# Ornis Svecica

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ORNIS SVECICA utges av Sveriges Ornitologiska Förening. Tidskriftens mål och inriktning är att utgöra ett forum för primära forskningsrapporter, idéutbyte, debatt och brev rörande ornitologins alla områden. Bidrag som rör Europas fågelfauna prioriteras. Bidrag om generella frågor tas emot oberoend av ursprung. Vi vill särskilt uppmuntra icke professionella ornitologer att sända in sina resultat och idéer men välkomnar givetvis bidrag från professionella forskare. Språket är svenska eller engelska med en utförlig sammanfattning på det andra språket.

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# Till prenumeranterna och övriga läsare

Jag beklagar den kraftiga förseningen i utgivandet av *Ornis Svecica*. Bara ett häfte av tidskriften har utkommit i år före det som nu föreligger. Vi har därför samlat alla bidrag till häftena 2–4 i detta gemensamma häfte som därmed avslutar volym 21, 2011. Trots att det således bara blivit två häften detta år omfattar volymen ändå normalt antal sidor.

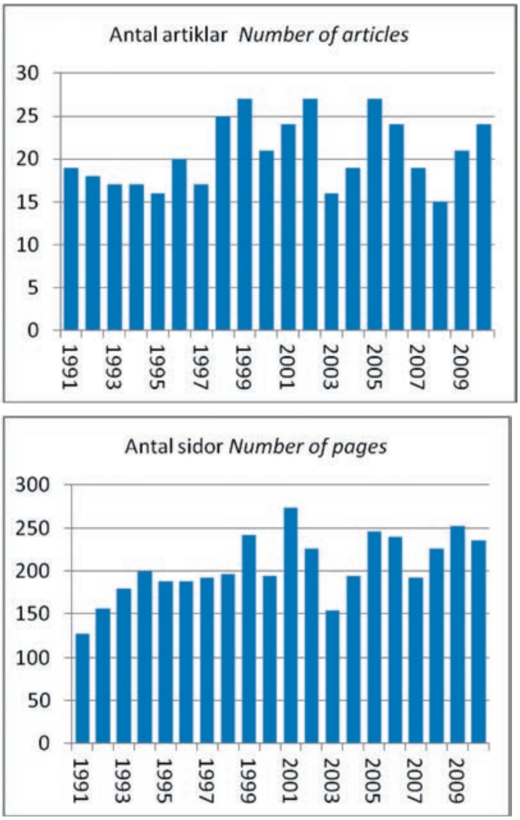
*Komplettering till gåshäftet, nr 3–4, 2010*
En av uppsatserna i detta häfte, den av Carol Fouque och Vincent Schricke om kanadagåsens förekomst och beståndsutveckling i Frankrike, presenterades ursprungligen på den konferens i Höllviken i oktober 2009 som hade titeln *Expanding Goose Populations and their Management*. Övriga föredrag från konferensen publicerades i ett särskilt häfte av *Ornis Svecica*, nummer 3–4, 2010. Kanadagåsuppsatsen skall således betraktas som en del av redovisningen från konferensen.

*Skriv fler uppsatser!*
Vi vill här passa på att uppmana ornitologerna till att skriva om sina undersökningar, som ofta förtjänar ett bättre öde än att förbli bara fältprotokoll. Vi är övertygade om att det finns många rika och spännande material ute i landet som väntar på att bli publicerade. I detta häfte finns fyra exempel på en typ av redovisningar som är synnerligen intressanta i perspektiv av långsiktiga förändringar av biotoper och klimat, nämligen de mångåriga studierna av flugsnappare, talgoxe och blåhake. Säkert finns det flera personer som samlat liknande tidsserier om olika arter. Uppsatsen om blåhaken är en föredömlig analys av ett material från en fågelstation, och de många fågelstationerna och fältstationerna har en nästan outtömlig källa av material att offentliggöra. Uppsatsen om halsmärkta gäss visar på den kraft som individmärkningen har när det gäller att kartlägga de detaljer i fåglarnas flyttning som traditionell ringmärkning inte klarar av. Och inom häckningsbiologin finns mycket att utforska, vilket uppsatserna om fjällpipare och skärsnäppa demonstrerar. För den typen av dåligt studerade arter är nästan varje kunskapstillskott värdefullt. Rapporten om en avvikande färgvariant hos ormvråk är ett gott exempel på att enstaka udda observationer också har stort intresse; fler kortrapporter vill vi ha. De många praktiska fågelskyddsarbeten som bedrivs i landet blir rätt sällan testade mera vetenskapligt; men här presenteras en studie av ortolansparvens ekologi som kopplas till ett eventuellt åtgärdsprogram. Och sist kan nämnas uppsatsen om imponerande tolv års dagliga räkningar av fåglarna vid ett fågelbord. Den råkar dessutom passa perfekt inför SOFs snart stundande kampanj, Vinterfåglar inpå knuten, då alla ornitologer räknar sina fågelbordsgäster.

**To subscribers and other readers**
I am sorry about the delay in publication of *Ornis Svecica*. In this issue that concludes volume 21, 2011, all remaining contribution for this volume are collected. Although only two issues have been published in 2011, the volume contains the normal number of pages.

The paper by Carol Fouque and Vincent Schricke on the Canada Goose in France was originally presented at a goose conference in 2009. The proceedings from that conference were published in *Ornis Svecica*, vol. 20, no. 3–4, 2010, and the paper is to be considered a part of those proceedings.

*Sören Svensson*



Figur 1. Antal artiklar och antal sidor i varje volym av Ornis Svecica åren 1991–2010.
*Number of articles and number of pages in each volume of Ornis Svecica in 1991–2010.*

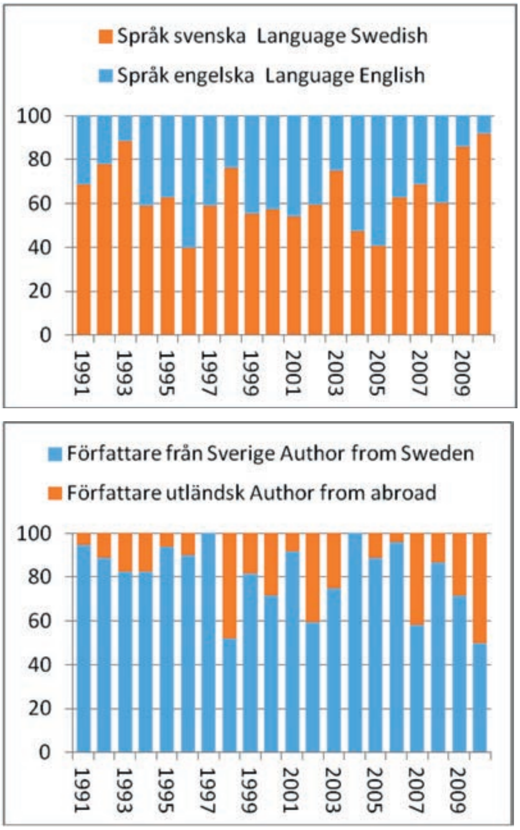


Figure 2. Artiklarnas huvudspråk och förste författarens hemland, fördelning i procent.
*Main language of the articles and country of residence of the first author, percent share.*

# Ornis Svecica 20 år

SÖREN SVENSSON

*Ornis Svecica* utkom första gången 1991. Det året ändrade Sveriges Ornitologiska Förening strategin för sina publikationer på ett genomgripande sätt. *Vår Fågelvärld* hade dessförinnan varit den enda tidskriften. När det fanns behov av ytterligare publicering skedde det som supplement. I *Vår Fågelvärld* samsades alla olika typer av bidrag, redovisningar av ornitologiska undersökningar lika väl som föreningsangelägenheter och populära artiklar om exempelvis fågelskydd och artbestämning. Därtill innehöll *Vår Fågelvärld* de för varje år allt tjockare fågelrapporterna, som samlade de spontana observationerna. År 1991 blev *Vår Fågelvärld* en modernare, rikt illustrerad tidskrift som skulle tillfredsställa ett bredare fågelintresse. *Ornis Svecica* fick i uppgift att ta hand om de vetenskapliga uppsatserna medan den nya årsboken *Fågelåret* kom att samla fågelrapporterna och återkommande redovisningar från olika projekt och fågelstationer.

Med år 2010 fyllde *Ornis Svecica* tjugo år. Här följer en kort tillbakablick och litet statistik om dessa första tjugo år. Totalt publicerades över 4000 sidor, fördelade på 413 artiklar. Därutöver innehöll tidskriften annat material, främst anmälningar av böcker och avhandlingar. Antalet sidor per årgång varierade mellan 128 och 274, i medeltal 205, och antalet artiklar mellan 15 och 27, i medeltal 21 (Figur 1).

Av artiklarna hade 329 (80%) en svensk förste författare och endast 84 en utländsk sådan (Figur 2). Vad gäller språket var det däremot engelskan som dominerade. Huvudspråket var engelska och sammanfattningen svensk i 64% av artiklarna (Figur 2). Eftersom författarna hade fritt val mellan engelska och svenska som huvudspråk är det uppenbart att majoriteten ville ha sina bidrag på engelska. Skälet är också uppenbart; om man vill bli läst och citerad inom den internationella vetenskapliga världen är det nödvändigt att skriva på engelska.

*Ornis Svecica* klarade sig igenom de första tjugo åren på ett utmärkt sätt och etablerade sig som en välkänd vetenskaplig tidskrift. Särskilt väl etablerade den sig som organ för svenska forskares publikationer om fåglar och fågelliv i Sverige, något som ju också var det främsta ursprungliga syftet. Mindre väl lyckades tidskriften locka till sig uppsatser av utländska författare om fåglar och fågelliv i utlandet. Och så kommer det nog att förbli. På det plan som *Ornis Svecica* opererar, dvs. steget under de stora, helt professionella (och kommersiella) akademiska tidskrifterna (t.ex. *Journal of Avian Biology*), konkurrerar vi med ett stort antal nationella tidskrifter till vilka respektive lands uppsatser i första hand söker sig. För närvarande finns inga planer på att aktivt verka för att ändra innehållet i *Ornis Svecica*. Det kommer som hittills att bestämmas av vad författare spontant sänder in. Men jag vill betona att vi mer än gärna ser ett ökat antal bidrag från hela Norden och övriga Nordeuropa och även Centraleuropa, som ju har en fågelfauna som är mycket lik den svenska. Tropikstudier av våra flyttfåglar under vintervistelsen är också lika välkomna.

*This is a brief review of the first twenty years of* Ornis Svecica*. In 1991 the Swedish Ornithological Society launched a new publication strategy:* Vår Fågelvärld*, the only journal since 1942, covering all types of material, was divided into four publications:* Vår Fågelvärld*,* Fågelvännen *(a more popular journal),* Fågelåret *(a yearbook), and Ornis Svecica. During its first twenty years* Ornis Svecica *published 413 articles and over 4000 pages. The number of articles and pages was rather stable (Figure 1), and Swedish authors and the English language were predominant (Figure 2). We encourage more submissions from abroad, particularly from northern Europe and about our birds during their winter stay in the tropics.*

ORNIS SVECICA 21: 69–78, 2011

# Status and trends of the Canada Goose *Branta canadensis* in France

## *Tillstånd och utveckling för kanadagåsen* Branta canadensis *i Frankrike*

CAROL FOUQUE & VINCENT SCHRICKE

### Abstract

An enquiry to determine the distribution and abundance of the Canada Goose *Branta candensis* in France was undertaken in 2008. Responses were received from 92 out of the 96 departments. Canada Geese were reported in 56 of the 92 departments, in 8 of which the species had only appeared after 2000. For half of the 56 departments, the species was observed only in summer. Canada Geese summered in 38 departments, numbering at least 4250 birds. At least 6000 birds are also thought to winter in France as of 2008/2009, when the species is more widespread. Winter numbers are increasing exponentially. In 5 departments, crop damage and public health issues have resulted in local management measures in the last 3 years (e.g. egg pricking and culling of adults). We discuss the need for further regulation and legislation in the light of these conflicts and hybridisation with other species.

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### Introduction

The Canada Goose *Branta canadensis* originates from the United States and Canada, but has been widely released in Europe since the 17th century, since when it has also escaped from zoos and private collections (Rehfisch et al. 2000). They were first released in Great Britain for ornamental purposes but also for wildfowl collections, food and hunting. At the beginning of the 20th century, Canada Geese were still released in Europe for hunting purposes, for example in Scandinavia. Breeding outside private collections was rare before the 19th century, but later became common in Europe.

In UK, after the second war, some regulation was needed because of the agricultural damage (destruction of eggs and individuals; relocation of adults caught during moulting). However, the effect of the latter effort was only to further disperse and increase the populations (Holloway 1996). Experts believe that the rapid increase began in the 1970s and 1980s when birds gathering in excessive numbers in parks and lakes were removed from there and released in the wild. Thus, councils and park keepers were unwittingly helping to spread their numbers (Syal 2009).The numbers have increased by a factor of five since the late 1960s (Rehfisch et al. 2000). In 1999, the UK held more than 2300 breeding pairs and the wintering population was probably about 80,000 (Dubois et al. 2007). With 8% increase per year, the number of Canada geese in Britain was expected to have risen to more than 200,000 by 2010 (Blair et al. 2000). In Belgium, the first observations were made in 1950–1960 (Lippens & Wille 1972) where the species first bred in the wild in 1973. In Flanders, there were 2700 wintering individuals in 1997 and nearly 10,000 individuals in 2004 (Anselin & Devos 2005). This species is also present in Denmark, Switzerland, Germany and Holland. The European population was estimated at about 160,000 individuals at the end of the 2000s (Dubois et al. 2007).

Most introductions of non-native species have occurred in Western Europe (Wright 2008, Hulme et al. 2009). The impact of alien species in Europe is close to 10 billion euros annually and this figure is an underestimate as potential economic and environmental impacts are unknown for almost 90% of these species (Hulme et al. 2009). The DAISIE project (Delivering Alien Invasive Species Inventories for Europe; www.europe-aliens.org), lists 100 alien invasive species which pose an environmental, human health, social or economical threat to society, including the Ruddy Duck *Oxyura jamaicensis*, the African Sacred Ibis *Threskiornis aethiopicus*, and the Canada Goose of particular concern in France (Vilà et al. 2009). Canada Goose lies in second place amongst the top-ten invasive DAISIE species with the highest number of different impact types on ecosystem services in Europe, with four categories of impact types.

