla arter ges i Figur 1. Varje enskild art presenteras på minst en sådan rutkarta och med motsvarande karta från den första alltyska atlasen (1985) vid sidan om (Figur 2), vilket ger en snabb uppfattning om vad som händ med utbredningen på trettio år, och i viss mån också med antalsförändringar. Fast här är det svårare att omedelbart tolka bilderna eftersom 1985 års atlas hade en annan och grövre skala för antalen, nämligen en tiopotens-



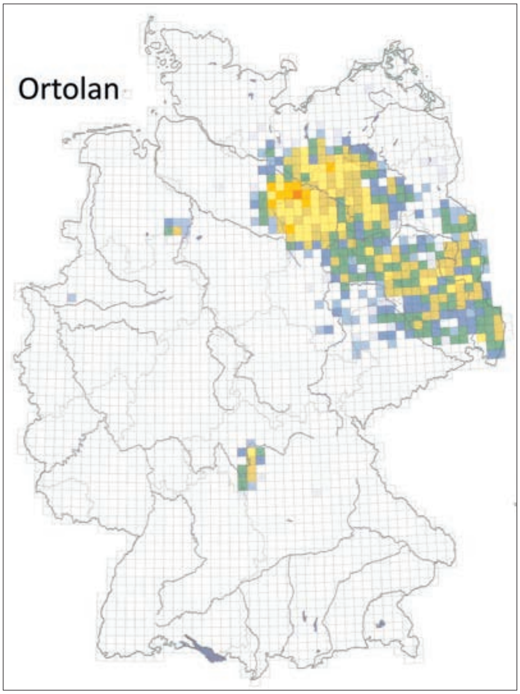
Figur 1. Antal arter i atlasrutorna. Till vänster summan av alla arter, till höger den procentuella andelen av dessa som är sällsynta och rödlistade. Båda visar en koncentration till den region som kallas nordosttyska låglandet och som i stort omfattar f.d. DDR.



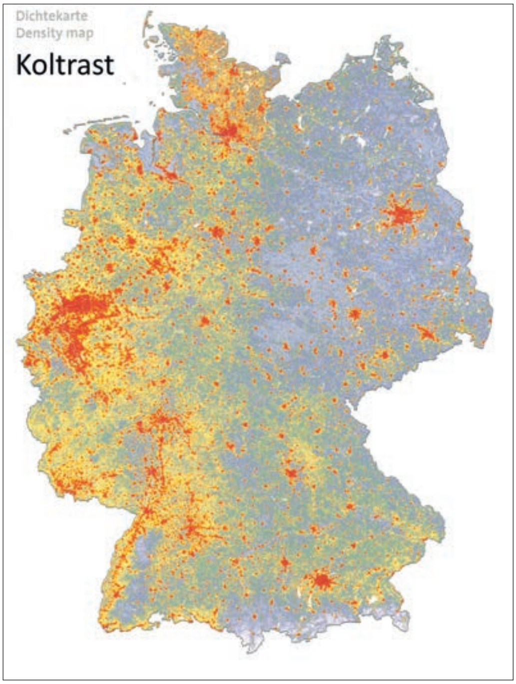
Figur 2. Fältpiplärkan får tjäna som exempel på hur alla arter minst redovisas i atlasboken: en karta för 2005–2009, en karta för 1985, antal par och skala för antal par i rutorna. Fältpiplärkan har försvunnit från större delen av Tyskland.