Canada Geese can be hunted under the Birds Directive (1979; Annexe II/1: hunting species) but this is not permitted under the Berne Convention (1979; Annexe III : protected species with regulation of hunting) and the Bonn Convention (1979; Annexe II: bad status with adapted measures for management).

Most of the introductions of Canada Geese in France were made between 1960 and 1970 for ornamental purpose. During1970–1980, further birds escaped from private properties and parks. In addition, hunters released birds into the wild to enhance future hunting opportunities. This favoured the establishment of feral populations in several part of the country (Pascal & Clergeau 2003). This French population is mostly sedentary, but the population increases in winters when birds from Scandinavia and the UK come to France. Some movements can be observed between feeding and resting sites but no moult migrations have been reported as in the UK. In the 1990s the French population was estimated at about 700 individuals. In France the Canada Goose is an exotic but protected species as all the other wild species of *Branta* genus (national list of protected species 1970: articles 1 and 5 revised by the ministry policy from the 17-04-1981). This legislation, which does not distinguish introduced individuals from wild ones, does not allow destruction of eggs or adults, catching, selling or buying, or transporting individuals, alive or dead. As the need for regulation has been rising during the last five years in places where damage occurs, this article attempts to make an up-dated synthesis about this species at the national level.

## Study area, material and methods

To update the status and distribution of the Canada Goose in France, a national enquiry was undertaken in 2008, using the national network of observers working on Waterfowl and Wetlands. This study was made by the French Hunting and Wildlife Agency (ONCFS) with the help of the national and local hunting associations (Fédérations départementales des chasseurs). Ninety-two responses were received from the total of 96 departments. The majority of the answers came from the environmental wardens of ONCFS (n=58) or from technicians in departmental hunting organisations (n=19). Other organisations provided information on this species in 7 departments.

Data were collected at the level of local authority districts but collated at the department level or at the scale of 10 km squares, a European standard georeferenced grid.

## Results

### *Decade of first observation and origin of the birds*

The decade of the first observation of the Canada Goose in nature was known for 31 of the 58 departments (Figure 1): one department in the 1960s, 6 departments in the 1970s and 9 departments in the 1990s. In the 2000s it appeared in 9 new departments, confirming the ongoing expansion. These 9 departments were located outside the centre of France. Old populations in 7 departments that were also located outside the centre of France and had the highest densities didn’t grow up until 2000.

The origin of the geese was known from 26 departments (Figure 2). In five cases they had escaped from ornithological parks but in more than half of the cases (n= 17), they had escaped from private properties or were released into the wild for hunting purposes. In one department, the birds could have come from neighbouring Belgium. Whatever the situation, we are dealing with a feral populations well adapted to their environment.

### *Numbers, distribution and trends in winter population*

Winter numbers were known for 54 of the 57 departments where the species was present (Figure 3). The numbers differed between the departments: 45% of them had less than 10 individuals, 7 had between 100 and 200, and 10 departments had more than 200, these highest densities being located in the centre of France. The French population could be estimated at about 6000 individuals in the winter 2008/2009.

The spatial distribution within each of the 54 departments differed: the majority of them (n=41, 73%) had 5 or less 10 km squares occupied by the species, being located in few sites. In these departments, it was still possible to prevent the expansion of the species further while in 10 other departments,

## Figur 1 : Decade of first observations

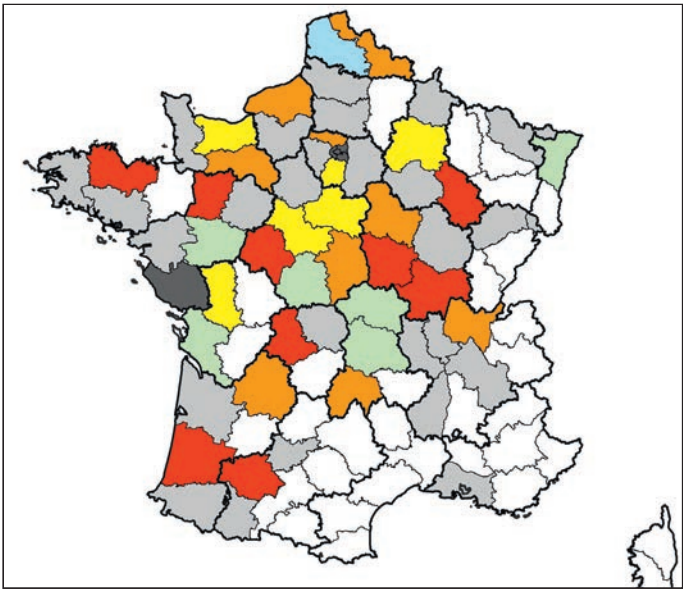

Figure 1. The decade when the Canada Goose was first recorded in the departments.
*Decenniet då kanadagåsen registrerades för första gången i departementen.*

## Figur 2 : Categories of origin

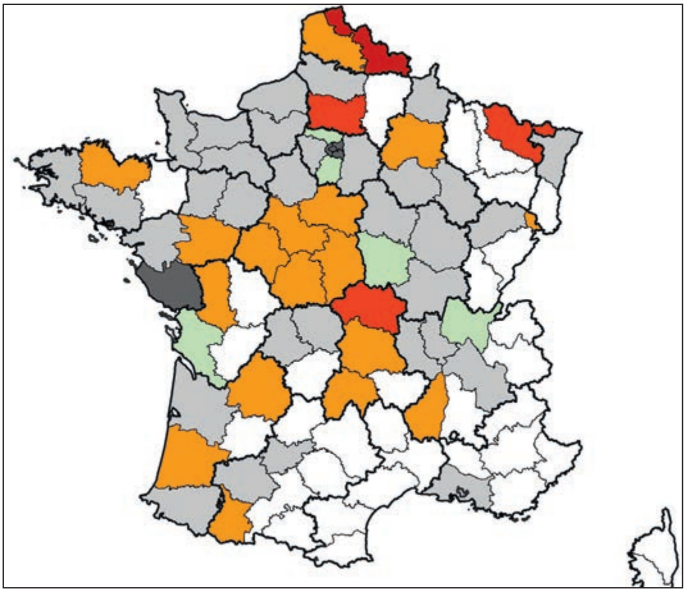

Figure 2. The origin of the Canada Geese in the different departments.
*Ursprunget för kanadagässen i de olika departementen.*

## Figure 3 : Winter distribution and density

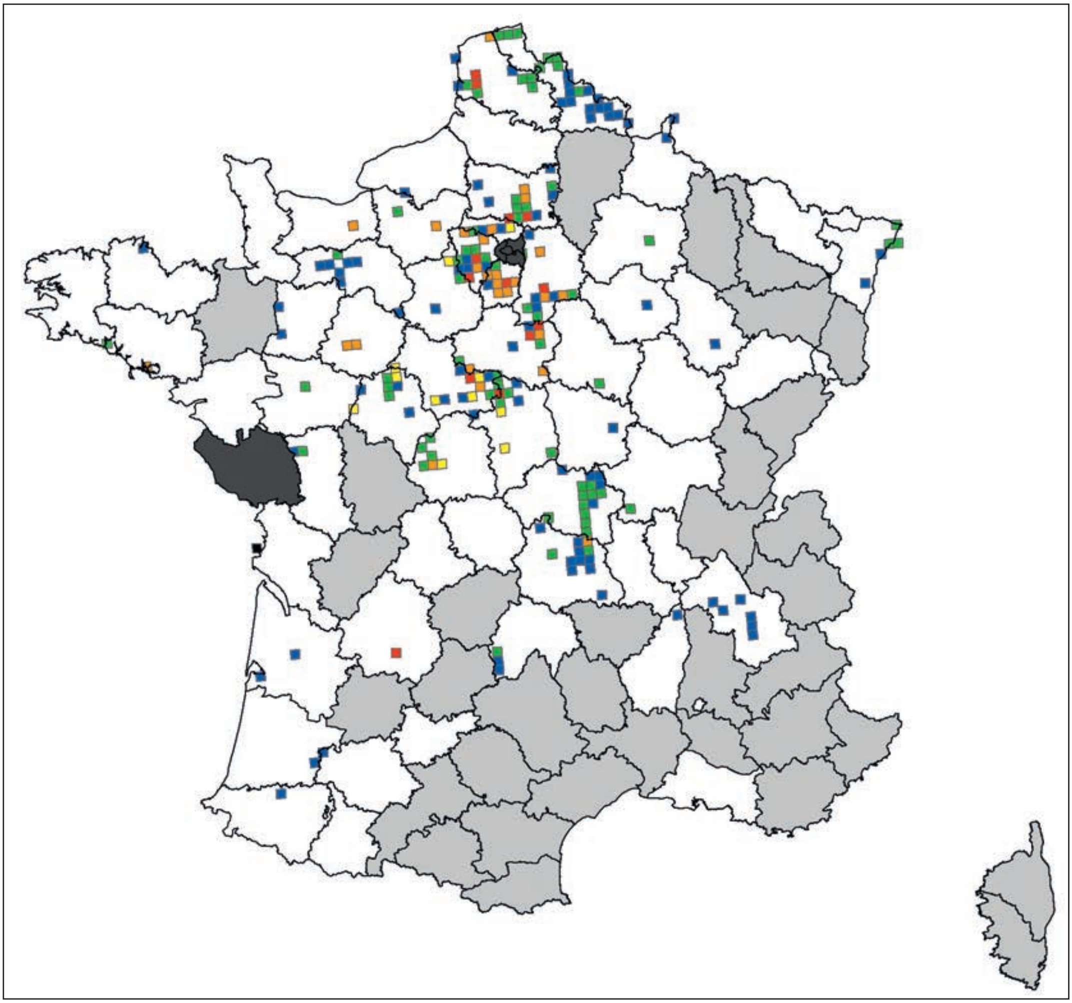

Figure 3. Winter distribution of the Canada Goose in the departments (presence/absence) and in 10 km squares (colour code for numbers).

*Kanadagåsens vinterförekomst i departementen (finns/saknas) och i 10 km rutort (färgkod för antal).*

the species seemed to be already very widespread.

About half of the 202 occupied 10 km squares had less than 10 individuals in winter. Nearly all of the squares with the highest numbers (50–200 individuals) were located in the centre of France. One square held more than 200 birds, located on an island on the Atlantic coast.

The winter population has shown an exponential increase (Dubois et al. 2007, Deceunink et al. 2009), with a rapid change after 2005 when about 3000 birds were recorded. Three years later, the population had doubled (6000 individuals in winter 2008/2009).

### *Numbers, distribution and trends in summer non-breeding and breeding population*

In summer, the species was observed in 39 departments, 18 less than in winter. The population seemed less widespread in summer than in winter. Summer distribution and minimum size of the Canada Goose population was known for the 39 departments. 45% of these had between 10 and 50 individuals (against 45% under 10 individuals in winter), mostly in central France, where 5 departments had more than 200 individuals (against 10 in winter) and 6 other ones had between 100 and 200 (same as in winter). The population was more evenly distributed between departments in summer than in winter. The minimum French summer population could be estimated at about 4250 individuals, which was 1500 below the number found in winter.

The breeding population of Canada Goose was not as large as the summer population because birds reproduce only when they are 3 years or older. The number of breeding pairs in 2006 was estimated by Wetlands International France to be between 200 to 250 in 35 departments (Dubois et al. 2007).

In 2008, the breeding population was distributed between 39 departments, with the same distribution as the non-breeding summer population: where there were summer observations of Canada Goose there were breeding pairs. The total number of breeding pairs in France was estimated at about 1100 in 2008. It was four times more than in 2006 but in 2006 the population was underestimated as no specific enquiry was made. The total number of communes occupied by the species in France was about 294 and quantitative data were known for 97% of them.

The breeding population was observed in 199 squares (Figure 4), against 212 in winter. 149 occupied squares had less than 5 breeding pairs and the highest densities per square were between 5 and 20 pairs. These squares were not all located in the centre of France as they were widespread all over the country, except the four squares which held more than 20 pairs.

### *Trends in annual numbers*

Trends in annual numbers (winter and summer population) were known in 44 of the 58 occupied departments (Figure 5). Populations had been increasing in 28 departments while populations were stable in 16 other ones. For example, the expansion of the populations from the centre of France to all the Loire river areas was obvious.

### *Impacts of the species*

The impacts of the Canada Goose, an herbivore species, on the natural ecosystem (vegetation belt of the water bodies) has not been studied in France but are frequently reported anecdotally.

In France, impacts of the species were identified in 31 of the 58 departments with annual presence. Several types of conflict were identified. The most important one was the damage on fields with young wheat and maize and on permanent hay meadows. This occurred in the centre of France with the highest goose densities. Problems linked to their feeding on the greens of golf courses were also mentioned. In one department, there was a public health problem in a leisure park associated with the abundance of dropping (feaces), considered responsible for eutrophication of water and the source of potential diseases. Other types of problems were due to adverse interactions with other species: laying eggs in nests of other geese, food and spatial competition with Mute Swan *Cygnus olor*, other species of geese and rails (Rallidae). In four departments, far away from each other, hybrids with Greylag *Goose Anser* anser were observed, suggesting a major risk of genetic introgression to the latter species.

When Canada Geese fed in hay meadows, the damage by intensive grazing was estimated to constitue a loss of 50% of the production of hay bales. One example comes from the Loing valley in the centre of France. There were no Canada Geese in 2004 and the production of one plot of meadows was 1000 hay bales. In 2005, with the grazing of 50 Canada Geese in the same plot, only 750 hay bales were produced, and in 2006 there were 80 geese and only 350 hay bales.

## Figure 4 : Distribution of breeding pairs and density

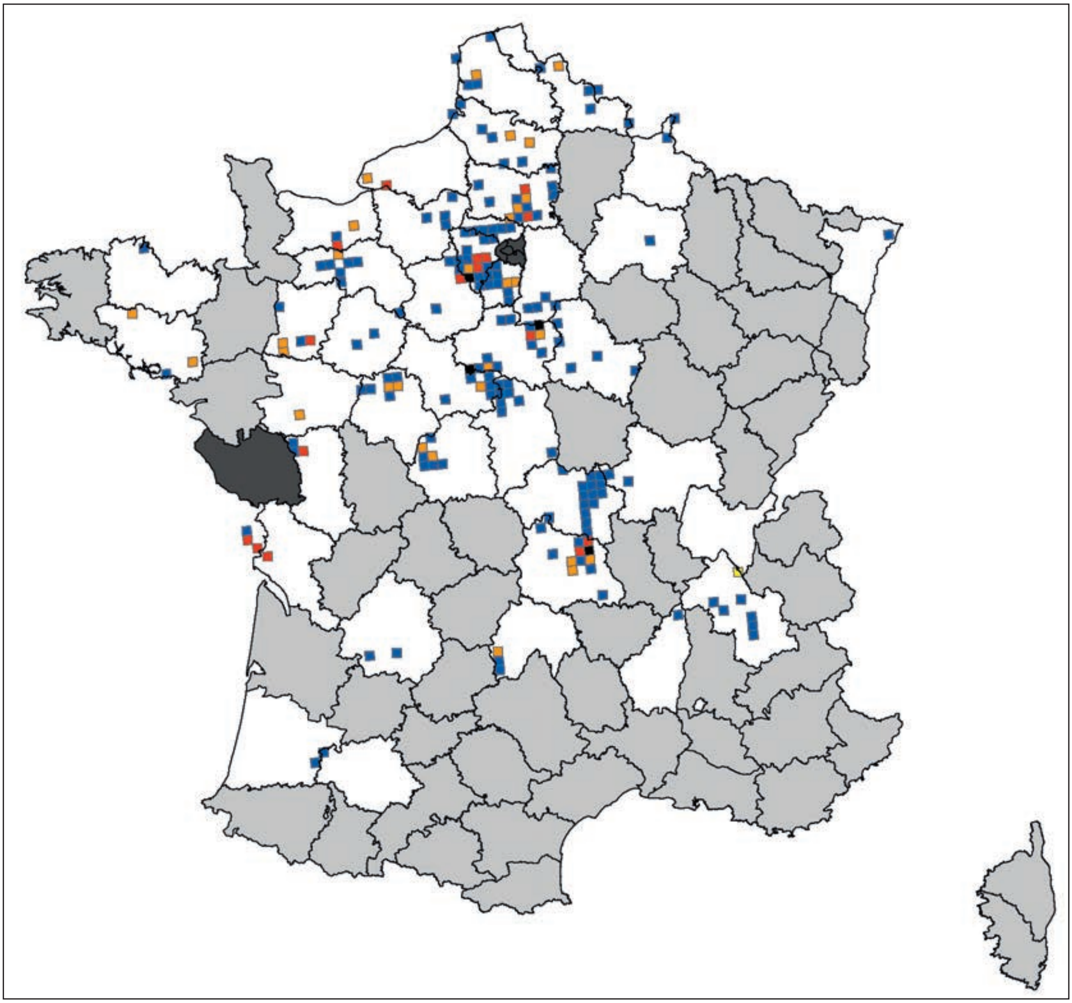

Figure 4. Number of breeding pairs of Canada Geese in the departments (presence/absence) and in 10 km squares (colour code for numbers).
*Antal häckande par av kanadagås i departementen (finns/saknas) och i 10 km rutor (färgkod för antal).*

**Figure 5 : Trends in annual numbers during the 2000's**

- ⬜ Absence (n=33)
- ⬛ Unknown status (n=5)
- ▨ Unknown trend (n=14)
- 🟦 Decrease (n=0)
- 🟨 Stable (n=16)
- 🟥 Increase (n=28)

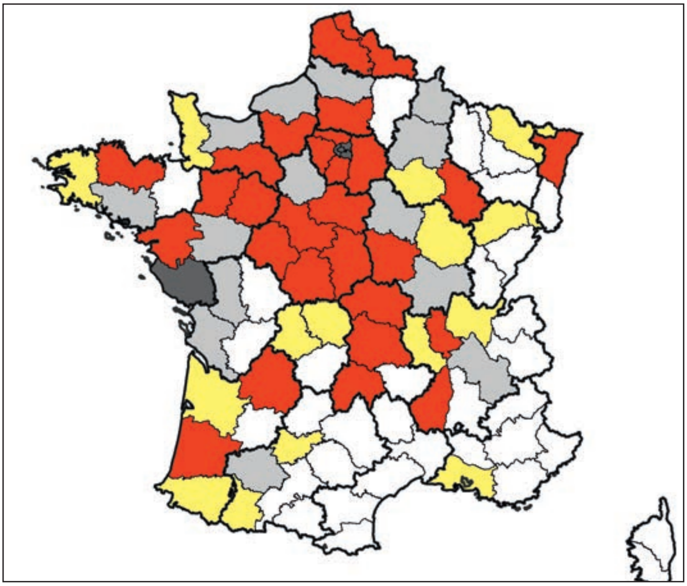

Figure 5. Trend in number of Canada Geese (winter and summer) in the departments in the 2000s.
*Antalstrend för kanadagås (vinter och sommar) i departementen på 2000-talet.*

### *Measures of regulation*

Regulation of the total Canada Goose population is not easy because of its protected status. However, it is possible to regulate the species on private land according to French Law. Wardens of ONCFS were responsible for these measures of regulation. So, during recent years, regulation measures have been implemented in France in several departments where there was damage to crops: since 2005 in one department in northern France, since 2007 in three departments in the centre, and in one more department in 2008. Three other departments could be concerned in 2009.

In these four departments, three methods of regulation were applied: shooting of adults and subadults, culling of eggs and, in one department, they were captured with a net and killed. The results linked to the regulation showed no strong effect on the populations. In one department where reproductive control was combined with an increase in adult mortality, the results were good as the population decreased dramatically but regulation was stopped before the population had been eradicated. The regulation in this department was a success because the birds were not able to escape far away when they were disturbed. In other departments where regulation started with the same methods, the number of birds did not decrease at the scale of the department because the geese moved to other sites within the department.

## Discussion

The difference between the winter (6000 individuals) and summer (4250 individuals) populations could be explained by several hundred birds which arrive to overwinter amongst the resident stock, mostly from Fennoscandia or perhaps from Britain, although no British ringing recoveries have been reported (Blair et al. 2000). But this difference is so high that it could also strongly suggests an underestimation of the summer population. The population is more difficult to estimate in summer than in winter because the tall vegetation around water bodies and also because the individuals were less aggregated in summer.

The problems caused by the increase in the non-native Canada Goose population are associated with the impacts it has on biodiversity and humans (Hugues et al. 1999). The Canada Goose is an herbivore that eats flowers, leaves, stalks and roots but also seeds and berries. The birds have considerable energy requirements and can spend more than 12 hours a day for feeding (Cramp & Simmons 1977). They feed in terrestrial habitats and like cereal fields (wheat and barley), colza (rape) fields and grass meadows. They also feed on the vegetation around water bodies and on the golf courses where there is short vegetation. Because they are gregarious, Canada Geese may destroy cultivated vegetation when walking and make some meadows or fields unproductive because of their droppings (Cramp & Simmons 1977). Impact on humans could be separated in two subcategories, economic or aesthetic. Collisions between airplanes and Canada Geese are responsible for 88 crashed planes and 243 human deaths at Heathrow in England (Syal 2009). Collisions between aircraft and birds cost the world civil aviation industry around 200,000 euros per year (Syal 2009). The high densities associated with leisure water bodies have been held responsible for the degradation of water quality (contribution to water eutrophication by their faeces). This species could be a disease vector and a public health risk. The greens of golf courses could be destroyed by grazing Canada Geese. Problems regarding hybridisation (individual level) and competition are thought to be minor despite much speculation, especially with regard to competition (Allan et al. 1995). Fabricius et al. (1974) documented considerable aggression between Canada Geese and Greylag Geese when nesting together on islands off the Swedish coast, but found no evidence of negative effects on the numbers of breeding pairs of either species. Master & Oplinger (1984), on the other hand, suggested that Mallard *Anas plathyrhynchos* productivity in the eastern United States may be negatively affected by increasing nesting densities of Canada Geese (Hughes et al. 1999).

Canada Geese tends to dominate wetland avian ecosystems (Rehfisch et al. 2000). This species could be aggressive with other smaller waterfowl (ducks) (Cramp & Simmons 1977). Space and feeding competition have been observed in UK where the densities were high (Gibbons et al. 1993). They can be aggressive in nest defence. They are known to kill ducks, Moorhen and Coot. When moving, Canada Geese could destroy eggs of fish or frogs.

Eradication of alien species is a key conservation tool to mitigate the impacts caused by biological invasions (Genovesi & Shine 2003, Genovesi 2005). The Convention on Biological Diversity considers eradication as the best alternative when prevention fails.

In England, Kirby and colleagues tried to model the dynamics of the population to find the important factors to consider for the regulation (Hughes et al. 1999). The theory was that the rate of population growth should decrease more rapidly when removing adults than nests, due to the high adult and juvenile survival of this long-lived bird. Moreover, 20 years is required to reduce the population from 100 to 10 with removal of 20% of the adults and 70% of the nests. The experience in the field in England brought a strong revelation. With an adult survival reduced to about 35–40% (obtained by regulation), the population will still continue to growth with 8% per year. This species has combines the advantages of longevity with high fecundity (producing 5 or 6 young each year). Effective regulation of the species depends on the nature of the site, the type of damage occurring and on the population biology of the local birds. In a given site, if there is suitable feeding habitat as grazing pasture or cereal fields, density-dependent factors are unlikely to act to regulate population size before high numbers of birds are present.

The cost of the impacts of alien invasive species over the world is estimated to 240 $ per year and per person (Mazaubert 2008). The monetary cost of the Canada Goose in Germany due to eutrophication is 1.02 million of euros per year (Gebhart 1996 in Vilà et al. 2009).

In Holland, before 2009, Canada Geese were not subject to regulation (compensation was paid for grey geese). In UK, destruction of eggs gave good results because the birds were aggregated around water bodies. In Belgium, the species was put on the list of hunting species since July 2008 while all the other geese has been protected since 1981 (Kuijcken, unpublished data). In this last country, a national hunting plan was launched but it produced a spreading of the population and pushed them in protected places. The situation in countries as New Zealand, England or Finland showed that impacts of Canada Geese cost a lot when the population start to spread. As effective regulation is expensive in money and time, regulation is most efficient if rapid and undertaken before the spread of the species.

In France, it seems that regulation measures taken until now were not efficient. In fact, it is know that density-dependent factors are acting to regulate population size only at long established breeding sites and natal-site fidelity prevents most of the non-breeding adults from moving away to establish new colonies elsewhere (Allan et al. 1995). So it could be better to leave geese at these old established sites with the same numbers of birds, to not kill non-breeding adult and to concentrate in other newly-established breeding sites where the carrying capacity will be reached for ten or more years.

Another possible solution would be to launch a national action plan to eradicate the species with an integrated management strategy (albeit with methods adapted to each site) but it would be efficient only with the collaboration of the neighbouring countries, since recolonisation from outside would be likely. If the species would be regulated only in France, the task would be prolonged and inefficient. The only solution is total eradication of the species in Europe where it is not native.

## Acknowledgements

One thousand observers from the French network "Waterfowl and Wetlands" have carried out the fieldwork. We would like to thank all of them for their efforts, which allowed the production of such a collective synthesis at the national scale. They are from ONCFS (at the regional and departmental levels and at the research and study direction) and from departmental hunting federations. We also acknowledge the help of Patricia Vincent for data computerization.

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## Sammanfattning

I Frankrike gjordes en riksomfattande enkät 2008 för att kartlägga kanadagåsens spridning och förekomst. Rapporteringen skedde dels på departementsnivå och dels för rutor om 10 gånger 10 kilometer. Resultatet redovisas i Figur 1–5.

De flesta introduktioner skedde åren 1960–1970 som prydnadsfåglar i parker. Under perioden 1970–1980 rymde fåglar från parker och fågelsamlingar och andra planterades ut för jaktändamål. Detta ledde till etableringen av viltlevande bestånd

på flera håll i landet. Dessa fåglar är i huvudsak stannfåglar. Vintertid har sedan också tillkommit fåglar från norra Europa.

Beståndet hade vuxit till 700 individer på 1990-talet. Vintern 2008/2009 var beståndet 6000 fåglar. Under häckningstiden 2008 registrerades 4250 individer, vilket är klart lägre än vinterbeståndet. Skillnaden bedöms som för stor för att kunna förklaras av övervintrande fåglar norrifrån och antyder därför att det häckande beståndet underskattades. Beståndet bedöms vara under fortsatt ökning i de flesta departement.

En del åtgärder för att förhindra spridning av kanadagåsen för att reducera olika typer av skadegörelse har vidtagits. Åtgärderna har dock inte varit framgångsrika och torde heller inte bli det om de bara genomförs i Frankrike. Då kommer återkolonisation att ske från grannländerna. Enda sättet att bli av med kanadagåsen är en samordnad utrotning av den i hela Europa.

ORNIS SVECICA 21: 79–91, 2011

# A 64-year study of a Pied Flycatcher *Ficedula hypoleuca* population

## *En 64 år lång studie av en svartvit flugsnapparpopulation*

KARL GUSTAV SCHÖLIN & HANS KÄLLANDER

### Abstract

A nestbox breeding population of Pied Flycatchers *Ficedula hypoleuca* was monitored during 64 years in a mixed coniferous-deciduous forest area near Örebro, South Central Sweden. The population showed a continuous average decline of c. 0.5 pairs per year, from c. 50% to c. 20% occupancy. There was a strong negative correlation between flycatcher numbers and those of other hole-nesters, but it is doubtful whether any causal relationship existed. Mean laying date was 24 May (17 May–3 June) and showed a negative correlation with mean May temperatures, yet no significant trend over the six decades. Mean laying date did, however, show an increased variation during the last 20 years. Mean clutch size varied between 5.76 and 7.08, with a mean of 6.34. It varied more during the last 30 years but without any significant relationship with mean laying date. A mean of 5.96 young fledged from broods that produced at least one fledgling vs 5.34 for all broods; the lower figure was mainly a consequence of nest predation by Pine Marten *Martes martes*, particularly after the early 1980s.