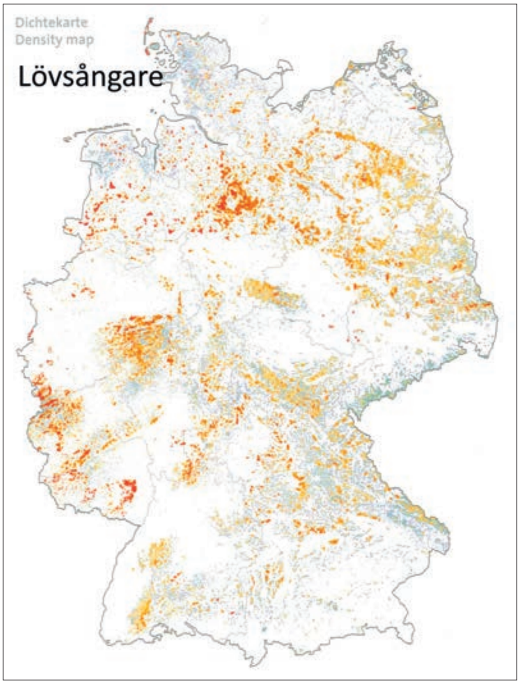


Figur 3. Kornsparven fanns över praktiskt taget hela Tyskland för trettio år sedan. Nu är den koncentrerad till nordöstra delen. Långsiktigt har antalet minskat men i nordöst har den faktiskt ökat kortsiktigt, femfaldigt under perioden 1991–2010. Med de c. 35.000 par som nu finns räknar man med att toppen har nåtts, tack vare omfattande trädor. Stödet för trädor upphörde 2007 och detta tillsammans med övergång till omfattande energiodling och andra biotopförluster kommer att drastiskt påverka beståndet negativt.

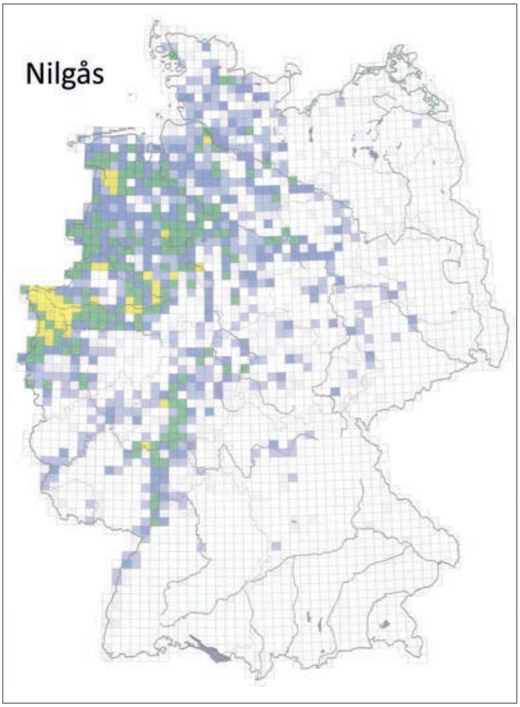


Figur 4. Ortolansparven är nästan utgången i södra Sverige. I Tyskland är situationen inte lika prekär, med kanske upp till 16.000 par, och rätt måttlig förändring sedan 1985. Inom det sammanhängande området har man noterat både upp- och nedgångar, och det finns kanske en del för Sverige att lära av ortolansparven i Tyskland.





Figur 5. Koltrast och lövsångare representerar arter som fått kartor med detaljupplösning. Det är fantastiskt att på detta sätt kunna visa hur stora täthetsskillnaderna är, något som inte riktigt framgår av de mer generaliserade kartorna. För koltraten är de vanligaste tätheterna från 8 p/kvkm (ljusblått) till över 70 (mörkrött) och med medelvärdet 40 (gult). Lövsångarens motsvarande tätheter är 5, 20 resp. 12 p/kvkm.



Figur 6. Nilgåsen finns numera över halva Tyskland. Kanske kommer den att invadera Sverige också?

skala, 1–10, 10–100 osv (Figur 3). Totala antalet par och beståndsförändring redovisas, det senare i den mån tillräckligt goda data finns, i form av ett diagram för perioden 1991–2010. Många artkartor är synnerligen intressanta ur svensk synvinkel eftersom de kan ge tips om potentiella förändringar i vårt land eller vara värdefulla på annat sätt. Ett exempel är otrolanen (Figur 4), som försvunnit från södra Sverige men har ett gott bestånd i likartade biotoper i Tyskland. Varför?