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### Introduction

Because Pied Flycatchers *Ficedula hypoleuca* readily accept nestboxes and are relative insensitive to disturbance, two conditions that make them easy to study, it is hardly surprising that there exists an enormous literature on the species. By far the largest number of studies deal with aspects of its breeding biology, and data on basic breeding parameters, such as start of egg laying, clutch size and fledging success, are available from practically all parts of the species' distribution range, including several places in Sweden. Much of this information has been presented in a monograph by Lundberg & Alatalo (1992). Their reference list, together with that of Winkel (1993), gives a good illustration of the amount of published information that exists on the Pied Flycatcher.

Here we report results from a long-term study of Pied Flycatchers initiated in 1948 and which is still on-going. We investigate long-term trends in breeding numbers and reproductive performance and analyse whether they may be correlated with spring temperatures and number of other hole-nesting species.

### Study area and methods

The study was started by the first author when he put up 80 nestboxes prior to the 1948 breeding season, and who has since carried out all field work and data collection. A description of the study area SE of Örebro in South Central Sweden (59° 14' N, 15° 13' E) is given in Schölin (2009). The area consists predominantly of mixed coniferous-deciduous forest, interspersed with small, nowadays often abandoned and partly overgrown fields. The latter process has led to an increase in the proportion of deciduous trees, especially birch *Betula* sp. and aspen *Populus tremula*, during the last 30 years. The nestboxes were placed at a height of c.2.5 m with some 40 to 50 m between them along a winding path within a 0.5×1 km area of forest. Many boxes were placed in forest clearings and at forest edges. The majority were normal wooden boxes, but about a third consisted of hollowed-out tree trunks. The mean base area of the boxes was c.112 cm$^2$, the entrance holes had a mean diameter of 30 mm and the distance from the lower rim of the entrance hole to the box base was on average 16 cm. The boxes, which had no

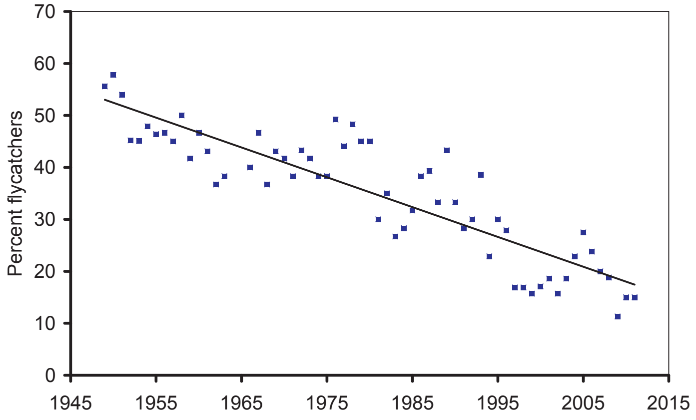

Figure 1. The negative population trend of Pied Flycatchers at Lövsätter, South Central Sweden, during 1949–2010 (1948 excluded because it was the first year with nestboxes).
*Den negativa trenden för svartvit flugsnapparpopulationen vid Lövsätter 1949–2010 (1948 har uteslutits eftersom holkbeståndet var nyetablerat detta år). Y-axeln visar procenten flugsnappare.*

anti-predator devices, were replaced successively as needed.

The nestboxes, which varied in number over the period, were checked about once a week to record clutch initiation, clutch size, nest success, etc. Sometimes inspection intervals were slightly longer (up to 10 days), which means that in some cases the laying date for a few clutches could not be determined with desirable precision. Those nests were excluded from analyses involving laying date. Sixteen clutches started in late June or early July, i.e. three weeks or more after the normal laying period, were excluded from all analyses (see von Haartman (1989) for the rationale for such exclusion). Likewise, the first year was omitted in analyses of population trends because no or very few Pied Flycatchers were expected to have shown "Ortstreue" in 1948.

Temperature data were taken from the Swedish Meteorological and Hydrological Institute's (SMHI) weather station at Örebro, about 5 km to the north-west of the study area. Data were analysed by standard statistical methods. In linear regressions with date as the independent variable, 1 May = 1, and when year is the independent variable, 1949 = 1. Linear regressions based on proportions were calculated on arcsin square-root transformed data but are presented as untransformed data. Means are given ± 1 standard deviation (SD) throughout.

## Results

### *Population trend and population fluctuations*

In the second year of the study, 1949, about 50% of the nestboxes were occupied by breeding Pied Flycatchers. This proportion had fallen to a mere 20% in 2011, a mean annual decrease corresponding to half a pair per year (Figure 1). Despite some numerical fluctuations during this long period, the decrease is highly statistically significant ($Y = -0.574X + 53.581$, df = 61, $P < 0.001$). It was weaker during the first half of the study ($b = -0.317$ %, $P = 0.002$) than during the latter half ($b = -0.750$ %, $P < 0.001$).

There was a strong negative correlation (Figure 2, $r_s = -0.808$, $P < 0.001$) between the proportions of nestboxes occupied by Pied Flycatchers and by other hole-nesters, especially Great Tits *Parus major* and Blue Tits *Cyanistes cyaneus*. The Great Tit population showed its strongest increase after the mid-1980s, while Blue Tits increased rapidly from about 1980. Even though a percentage of boxes

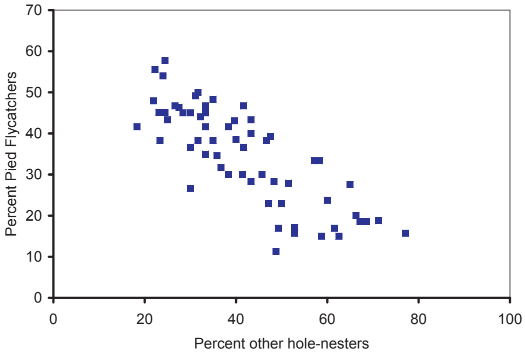

Figure 2. The relationship between percentages of Pied Flycatchers and of other hole-nesters at Lövsätter.
*Relationen mellan procenten svartvita flugsnappare Y-axeln) och procenten övriga hålhäckare (X-axeln) vid Lövsätter.*

remained empty in each year (mean 23.4, range 6.7–43.3), the higher proportions of other hole-nesters may suggest a direct influence on flycatcher numbers. We analysed this by using GLM, with the percentage flycatchers in year *t*+1 as the dependent variable and with the percentage flycatchers in year *t*, their number of fledglings in year *t* and the percentage of other hole-nesters in year *t*+1 as independent variables. Only the percentages of flycatchers ($P < 0.001$) and of other hole-nesters ($P = 0.002$) were statistically significant.

With respect to yearly variations in population size, some studies have found that the production of fledglings in one year affects the number of pairs in the following year. In our study only a weak correlation ($r = 0.267$, $N = 60$, $P = 0.039$) was found between mean number of fledged young in year t and population change (in %) to year *t*+1. This correlation was based on nests from which at least one young fledged.

### *Laying date*

Mean laying date varied during the study period from 17 May in the earliest year (1994) to 3 June in the latest year (1991), with 24 May as the overall mean (N = 61 years; Figure 3). May temperatures showed a weak, non-significant trend ($b = 0.016$ degrees per year, $P = 0.060$) during 1948–2011 (Figure 4) and there was no trend in laying date ($b = 0.002$, $P = 0.919$). There was, however, a negative trend in mean laying date vs temperature (linear regression, $Y = -0.807X + 32.358$, $R^2 = 0.138$, $P = 0.003$). The relationship between mean May temperature and the season's first egg (Table 1) differed only marginally from these figures ($b = -0.802$).

To see if other hole-nesters affected the laying time of the Pied Flycatchers, we ran a GLM with mean laying time of the flycatchers as the dependent variable and May temperature and the percentage of other hole-nesters as independent variables. Mean laying date was still negatively related to May temperature ($b = -0.789$, $P = 0.004$), whereas other hole-nesters were not ($b = -0.010$, $P = 0.654$).

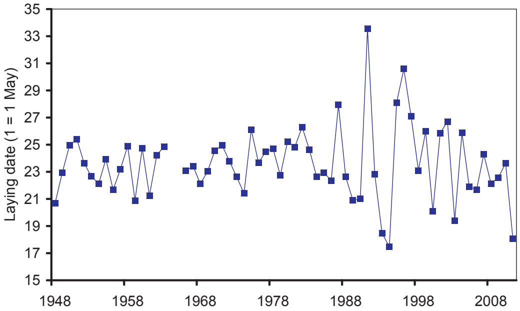

Figure 3. Mean laying date of Pied Flycatchers at Lövsätter during 1948–2011.
*Medeldatum för första ägget under vart och ett av åren 1948–2011. Y-axeln visar datum i maj.*

Table 1. The earliest clutch initiation date (May) in each year 1949–2011.
*Tidigast lagda ägget i vart och ett av åren 1949–2011.*

| Year | Date | Year | Date | Year | Date | Year | Date |
|---|---|---|---|---|---|---|---|
| *År* | *Datum* | *År* | *Datum* | *År* | *Datum* | *År* | *Datum* |
| 1949 | 17 | 1965 | - | 1981 | 20 | 1997 | 20 |
| 1950 | 14 | 1966 | 16 | 1982 | 21 | 1998 | 14 |
| 1951 | 17 | 1967 | 16 | 1983 | 20 | 1999 | 22 |
| 1952 | 18 | 1968 | 20 | 1984 | 18 | 2000 | 16 |
| 1953 | 16 | 1969 | 18 | 1985 | 16 | 2001 | 18 |
| 1954 | 19 | 1970 | 21 | 1986 | 16 | 2002 | 18 |
| 1955 | 15 | 1971 | 19 | 1987 | 20 | 2003 | 18 |
| 1956 | 14 | 1972 | 18 | 1988 | 16 | 2004 | 12 |
| 1957 | 16 | 1973 | 17 | 1989 | 20 | 2005 | 14 |
| 1958 | 20 | 1974 | 17 | 1990 | 19 | 2006 | 12 |
| 1959 | 16 | 1975 | 18 | 1991 | 20 | 2007 | 11 |
| 1960 | 20 | 1976 | 18 | 1992 | 16 | 2008 | 12 |
| 1961 | 18 | 1977 | 24 | 1993 | 10 | 2009 | 17 |
| 1962 | 21 | 1978 | 18 | 1994 | 10 | 2010 | 16 |
| 1963 | 19 | 1979 | 16 | 1995 | 23 | 2011 | 15 |
| 1964 | - | 1980 | 20 | 1996 | 21 | | |

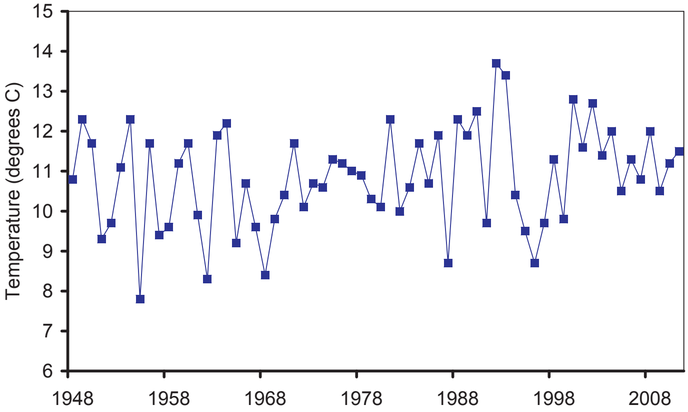

Figure 4. Mean May temperatures during 1948–2011 as recorded at Örebro, c.5 km to the north-west of Lövsätter.
*Medeltemperaturen (Y-axeln) under åren 1948–2011 för Örebro, c.5 km nordväst om Lövsätter.*

### *Clutch size*

The overall clutch mean for 1948–2011 was 6.34 (Appendix 1), with a modal clutch size of six eggs. The lowest mean clutch size (5.76) was recorded in 1991, the highest (7.08) in 2011. During the first half of the study, mean clutch size remained relatively stable at 6.24 eggs (coefficient of variation, CV = 2.2%), but during the second part it varied considerably more between years (CV = 4.5%; Figure 5). This was probably an effect of the more variable laying dates during the latter period (cf. Figure 3). Mean clutch size showed a weak but significant negative relationship with population density expressed as percent nestboxes occupied by Pied Flycatchers (Figure 6; linear regression, $Y = -0.008X + 6.658$, df = 59, $R^2 = 0.147$, $P = 0.002$). In a GLM with clutch size as the dependent variable and with mean laying date, May temperature, percent other hole-nesters and percent Pied Flycatchers as independent variables, only mean laying date and percent Pied Flycatchers were statistically significant ($P = 0.006$ and $< 0.001$, respectively). Within years clutch size generally decreased with laying date. Standardized to median laying date each year, the decrease was $Y = -0.070X + 6.471$, $R^2 = 0.821$, $P < 0.001$. However, clutches of seven eggs were less common after median laying date during the first half of the study than during the second half (38 of 325 clutches vs 74 of 182; $\chi^2 = 252.1$, df 1, $P < 0.001$).

### *Breeding success*

Including all breeding attempts, the mean number of fledged young was 5.34, slightly lower than for successful pairs (5.96) (Appendix 2). Excluding total clutch and brood losses, the proportion of eggs laid that resulted in fledged young varied relatively little between years, from 78% to 100%, with a mean of 93 ± 4.2%. Total losses were, however, relatively common in some years. Out of the 1397 nests in which a clutch was initiated, 133 (9.5%) failed completely. During 1948–1981, 50 out of 911 clutches failed (5.5%) vs 83 out of 486 (17.1%) during 1982–2011. Particularly from 1983 onwards failures were predominantly an effect of predation by Pine Marten *Martes martes*. During these last 29 years, marten predation occurred during 15 years and caused total loss in 55 nests and partial losses in an additional 13 nests (55 nestlings out of 83; Table 2). Great Spotted Woodpecker *Dendrocopos major* depredated 15 broods, in 40 boxes all nestlings were found dead, usually shortly after hatching, 12 clutches were deserted, and another 12 nests were found empty but intact.

## Discussion

### *Population trends and fluctuations*

The studied Pied Flycatcher population decreased, with minor fluctuations, from about 50 pairs during the first years of the study to 12 pairs in 2011. The present study documents that the decrease of the Swedish Pied Flycatcher population may have been going on for some six decades, but unfortunately comparative data series of sufficient duration are lacking for establishing whether this is true or not. Although there was a strong negative correlation between the percentages of flycatchers and of other hole-nesters, it is doubtful whether this indeed constitutes a causal link. Not only was there always empty boxes available but, in particu-

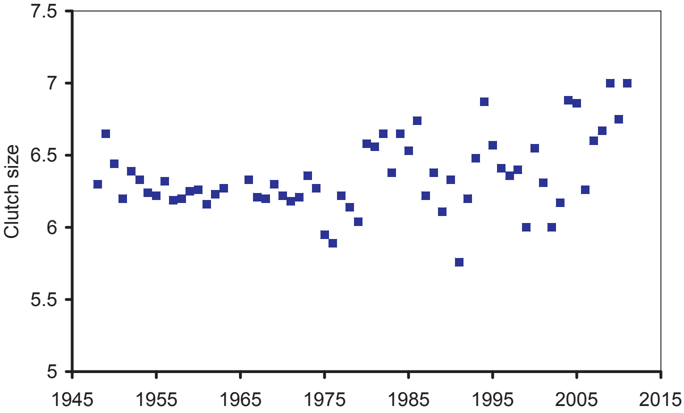

Figure 5. Mean clutch size of Pied Flycatchers at Lövsätter during 1948–2011.
*Medelkullens storlek (Y-axeln) hos svartvit flugsnappare vid Lövsätter de olika åren 1948–2011.*

lar, there was no correlation at all between number of empty boxes and Pied Flycatcher numbers (r = 0.007).

During the last few decades, a negative trend in Pied Flycatcher population size has been observed in some other Swedish nestbox studies (Sjöberg 2006, E. Nyholm in litt.) as well as in the Swedish Bird Monitoring Programme (Ottvall et al. 2009). The results from nestbox studies in two deciduous woods near Lund (55° 44' N, 13° 18' E) also reflect this trend. During the first half of the 1970s the mean number of Pied Flycatcher pairs was 30 and 19, respectively (HK unpubl. data). During 2004–2010, when a large number of nestboxes was again available in these woods, not a single flycatcher pair bred in the boxes (D. Hasselquist pers. comm.). The autumn figures from the standardized bird ringing at Falsterbo Bird Observatory are another indication of a population decrease. These show a negative trend for the Pied Flycatcher over the period 1980–2011 ($r_s = -0.447$, $P < 0.01$) (Table 3). The Swedish Pied Flycatcher population thus seems to have been decreasing for decades but the reason for this is uncertain. One possibility is that forests have become denser and thereby less attractive to flycatchers. This may be true in southern Sweden but is less likely in the north. Another possibility is that the flycatchers' wintering grounds or migratory stop-over sites have deteriorated.

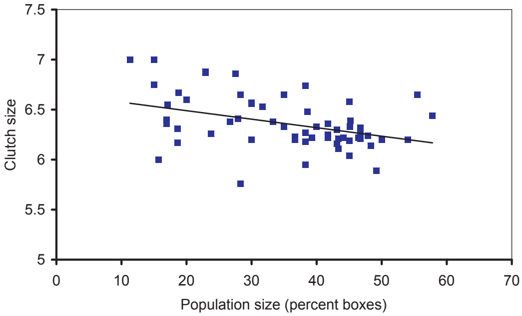

Figure 6. The relationship between Pied Flycatcher mean clutch size and population density (expressed as percent occupied nestboxes), Lövsätter 1948–2010.
*Sambandet mellan medelkullens storlek (Y-axeln) och populationstätheten (X-axeln) uttryckt som procent av antalet holkar hos svartvita flugsnappare vid Lövsätter.*

In a nestbox population in England, a strong decrease took place recently, from 80 pairs in 1990 to 23 pairs in 2004, corresponding to a decrease by 4.2 pairs per year (Goodenough et al. 2009), but data from the preceding period showed a strong increase (A.E. Goodenough in litt.). In a long-term (1957–1989) German study (Winkel 1989, 1993), no trend was detected. Likewise, no statistically significant trend was found for the Pied Flycatcher in German capture data from 1972 to 1996 (Berthold et al. 1998). Pied Flycatchers also colonized northern Belgium (Dhondt et al. 1987), so the pattern of population changes is complicated.

With respect to causes of short-term fluctuations, Virolainen (1984) and Goodenough et al. (2009) found a significant correlation between mean number of fledglings in each year (year *t*) and the percent change in population size to the following year (*t*+1). A reasonable assumption behind this is that the mean number of fledglings reflects the general environmental conditions during the breeding season. If these conditions are similar over larger areas, as could be expected for temperature and precipitation, one would also expect a correlation

Table 2. Pine Marten* predation on Pied Flycatcher broods during 1983 through 2011 at Lövsätter. The table gives the number of nests suffering total loss and partial loss in each year.
*Mårdpredationens* fördelning på totalförluster och partiella förluster hos svartvit flugsnappare vid Lövsätter åren 1983–2011.*

| Year<br>*År* | Total losses<br>*Totalförluster* | Partial losses<br>*Delförluster* |
|---|---|---|
| 1983 | 5 | 0 |
| 1984 | 0 | 0 |
| 1985 | 5 | 0 |
| 1986 | 6 | 1 |
| 1987 | 4 | 1 |
| 1988 | 0 | 0 |
| 1989 | 0 | 0 |
| 1990 | 0 | 1 |
| 1991 | 3 | 0 |
| 1992 | 0 | 0 |
| 1993 | 12 | 1 |
| 1994 | 2 | 0 |
| 1995 | 5 | 4 |
| 1996 | 0 | 0 |
| 1997 | 3 | 1 |
| 1998 | 0 | 0 |
| 1999 | 0 | 0 |
| 2000 | 0 | 0 |
| 2001 | 0 | 0 |
| 2002 | 0 | 0 |
| 2003 | 0 | 0 |
| 2004 | 0 | 0 |
| 2005 | 0 | 0 |
| 2006 | 3 | 0 |
| 2007 | 6 | 0 |
| 2008 | 1 | 1 |
| 2009 | 0 | 0 |
| 2010 | 0 | 2 |
| 2010 | 0 | 0 |
| 2011 | 0 | 0 |

* Pine Marten predation is easy to identify because of nest material hanging out of the entrance hole.
** Mårdpredation identifieras lätt på att bomaterial hänger ut ur ingångshålet.*

between mean numbers of fledglings and capture indices at bird observatories. Such a correlation was found between mean number of fledglings in our study and autumn numbers of juvenile flycatchers captured at Falsterbo (rs = 0.401, P<0.05).

In Artemyev's (2008) study, the factor explaining the largest proportion of the variance in population fluctuation was the proportion of young (2Y) immigrants, which in turn correlated with ambient temperatures during the flycatchers' spring arrival period. Artemyev speculates that spring temperature may influence both mortality and breeding rates of second-year birds.

### *Laying date*

A negative relationship between flycatcher laying date and ambient temperature, as found in the present study, has also been found in many other studies. Thus, in a study comprising Pied Flycatcher populations from most parts of Europe, this relationship was statistically significant for 20 out of 23 populations (Both et al. 2004). Considering that meteorological conditions, such as temperature, may vary in parallel over fairly large areas, it comes as no surprise that laying dates in those years that were common in the studies of Borgström (1990, 2001), Nilsson (2008) and the present one were strongly correlated in each case (r = 0.66–0.86, P < 0.001; the distances between the three study areas are between 130 and 380 km).

In Pied Flycatchers, a gradually earlier breeding during the period 1970–1995 was found by Winkel & Hudde (1997), and the Europe-wide study of Both et al. (2004) documented successively earlier laying dates during the 1980s and 1990s in most but not all of the flycatcher populations studied. Thus, only one of the four Swedish populations included in their study showed a (non-significant) trend towards earlier laying and none of them showed an

Table 3. Comparisons of population declines of Pied Flycatchers in some Swedish long-term studies. The slopes for corresponding years in the present study are given, as are the correlation coefficients.
*Jämförelse av negative trender i svenska studier av svartvit flugsnappare. Tabellen ger regressionskoefficienten för de fyra lokalerna och för motsvarande år i denna studie. Dessutom ges korrelationskoefficienten (r).*

| Year<br>*År* | Locality<br>*Lokal* | Slope<br>*Lutning* | This study<br>*Denna studie* | Correlation<br>*Korrelation* | Refernce<br>*Reference* |
|---|---|---|---|---|---|
| 1965–2010 | Ammarnäs | –0.852 % | –0.694 % | r = 0 671 | E. Nyholm in litt. |
| 1978–2006 | Jämtland | –0.900 % | –0.858 % | r = 0.667 | Sjöberg (2006) |
| 1980–2011 | Falsterbo | –3.894 inds | –0.754 % | r = 0.413 | Falsterbo Bird Observatory in litt. |
| 1980–2010 | Sweden | –1.400 % | –0.758 % | r = 0.777 | S. Svensson in litt. |

increase in temperature. The results of the present study as well as those of Borgström (1990, 2001) and Nilsson (2008) agree with this finding: neither May temperature nor laying date showed any statistically significant trend across years.

### *Clutch size*

The mean clutch size observed in this study, 6.34 eggs, is very similar to clutch sizes found in other studies with similar laying dates (e.g. Hildén & Haartman 1987, Borgström 1990, 2001, Lundberg & Alatalo 1992, Nilsson 2008). It showed a weak negative relationship to population density (percent occupied boxes). A similar weak influence of population density on clutch size was found by Virolainen (1984). Clutch size decreases with the progress of the season (see below), but Virolainen's result remained after he removed the effect of laying date. Since one-year old females lay somewhat smaller clutches than older ones even after correction for laying date (Alatalo & Lundberg 1992), a larger proportion of one-year old females in high-density years could contribute to the observed density effect.

In accordance with other studies where both clutch sizes and laying dates have been reported (for references, see Winkel 1993), clutch size decreased with the progress of the season, the so called "calendar effect" (von Haartman 1966). The decrease in the present study was 0.07 eggs per day later that clutches were started. This falls within the range normally reported (0.06–0.09; Winkel 1993), but lower values have also been documented (e.g. 0.05; Virolainen 1984, and 0.053 for 13 combined areas in Finland; Hildén & Haartman 1987). However, the laying pattern in our study varied much between years and during the second half of the study, a high proportion of 7-egg clutches was laid after the median laying date. The 'calendar effect' may be an adaptation to a seasonally deteriorating food supply as demonstrated experimentally by Siikamäki (1998), who showed that when supplied with extra food, delayed broods survived better than similarly delayed broods without food supplementation.

### *Breeding success*

Including total losses, a mean of 5.34 young fledged, corresponding to 84% of eggs laid, which according to Järvinen (1983) is well above the production necessary to make the population self-sustained (4.4 fledglings per breeding attempt). In only nine of the 62 years of the study was this number not attained and in each case this was mainly the result of predation. Nest predation is often local, but following the strong reduction of Red Fox *Vulpes vulpes* numbers because of sarcoptic mange which spread in Sweden in the 1980s (Lindström et al. 1995), there was a general increase of Pine Martens, which may have impacted on hole-nesting (as well as other) birds over large areas. It is, however, unlikely that nest predation by Pine Martens can explain the negative trend seen in several Swedish Pied Flycatcher populations both because the decrease started before the Pine Marten population increased and because the decrease has continued after Red Fox populations recovered.

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## Sammanfattning

Eftersom den svartvita flugsnapparen gärna häckar i holkar finns en omfattande litteratur om arten, särskilt dess häckningsbiologi (se Lundberg & Alatalo 1992). Denna uppsats redovisar resultaten från en långtidsstudie, som initierades 1948 och som fortfarande pågår. Dess viktigaste resultat är nog den negativa betåndsutveckling som fortgått alltsedan studiens start.

### *Metod*

Inför häckningssäsongen 1948 satte uppsatsens försteförfattare upp 80 holkar i ett skogsområde sydost om Örebro och han har också stått för allt fältarbete sedan dess. Området har beskrivits i Schölin (2009) och består huvudsakligen av blandskog omväxlande med små, numera delvis övergivna och igenväxande åkerlyckor. Holkarna placerades på c.2,5 m höjd med 40–50 meters mellanrum längs en vindlande rutt inom en yta av ungefär 0,5 x 1 km. Flertalet holkar var gjorda av brädor, medan ungefär en tredjedel bestod av urholkade trädstammar. De hade en genomsnittlig bottenyta av 112 $cm^2$ och ingångshål med 30 mm diameter placerat c.16 cm från holkens botten. De kontrollerades i allmänhet en gång i veckan (ibland litet glesare) för att bestämma häckningsstart, kullstorlek, ungöverlevnad, osv. Kullar för vilka läggningsstarten inte blev tillfredställande bestämd har uteslutits från beräkning av läggstart medan 16 kullar, som startats i slutet av juni eller senare, uteslutits helt och hållet (se von Haartman 1989). Temperaturdata för maj har tagits from SMHI:s station i Örebro. Statistiska analyser har utförts med sedvanliga metoder, och i linjära regressioner, där datum utgör den oberoende variabeln är 1 maj = 1, och i fall där denna variabel är år, är 1949 = 1. Regressioner med procent har arcsin-kvadratrot-transformerats, men otransformerade värden anges i texten. Medeltal presenteras ± standardavvikelsen (SD).