För många allmänna arter redovisas ytterligare en karta, en karta som räknats fram genom modellering utifrån detaljerade revirkarteringar i tusentals provytor. Vid dessa inventeringar har varje registrerad fågel bestämts till sin position på arbetskartan. Dessa positioner har sedan lagts in som ett skikt i ett geografiskt informationssystem tillsammans med skikt om geografi, topografi, markanvändning, klimat och ett stort antal andra faktorer. Bearbetningen har skett med mycket hög upplösning (10 till 25 meter) under själva modelleringen och därefter generaliserats till redovisningsrutornas storlek. Vid en ytlig jämförelse mellan modell- och observationskartan ser man inte så stora skillnader, men närmare granskning ger intressanta detaljer som kommenteras i texten. De två kartorna ger ofta olika totalskattningar för antalet par. I rätt många fall ligger maxvärdet från modelleringen under minimivärdet för observationsskattningarna. Jag visar inte någon modelleringskarta av detta slag, men de utgör i princip generaliserade versioner av de detaljkartor som omtalas i följande stycke.

För de allra talrikaste arterna ger användandet av den detaljerade omvärldsinformation man lagt in i modellerna möjlighet att presentera särdeles intressanta och nyskapande kartor, nämligen utbredningskartor med en upplösning på 25 gånger 25 meter (Figur 5). Dessa kartor är spektakulära i sin detaljrikedom och man kan naturligtvis undra hur exakta och korrekta de är. Men man har lagt mycket arbete på validering och det är ingen tvekan om att de i allt väsentligt visar verkligheten trots att de faktiskt inprickade fågelpositioner som modellen använder bara utgör en ringa bråkdel av alla fågelrevir i Tyskland. Inom parentes kan nämnas att de svenska punkttaxeringarna har börjat användas på liknande sätt genom att omvärldskartor skiktas ihop med fågelobservationerna vid punkterna, men det är en annan historia.

Oändligt mycket mer skulle kunna sägas om denna förnämliga 800-sidiga tyska fågelatlas. Men de smakprov av kartor som jag tagit med i denna anmälan bör ge en god bild av den höga klass som informationen i atlasen håller. Utöver kartor och diagram har varje art i det närmaste en hel sida text med förklaringar och analyser.

I boken ges en tabell över Tysklands talrikaste fåglar, de med över en miljon par. Tabellen återges här tillsammans med motsvarande antal för Sverige (Tyskland har ungefär fyra femtedelar av Sveriges landyta). Skillnaderna är rätt påtagliga, men av några arter finns det ungefär lika många, t.ex. bofink och rödhake. Men lövsångaren skiljer sig ordentligt, Sverige har tolv gånger så många. Tyskland ståtar med en och en halv miljon par brandkronad kungsfågel, att jämföra med Sveriges förmodligen färre än hundra.

Miljoner par	Tyskland	Sverige
Bofink	8,2	8,4
Koltrast	8,1	1,8
Talgoxe	5,8	2,6
Gråsparv	4,3	0,5
Svarthätta	3,8	1,2
Rödhake	3,7	3,8
Blåmes	3,6	0,7
Stare	3,5	0,6
Gransångare	3,1	0,2
Ringduva	2,9	1,0
Gärdsmyg	2,8	0,5
Grönfink	2,0	0,7
Sånglärka	1,7	0,8
Taltrast	1,6	1,9
Järnsparv	1,6	0,6
Brandkrona	1,5	0,0
Gulsparv	1,5	0,9
Svartmes	1,5	0,4
Kungsfågel	1,4	3,0
Nötväcka	1,2	1,9
Lövsångare	1,1	13,2
Trädgårdssångare	1.1	1,2

En av de saker som atlasen kan informera om är förändringar som är på gång i Tyskland och som kan förutspå liknande förändringar i Sverige. En sådan art är nilgåsen (Figur 6) som från någon enstaka förekomst 1985 nu invaderat halva Tyskland.

Litteraturlistan omfattar 2098 referenser. Det är bara att gratulera Tyskland till ett enastående bokverk. Med tanke på att Tyskland är vår närmaste granne i söder borde boken vara självklar på alla välförsedda svenska bibliotek och hos seriösa faunistiker.

SÖREN SVENSSON