### *Resultat*

Vid studiens start 1949 var c.50% av holkarna bebodda av svartvita flugsnappare. Denna andel hade år 2011 fallit till knappa 20%, en årlig minskning som svarar mot ett halvt par per år (Figur 1). Minskningen är höggradigt statistiskt signifikant ($P < 0,001$).

Det fanns ett starkt negativt samband mellan antalet flugsnappare och antalet övriga holkhäckare, främst talgoxe *Parus major* och blåmes *Cyanistes caeruleus* (Figur 2, $r_s = -0.808$, $P < 0,001$), dvs många övriga hålhäckare betydde färre flugsnappare, men det fanns varje år ett antal tomma holkar. Det är osäkert om det föreligger ett orsakssamband mellan mesarnas ökning och flugsnapparnas minskning. Vi fann ett relativt svagt (men signifikant) samband mellan medelproduktionen av flygga ungar ett år och beståndsstorleken följande häckningssäsong.

Medeldatum för läggstarten varierade under studieperioden från 17 maj det tidigaste året (1994) till 3 juni det senaste (1991), med 24 maj som medeltal för alla år sammantagna (N = 61 år). Läggstarten var negativt relaterad till medeltemperaturen i maj, dvs ju högre majtemperatur desto tidigare start. Det tidigast lagda ägget (Tabell 1) under något år lades den 10 maj (1993 och 1994). Vare sig majtemperatur eller läggstart visade någon statistiskt signifikant trend över de sex decennierna (Figur 3, Figur 4).

Kullstorleken för samtliga år 1948–2011 var 6,34, med 6-kullar som de mest frekventa. Den lägsta genomsnittliga kullstorleken (5,76) registrerades 1991, den högsta (7,08) 2011 (Appendix 1). Under studiens första hälft låg medelkullstorleken relativt stabilt kring 6,24 ägg (variationskoefficienten, CV = 2,2%), medan den under den andra hälften varierade avsevärt mer mellan åren (CV = 4,5%) (Figur 5), troligen en effekt av mer variabla läggdatum under den senare perioden (jfr Figur 3) och en lägre populationstäthet (Figur 6). Medelkullen de olika åren minskade med 0,07 ägg/dag när materialet standardiserats efter medianläggdatum.

Medelantalet flygga ungar per kull beräknat på 1397 påbörjade kullar var 5,34 och för 1264 kullar i vilka minst en unge kom på vingarna, 5,96 (Appendix 2). Om alla kullar med totalförluster utesluts, så resulterade mellan 78 och 100 procent av lagda ägg i flygga ungar (medeltal 93%). Totalförluster var emellertid ganska vanliga. Av de 1397 påbörjade kullarna misslyckades 133 (9,5%) helt. Särskilt efter 1983 var förlusterna huvudsakligen orsakade av mårdpredation (Tabell 2), som förekom under 15 av de 29 åren. Andra totalförluster orsakades av större hackspett *Dendrocopos major* (15 kullar), övergivningar (12 kullar) och ungdöd (40 kullar, vanligen kort tid efter kläckning). I ytterligare 12 fall var bona tomma men intakta.

## *Diskussion*

Under de senaste åren har negativa populationstrender för svartvit flugsnappare noterats i en del svenska studier (Sjöberg 2006, E. Nyholm i brev, Ottvall m.fl. 2009). I två lövskogsdungar, där en av författarna till denna uppsats (HK) på 1970-talet i sina holkar hade i medeltal 30 respektive 19 par flugsnappare, har i ett nytt holkprojekt under åren 2004–2010 inte ett enda par häckat (D. Hasselquist i brev). En ytterligare indikation på en negativ beståndsutveckling kommer från Falsterbo fågelstations standardiserade ringmärkningar, vilka visar en statistiskt signifikant negativ trend för svartvit flugsnappare under perioden 1980–2011 (Tabell 3). Vår studie visar att beståndsminskningen kan ha pågått betydligt längre, men beklagligtvis tycks dataserier av motsvarande längd saknas som jämförelse.

Som också iakttagits i flera andra undersökningar (se t.ex. Both m.fl. 2004), varierade medeldatum för värpstarten de olika åren med maj månads medeltemperatur. Eftersom väderförhållanden ofta är relativt likartade åtminstone över måttligt stora områden, är det föga förvånande att läggdatum var starkt korrelerade mellan Råda i Värmland (Borgström 1990, 2001), trakten mellan Tranås och Gränna (Nilsson 2008) och Örebro-trakten (denna studie). Avstånden mellan de tre lokalerna är 130–380 km.

I en studie av Both m.fl. (2004), baserad på flugsnappardata från praktiskt taget hela Europa, fann man i flertalet fall att läggstarten under 1980- och 1990-talen inträffat allt tidigare liksom att temperaturen stigit under samma period. Undantag utgjorde några av de ingående svenska lokalerna, där varken majtemperaturen eller läggstarten förändrats under de två decennierna. Vår studie, liksom de nämnda studierna av Borgström och Nilsson, passar in i detta mönster; varken majtemperatur eller läggdatum uppvisar någon trend under de år respektive studie pågått.

Den genomsnittliga kullstorleken, 6,34 ägg, ligger inom samma ganska snäva intervall som konstaterats inom områden med likartade läggdatum (Haartman & Hildén 1987, Borgström 1990, 2001, Lundberg & Alatalo 1992, Nilsson 2008). Den visade ett svagt negativt samband med antalet häckande par, något som också Virolainen (1984) fann. Hos den svartvita flugsnapparen minskar kullstorleken med säsongens framskridande, den s.k. kalendereffekten (Haartman 1966). Minskningen i denna studie var 0,07 ägg per dag, vilket ligger inom ramen för de oftast rapporterade värdena (Winkel 1993).

Med totalförluster inkluderade, blev i medeltal 5,34 ungar flygga, eller 84% av lagda ägg. Enligt Järvinen (1983) krävs 4,4 flygga ungar för att beståndet skall upprätthållas utan inflyttning. Under blott nio av de 61 åren nåddes inte denna nivå, nästan uteslutande beroende på predation, framför allt av mård (Tabell 1). Den iakttagna beståndsminskningen kan därför knappast tillskrivas ett dåligt häckningsresultat.

Appendix 1. Yearly clutch size distributions and mean clutch sizes of Pied Flycatchers at Lövsätter, South Central Sweden during 1948–2010. No complete clutches with less than 4 eggs.
*Kullstorleksfördelning och medelkullstorlekar för svartvita flugsnappare vid Lövsätter sydost om Örebro under åren 1948–2010. Inga fulla kullar med färre än 4 ägg.*

| | Clutch size *Kullstorlek* | | | | | Total number of eggs laid *Totala antalet lagda ägg* | No. of clutches *Antal kullar* | Mean clutch size *Medelantal ägg* |
|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | | | |
| 1948 | 1 | 5 | 6 | 15 | | 170 | 27 | 6.30 |
| 1949 | | 1 | 20 | 23 | 5 | 326 | 49 | 6.65 |
| 1950 | | 2 | 27 | 21 | 2 | 335 | 52 | 6.44 |
| 1951 | 3 | 3 | 29 | 18 | 1 | 335 | 54 | 6.20 |
| 1952 | | 7 | 21 | 11 | 3 | 262 | 42 | 6.39 |
| 1953 | | 5 | 17 | 11 | 3 | 228 | 36 | 6.33 |
| 1954 | | 5 | 18 | 9 | 2 | 212 | 34 | 6.24 |
| 1955 | | 5 | 18 | 6 | 3 | 199 | 32 | 6.22 |
| 1956 | 1 | 3 | 13 | 8 | 3 | 177 | 28 | 6.32 |
| 1957 | | 5 | 14 | 6 | 2 | 167 | 27 | 6.19 |
| 1958 | | 6 | 16 | 4 | 4 | 186 | 30 | 6.20 |
| 1959 | | 3 | 13 | 7 | 1 | 150 | 24 | 6.25 |
| 1960 | | 4 | 14 | 7 | 2 | 169 | 27 | 6.26 |
| 1961 | | 6 | 12 | 4 | 3 | 154 | 25 | 6.16 |
| 1962 | | 2 | 15 | 3 | 2 | 137 | 22 | 6.23 |
| 1963 | | 3 | 12 | 5 | 2 | 138 | 22 | 6.27 |
| 1964 | | | | | | | | |
| 1965 | | | | | | | | |
| 1966 | | 3 | 12 | 7 | 2 | 152 | 24 | 6.33 |
| 1967 | 1 | 2 | 17 | 6 | 2 | 174 | 28 | 6.21 |
| 1968 | | 4 | 9 | 6 | 1 | 124 | 20 | 6.20 |
| 1969 | | 4 | 10 | 7 | 2 | 145 | 23 | 6.30 |
| 1970 | | 4 | 12 | 5 | 2 | 143 | 23 | 6.22 |
| 1971 | 1 | 3 | 11 | 5 | 2 | 136 | 22 | 6.13 |
| 1972 | 1 | 3 | 12 | 6 | 2 | 149 | 24 | 6.21 |
| 1973 | | 2 | 15 | 5 | 3 | 159 | 25 | 6.36 |
| 1974 | | 3 | 12 | 5 | 2 | 138 | 22 | 6.27 |
| 1975 | | 5 | 11 | 4 | | 119 | 20 | 5.95 |
| 1976 | 1 | 7 | 15 | 4 | 1 | 165 | 28 | 5.89 |
| 1977 | | 2 | 15 | 5 | 1 | 143 | 23 | 6.22 |
| 1978 | | 4 | 16 | 8 | | 172 | 28 | 6.14 |
| 1979 | 1 | 5 | 13 | 6 | 1 | 157 | 26 | 6.04 |
| 1980 | | 2 | 9 | 13 | 2 | 171 | 26 | 6.58 |
| 1981 | | 2 | 7 | 6 | 3 | 118 | 18 | 6.56 |
| 1982 | | 1 | 7 | 10 | 2 | 133 | 20 | 6.65 |
| 1983 | | 2 | 7 | 6 | 1 | 102 | 16 | 6.38 |
| 1984 | | 2 | 4 | 9 | 2 | 113 | 17 | 6.65 |
| 1985 | | 2 | 5 | 9 | 1 | 111 | 17 | 6.53 |
| 1986 | | | 10 | 9 | 4 | 155 | 23 | 6.74 |
| 1987 | | 2 | 14 | 7 | | 143 | 23 | 6.22 |
| 1988 | 1 | 2 | 6 | 12 | | 134 | 21 | 6.38 |
| 1989 | 1 | 2 | 9 | 6 | | 110 | 18 | 6.11 |
| 1990 | | 2 | 9 | 6 | 1 | 114 | 18 | 6.33 |
| 1991 | 2 | 3 | 9 | 3 | | 98 | 17 | 5.76 |
| 1992 | 2 | 3 | 5 | 9 | 1 | 124 | 20 | 6.20 |
| 1993 | 1 | 1 | 12 | 7 | 4 | 162 | 25 | 6.48 |
| 1994 | | | 4 | 9 | 2 | 103 | 15 | 6.87 |
| 1995 | | 1 | 7 | 13 | | 138 | 21 | 6.57 |

Appendix 1 forts.

| | Clutch size *Kullstorlek* | | | | | Total number of eggs laid *Totala antalet lagda ägg* | No. of clutches *Antal kullar* | Mean clutch size *Medelantal ägg* |
|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | | | |
| 1977 | | 2 | 15 | 5 | 1 | 143 | 23 | 6.22 |
| 1978 | | 4 | 16 | 8 | | 172 | 28 | 6.14 |
| 1979 | 1 | 5 | 13 | 6 | 1 | 157 | 26 | 6.04 |
| 1980 | | 2 | 9 | 13 | 2 | 171 | 26 | 6.58 |
| 1981 | | 2 | 7 | 6 | 3 | 118 | 18 | 6.56 |
| 1982 | | 1 | 7 | 10 | 2 | 133 | 20 | 6.65 |
| 1983 | | 2 | 7 | 6 | 1 | 102 | 16 | 6.38 |
| 1984 | | 2 | 4 | 9 | 2 | 113 | 17 | 6.65 |
| 1985 | | 2 | 5 | 9 | 1 | 111 | 17 | 6.53 |
| 1986 | | | 10 | 9 | 4 | 155 | 23 | 6.74 |
| 1987 | | 2 | 14 | 7 | | 143 | 23 | 6.22 |
| 1988 | 1 | 2 | 6 | 12 | | 134 | 21 | 6.38 |
| 1989 | 1 | 2 | 9 | 6 | | 110 | 18 | 6.11 |
| 1990 | | 2 | 9 | 6 | 1 | 114 | 18 | 6.33 |
| 1991 | 2 | 3 | 9 | 3 | | 98 | 17 | 5.76 |
| 1992 | 2 | 3 | 5 | 9 | 1 | 124 | 20 | 6.20 |
| 1993 | 1 | 1 | 12 | 7 | 4 | 162 | 25 | 6.48 |
| 1994 | | | 4 | 9 | 2 | 103 | 15 | 6.87 |
| 1995 | | 1 | 7 | 13 | | 138 | 21 | 6.57 |
| 1996 | | 1 | 8 | 8 | | 109 | 17 | 6.41 |
| 1997 | | 1 | 5 | 5 | | 70 | 11 | 6.36 |
| 1998 | | 1 | 4 | 5 | | 64 | 10 | 6.40 |
| 1999 | 2 | | 4 | 4 | | 60 | 10 | 6.00 |
| 2000 | | 1 | 5 | 3 | 2 | 72 | 11 | 6.55 |
| 2001 | | 2 | 6 | 4 | 1 | 82 | 13 | 6.31 |
| 2002 | 1 | 2 | 5 | 2 | 1 | 66 | 11 | 6.00 |
| 2003 | 1 | | 7 | 4 | | 74 | 12 | 6.17 |
| 2004 | | | 4 | 10 | 2 | 110 | 16 | 6.88 |
| 2005 | | | 5 | 15 | 2 | 151 | 22 | 6.86 |
| 2006 | 1 | 2 | 7 | 9 | | 119 | 19 | 6.26 |
| 2007 | | | 8 | 5 | 2 | 99 | 15 | 6.60 |
| 2008 | | 1 | 4 | 9 | 1 | 100 | 15 | 6.67 |
| 2009 | | | 2 | 5 | 2 | 63 | 9 | 7.00 |
| 2010 | | 1 | 3 | 6 | 2 | 81 | 12 | 6.75 |
| 2011 | | | 2 | 7 | 3 | 85 | 12 | 7.08 |
| Total | 22 | 155 | 648 | 472 | 100 | 8855 | 1397 | 6.34 |
| % | 1.6 | 11.1 | 46.4 | 33.8 | 7.2 | | | |

Appendix 2. Number of Pied Flycatcher broods at Lövsätter, South Central Sweden from which 0, 1, 2, 3, etc. young fledged in each year and mean number of fledged young per brood for all broods (1) and for broods that produced at least one fledgling (2).
*Antal kullar från vilka 0, 1, 2, 3, etc. ungar blev flygga respektive år samt medeltal flygga för samtliga kullar (1) och från kullar där minst en unge blev flygg vid Lövsätter sydost om Örebro 1948–2010.*

| | No. of young fledged *Antal flygga ungar* | | | | | | | | | Total fledged *Flygga totalt* | No. of broods (1) *Antal kullar* (1) | Mean per brood (1) *Medeltal per kull* (1) | No. of broods (2) *Antal kullar* (2) | Mean per brood (2) *Medeltal per kull* (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | |
| 1948 | 3 | | | | 2 | 6 | 7 | 9 | | 143 | 27 | 5.30 | 24 | 5.96 |
| 1949 | 3 | | 1 | 1 | 1 | 4 | 20 | 17 | 2 | 284 | 49 | 5.80 | 46 | 6.17 |
| 1950 | 3 | | 1 | 1 | 5 | 7 | 21 | 13 | 1 | 285 | 52 | 5.48 | 49 | 5.82 |
| 1951 | | | 1 | | 5 | 7 | 26 | 14 | 1 | 319 | 54 | 5.91 | 54 | 5.91 |
| 1952 | 2 | | | 1 | | 13 | 15 | 8 | 3 | 238 | 42 | 5.67 | 40 | 5.95 |
| 1953 | 3 | | | 1 | 1 | 7 | 15 | 7 | 2 | 197 | 36 | 5.47 | 33 | 5.97 |
| 1954 | 3 | | | | 1 | 6 | 17 | 5 | 2 | 187 | 34 | 5.50 | 31 | 6.03 |
| 1955 | 1 | | 1 | | 2 | 8 | 13 | 5 | 2 | 179 | 32 | 5.59 | 31 | 5.77 |
| 1956 | 1 | | 1 | | 3 | 4 | 11 | 6 | 2 | 158 | 28 | 5.64 | 27 | 5.85 |
| 1957 | 1 | | | | 1 | 8 | 11 | 5 | 1 | 153 | 27 | 5.67 | 26 | 5.88 |
| 1958 | 4 | | | | 1 | 5 | 12 | 5 | 3 | 160 | 30 | 5.33 | 26 | 6.15 |
| 1959 | 2 | | | | | 3 | 11 | 7 | 1 | 138 | 24 | 5.75 | 22 | 6.27 |
| 1960 | 4 | 1 | | | 1 | 3 | 13 | 4 | 1 | 134 | 27 | 4.96 | 23 | 5.83 |
| 1961 | 1 | | | | | 8 | 11 | 3 | 2 | 143 | 25 | 5.72 | 24 | 5.96 |
| 1962 | | | | | | 6 | 11 | 4 | 1 | 132 | 22 | 6.00 | 22 | 6.00 |
| 1963 | | | | | | 6 | 9 | 5 | 2 | 135 | 22 | 6.14 | 22 | 6.14 |
| 1964 | | | | | | | | | | | | | | |
| 1965 | | | | | | | | | | | | | | |
| 1966 | | | | | 1 | 4 | 12 | 6 | 1 | 146 | 24 | 6.08 | 24 | 6.08 |
| 1967 | 2 | | | | 2 | 3 | 14 | 5 | 2 | 158 | 28 | 5.64 | 26 | 6.08 |
| 1968 | 1 | | | | | 5 | 7 | 6 | 1 | 117 | 20 | 5.85 | 19 | 6.16 |
| 1969 | | | | | | 6 | 11 | 4 | 2 | 140 | 23 | 6.09 | 23 | 6.09 |
| 1970 | 1 | | | | 1 | 6 | 10 | 3 | 2 | 131 | 23 | 5.70 | 22 | 5.95 |
| 1971 | 1 | | | | 1 | 6 | 8 | 5 | 1 | 125 | 22 | 5.68 | 21 | 5.95 |
| 1972 | 2 | | | | | 6 | 10 | 5 | 1 | 133 | 24 | 5.54 | 22 | 6.05 |
| 1973 | | | | | | 5 | 16 | 3 | 1 | 150 | 25 | 6.00 | 25 | 6.00 |
| 1974 | 1 | | | | | 7 | 9 | 4 | 1 | 125 | 22 | 5.68 | 21 | 5.95 |
| 1975 | 1 | | | | 1 | 7 | 10 | 1 | | 106 | 20 | 5.30 | 19 | 5.58 |
| 1976 | 2 | | | 1 | 3 | 10 | 9 | 3 | | 140 | 28 | 5.00 | 26 | 5.38 |
| 1977 | 4 | | | | | 4 | 12 | 3 | | 113 | 23 | 4.91 | 19 | 5.95 |
| 1978 | 2 | | 1 | | | 10 | 13 | 2 | | 144 | 28 | 5.14 | 26 | 5.54 |
| 1979 | 2 | | | | 1 | 9 | 11 | 3 | | 136 | 26 | 5.23 | 24 | 5.67 |
| 1980 | | | 1 | | 1 | 3 | 12 | 9 | | 156 | 26 | 6.00 | 26 | 6.00 |
| 1981 | | | | | | 3 | 6 | 8 | 1 | 115 | 18 | 6.39 | 18 | 6.39 |
| 1982 | | | | | | 3 | 8 | 8 | 1 | 127 | 20 | 6.35 | 20 | 6.35 |
| 1983 | 6 | | | | 1 | 3 | | 6 | | 61 | 16 | 3.81 | 10 | 6.10 |
| 1984 | 1 | | | | | 2 | 6 | 7 | 1 | 103 | 17 | 6.06 | 16 | 6.44 |
| 1985 | 4 | | | | | 2 | 3 | 8 | | 84 | 17 | 4.94 | 13 | 6.46 |
| 1986 | 6 | | 1 | | | 1 | 5 | 9 | 1 | 108 | 23 | 4.70 | 17 | 6.35 |
| 1987 | 6 | 1 | 1 | | | 3 | 10 | 2 | | 92 | 23 | 4.00 | 17 | 5.41 |
| 1988 | | | | | 1 | 3 | 7 | 10 | | 131 | 21 | 6.24 | 21 | 6.24 |
| 1989 | 1 | 1 | | | 2 | 1 | 9 | 4 | | 96 | 18 | 5.33 | 17 | 5.65 |
| 1990 | 1 | | 1 | 2 | 1 | 4 | 5 | 3 | 1 | 91 | 18 | 5.06 | 17 | 5.35 |
| 1991 | 4 | | 1 | | 2 | 3 | 6 | 1 | | 68 | 17 | 4.00 | 13 | 5.23 |
| 1992 | | | | | 3 | 5 | 7 | 4 | 1 | 115 | 20 | 5.75 | 20 | 5.75 |

Appendix 2. forts

| | No. of young fledged *Antal flygga ungar* | | | | | | | | | Total fledged *Flygga totalt* | No. of broods ( 1 ) *Antal kullar* ( 1 ) | Mean per brood ( 1 ) *Medeltal per kull* ( 1 ) | No. of broods ( 2 ) *Antal kullar* ( 2 ) | Mean per brood ( 2 ) *Medeltal per kull* ( 2 ) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | | | |
| 1993 | 14 | | 1 | | 2 | 3 | 4 | 1 | | 56 | 25 | 2.24 | 11 | 5.09 |
| 1094 | 4 | | 1 | 1 | | 1 | 3 | 4 | 1 | 64 | 15 | 4.27 | 11 | 5.82 |
| 1995 | 6 | 1 | 1 | 2 | 1 | 2 | 5 | 3 | | 74 | 21 | 3.52 | 15 | 4.93 |
| 1996 | 3 | 1 | | 1 | 1 | 2 | 4 | 5 | | 77 | 17 | 4.53 | 14 | 5.50 |
| 1997 | 4 | 1 | | | 2 | 1 | 2 | 1 | | 33 | 11 | 3.00 | 7 | 4.71 |
| 1998 | 1 | | | | 1 | 1 | 3 | 4 | | 55 | 10 | 5.50 | 9 | 6.11 |
| 1999 | 3 | | | | 1 | 2 | 2 | 2 | | 40 | 10 | 4.00 | 7 | 5.71 |
| 2000 | | | | | | 1 | 6 | 4 | | 69 | 11 | 6.27 | 11 | 6.27 |
| 2001 | | | | | 1 | 4 | 5 | 3 | | 75 | 13 | 5.77 | 13 | 5.77 |
| 2002 | 1 | 1 | | | 2 | 1 | 5 | 1 | | 51 | 11 | 4.64 | 10 | 5.10 |
| 2003 | 1 | | | | 3 | | 6 | 2 | | 62 | 12 | 5.17 | 11 | 5.64 |
| 2004 | 2 | | 1 | | 1 | 4 | 2 | 4 | 2 | 82 | 16 | 5.13 | 14 | 5.86 |
| 2005 | | | | | | 3 | 7 | 10 | 2 | 143 | 22 | 6.50 | 22 | 6.50 |
| 2006 | 7 | 1 | 1 | | 1 | 1 | 5 | 3 | | 63 | 19 | 3.32 | 12 | 5.25 |
| 2007 | 6 | | | 1 | 1 | 4 | 2 | | 1 | 47 | 15 | 3.13 | 9 | 5.22 |
| 2008 | 1 | 1 | | | 2 | 1 | 5 | 5 | | 79 | 15 | 5.27 | 14 | 5.64 |
| 2009 | 1 | | | | | 1 | 3 | 3 | 1 | 52 | 9 | 5.78 | 8 | 6.50 |
| 2010 | | 1 | | | 1 | 1 | 5 | 3 | 1 | 69 | 12 | 5.83 | 12 | 5.75 |
| 2011 | | | | | 2 | 1 | 5 | 3 | 1 | 72 | 12 | 6.00 | 12 | 6.00 |
| Total | 133 | 10 | 16 | 12 | 66 | 259 | 538 | 310 | 53 | 7459 | 1397 | 5.34 | 1264 | 5.96 |

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# Population fluctuations and timing of spring migration of the Scandinavian Bluethroat *Luscinia svecica svecica* at Ottenby Bird Observatory, Sweden, 1955–2008

## *Beståndsvariationer och tidsförlopp för vårflyttningen hos den skandinaviska blåhaken* Luscinia svecica svecica *vid Ottenby fågelstation, Sverige, 1955–2008*

STAFFAN SVANBERG & JONAS WALDENSTRÖM

## Abstract

In this study, 54 years (1955–2008) of consecutive trapping data from Ottenby Bird Observatory on the island of Öland, SE Sweden, was used to analyze the spring passage of the Scandinavian subspecies of the Bluethroat *Luscinia svecica svecica*. The aim was to investigate trends in the numbers of Bluethroat passing this site and to provide statistics related to the phenology of migration. Trapping of Bluethroats at Ottenby may be seen as an index of population numbers in the recruitment area, especially for the latest decades when trapping conditions have been standardized. The number of trapped individuals was stable both in the long and short term, but median spring passage has become significantly earlier over the study period. The spring migration of the species showed clear age and sex related differences in timing. Male Bluethroats preceded females with about three days, and adult birds preceded juveniles of both sexes. Finally, the local weather during the peak passage significantly affected the number of trapped individuals, with the largest number trapped in days with head winds from the northwest sector.

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### Introduction

The Bluethroat *Luscinia svecica* is an enigmatic small songbird with a brightly coloured throat and a characteristic flute-like song. In Scandinavia, it is represented by the subspecies *L. s. svecica* (Mullarney et al. 1999). The species breed in birch (*Betula pubescens*) forests in the Scandinavian mountain range and above the treeline in willow (*Salix* spp.) shrubberies (Svensson et al. 1999). Census data from the Swedish part of the breeding range suggest a long-term population decline, of the order of 10–29% in the period 1977–2006 (Ottvall et al. 2008). However, during the latter part of the period (1997–2006) the decrease has levelled off, and the trend become more stable (Ottvall et al. 2008). Unlike most other long-distance migrants breeding in Scandinavia, the Bluethroat has a south-easterly migration route in autumn. There are very few ringing recoveries from passage or winter, but those at hand imply a migration to presumed winter grounds in Pakistan and India (Ellegren & Staav 1990, Cramp et al. 1988, Mullarney et al. 1999, Staav & Fransson 2007, Fransson & Hall-Karlsson 2008). Increased ringing in the breeding range is not expected to significantly increase the number of ring recoveries from migration or wintering sites. Another way of yielding data on the species migration pathways would be to use small logging devices, such as ‘light loggers' that recently have been deployed in some passerine species (Bächler et al. 2010).

The stopover biology of Bluethroats in autumn has been studied in different Swedish localities. It seems that the species leaves the mountain range in August for stopover sites in the Swedish lowland, especially at coastal marshes and reeds. These sites are utilized for short stopovers, often less than a week. Adult Bluethroats are better than juveniles at putting on mass and also depart from stopover sites significantly earlier compared to juvenile birds (Lindström et al. 1985, Ellegren 1990a, Ellegren 1990b, Ellegren 1991).

In spring, Bluethroats pass eastern Sweden rapidly on the way to their breeding grounds (Pettersson 1993). Most ringing schemes at bird observatories in Sweden are operated mainly in autumn, and of the sites managed in spring, only a few trap Bluethroats in any significant numbers. Ottenby Bird Observatory in southeastern Sweden is one of these sites and Pettersson (1993) compiled descriptive data on the species' passage at the site until 1992. In the present study, we analyse all data from Ottenby bird Observatory in the years 1955–2008, a time series of 54 years.

Since the 1970s, the spring temperature in the northern hemisphere has increased (Both & Visser 2001, Raion 2008). The change towards a warmer climate in northern Europe has affected the timing of seasonal activities among both animals and plants (Walther et al. 2002). On an evolutionary timescale, migratory birds have evolved migration patterns to match peaks in food availability during the spring (Jonzén et al. 2006). A rapid change in climate can lead to a mismatch between arrival date and peak food availability, and can thereby affect migratory birds negatively and cause population declines. The generally earlier arrival of spring in Europe is thought to affect the arrival of migratory birds to their breeding grounds and has been the subject of several studies (Both & Visser 2001, Hüppop & Hüppop 2003, Stervander et al. 2005, Jonsén et al. 2006, Raione 2008). The main picture is that the spring arrival of birds is pushed forward to earlier dates. One of several effects that influence the climate in northern Europe is the North Atlantic Oscillation index (NAO) which has been used in many studies to test the impact of climate variability on spring arrival. The index describes the difference between the normalized sea-level preassure at the Azores and Iceland during winter and early spring. Negative values are associated with less precipitation and lower temperatures, and positive values with higher temperatures and more precipitation (Hurrell 1995, Ottersen et al. 2001). High positive values thereby indicate earlier arrival of spring in northen Europe. In the last decade studies have shown that the NAO affects the timing of spring migration in birds (Forchhammer et al. 2002, Hubalek 2003, Hüppop & Hüppop 2003, Stervander et al. 2005, Jonsén et al. 2006). Analysing data from Ottenby, Stervander et al. (2005) showed that the arrival date of Bluethroats, unlike many species wintering in West Africa or Europe, was not correlated with NAO. However, mean spring arrival was found to become progressively earlier during the study period, with on average 0.062 days/year.

The facts that the Bluethroat has a different migration direction compared to most Scandinavian long distance migrants, shows a long term population decrease on breeding sites (Ottvall et al. 2008) and inhabits a breeding habitat subject to changes due to climate conditions (Moen et al. 2004) warrant the need of studying population trends in this species. Here, we analyse trends both in abundance at spring migration and in median spring passage over more than 50 years of trapping data.

## Material & Method

### *Study area, data and time series*

Ottenby Bird Observatory is located at the southernmost point of Öland (56°12´N, 16°24´E), an island situated off the southeastern coast of Sweden. Trapping and ringing of birds have been carried out at Ottenby since 1946 and the spring trapping scheme has been standardized since 1979. The standardization includes daily trapping from 15 March until 15 June each year, each trapping day beginning 30 min before sunrise and ending at 11AM (Lindström et al. 2008). Birds are trapped with mist nets that are positioned at fixed places in the observatory garden, and with two stationary funnel traps of Helgoland-type (Stervander et al. 2005, Lindström et al. 2008). The number of nets used on a given day is dependent on the weather, where heavy winds or rain reduces the number operated. However, the Helgoland traps are always in use. When a bird is trapped and ringed, the sex and age is determined and its wing length, body mass and fat score are registered.

Ringing data from all individuals from 1946 through 2008 was extracted from the observatory database. We excluded the first 10 years in the period because they had insufficient coverage of the main Bluethroat passage period. Furthermore, 8 birds that belonged to the subspecies *L. s. cyanecula* – a vagrant to the area – were also omitted from the study which resulted in a total of 1922 birds available for analyses. As noted above, the standardized trapping scheme ends at 11AM. The ringers note the clock hour when each bird was ringed (i.e. not trapping hour), and we included all birds with a clock hour up to and including 12AM for analyzes of population trends, thereby excluding birds haphazardly trapped in the afternoons or during special cicumstances. In 1966 and 1967 the number of days with trapping was limited and the the trapping effort only reached 17% and 60%, respectively.

Statistical analyses were made in the statistical software SPSS v. 17.0, Statistica v. 8.0, Excel 2000 and R v. 2.10.0.

### *Trends in trapping numbers*

The time series was divided into two: one comprising the total period 1955–2008, and one restricted time series covering the standardized period 1979–2008. Trends in the number of ringed birds at Ottenby during spring passage were then analysed with regression analyses, using year as predictor and the number of trapped birds as the dependent factor. Trapping numbers were log-transformed to achieve normality. No autocorrelation was found with a lag time up to 5 years. Where possible, analyses were done separately for adult and younger (born the previous summer) birds.

### *Median spring passage and differences between sex, age and size categories*

Wilcoxon rank sum tests were used to analyse if the median spring passage of Bluethroats at Ottenby has changed over time. The median date of passage of the entire population was calculated separately for the three decades of standardized trapping (1979–1988, 1989–1998 and 1999–2008). To analyse age and sex-related differences in the phenology of migration from the whole time period (1955–2008), we used two-sample t-tests assuming unequal variance. For both analyses, we omitted 17 birds ringed in April and June. The spring passage of the species at Ottenby is very condensed in time, and the number of excluded individuals comprised 0.9 % of the total.

Finally, we tested predictors of the median spring passage with general linear models (GLMs). To perform the analysis, the date value was parameterized into Julian date, with 1 May as day 1 and the 31 May as day 31. The median spring passage was used as the dependent variable and we included sex, age, year and their two-ways interaction into a full model. Insignificant interactions and factors were eliminated stepwise to yield a final model.

### *Local weather and numbers of Bluethroats trapped*

At Ottenby, daily diaries are written that sum the trappings, bird observations and other events of importance for the observatory. Weather data such as temperature (C°), wind direction, wind strength (m/s) and cloud cover (a scale from 1 to 8, where 8 is full overcast) from a local weather station are also noted. These weather data were collected and used to analyse if local weather had any impact on the number of Bluethroats trapped. The wind direction was described in sixteen different directions (N, NNE, NE, ENE, etc.), which we categorized into eight categories (N, NW, W, SW, S, SE, E and NE) combining the two closest directions, e.g. N and NNE became N. To achieve normal distribution of data, a log-transformation of trapping numbers was made. GLMs were developed with number of trapped Bluethroats as the dependent factor and temperature, wind strength, cloud cover, wind direction and the interaction between wind direction and wind strength as factors. Insignificant interactions and factors were taken away stepwise to yield a final model.

## Results

Bluethroats were trapped each year in 1955–2008 (Figure 1), with a condensed passage mainly limited to May (Figure 2).

### *Population trends*

The number of trapped Bluethroats varied over time and the analyses of trends in numbers trapped gave different results depending on which part of the time series that was analysed. Using the full time series, 1955–2008, the number of trapped birds increased significantly over time with 1.7% per year (Figure 3a; F = 19.20, d.f. = 51, P < 0.001). However, looking only at the standardized trapping period 1979–2008, there was no change in trapping numbers neither for the total number of birds (Figure 3a; F = 0.40, d.f. = 28, P = 0.53), nor for the numbers of trapped adults and young birds treated separately (Figure 3b; adult: F = 0.17, d.f. = 26, P = 0.68; younger birds: F = 3.59, d.f. = 27, P = 0.07). However, the negative trend for younger birds was close to statistically significant.

### *Spring passage*

The median date of passage during three decades of standarized trapping was 15 May in 1979–1988, 18 May in 1989–1998 and 13 May in 1999–2008. There was a significant difference between the two first decades, 1979–1988 and 1989–1998 (W = 124885, P < 0.001), and also betwen the last two decades, 1989–1998 and 1999–2008 (W = 204903, P < 0.001).

The median date of passage showed significant differences between males and females (Table 1; d.f. = 1764, T = -14.63, P < 0.001) by ~3 days. The results also showed differences in time of passage between age categories (Table 1; Figure 4), where

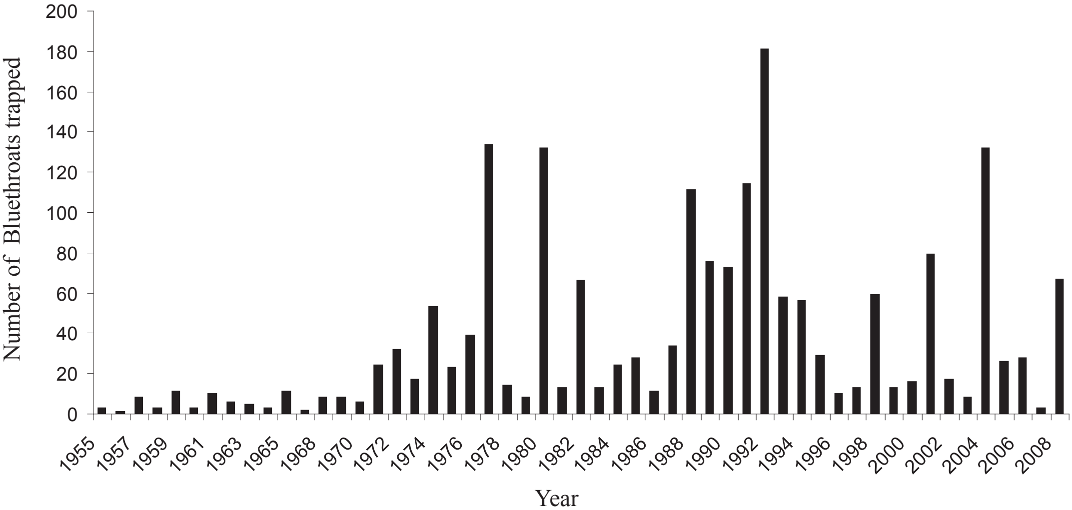

Figure 1. Number of Bluethroats trapped each year in 1955–2008.
*Antal fångade blåhakar varje år under 1955–2008.*

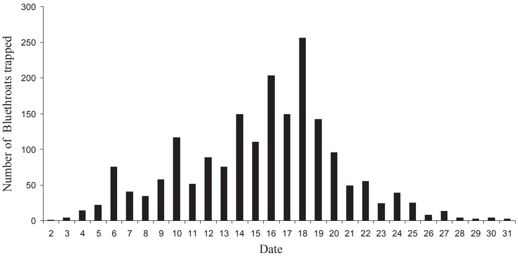

Figure 2. Number of Bluethroats trapped at each date in May in 1955–2008.
*Antal fångade blåhakar varje datum i maj under 1955–2008.*

adult males passed ~3 days before juvenile males (d.f.= 749, T = 8.13, P < 0.001) and female adults passed ~2 days earlier than juvenile females (d.f. = 668, T = 5.49, P < 0.001).

Analysis of predictors of the median date showed that passage was influenced by sex, year, the interaction sex*year, the interaction sex*age, and the interaction year*age (Table 2). However, age alone did not show any significant impact on spring arrival (Table 2).

### *Local weather and numbers of Bluethroats trapped*

An analysis of the local weather data showed that wind direction was the factor affecting the number

Table 1. Median date of arrival of both sexes and their two age categories for the time period 1955–2008.
*Median för ankomstdatum för båda könen och ålderskategorier för tidsperioden 1955–2008.*

| | Median date | St. dev |
|---|---|---|
| All birds | 16 May | 4.93 |
| Juveniles | 17 May | 4.79 |
| Adults | 14 May | 4.71 |
| All males | 15 May | 4.95 |
| Juvenile males | 16 May | 4.88 |
| Adult males | 13 May | 4.59 |
| All females | 18 May | 4.24 |
| Juvenile females | 18 May | 4.16 |
| Adult females | 16 May | 4.01 |

Table 2. Analysis of the predictors of median date of arrival.
*Analys av variabler som påverkar datum för ankomst.*

| Predictors<br>*Variabler* | d.f | F | P |
|---|---|---|---|
| Sex | 2 | 15.55 | 0.011 |
| Age | 2 | 1.76 | 0.324 |
| Year | 32 | 2.80 | 0.002 |
| Sex*Year | 20 | 4.62 | 0.003 |
| Sex*Age | 2 | 10.48 | 0.002 |
| Year*Age | 24 | 3.59 | 0.010 |

# Population trends

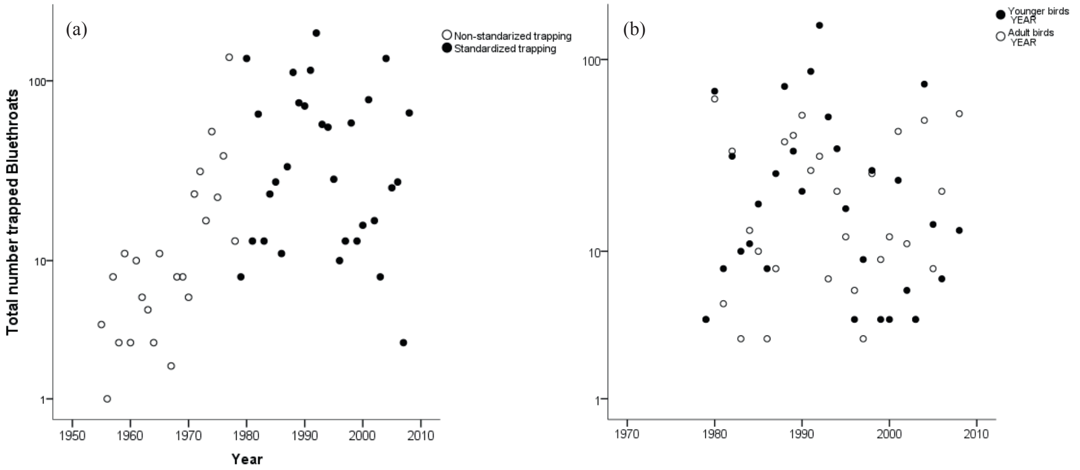

Figure 3. (a) Population trends for the full time series (1955–2008) and the standardized trapping (1979–2008). (b) Trends among adult and younger birds the standardized trapping.
*(a) Populationstrender för hela tidsserien, 1955–2008 (°), samt den standardiserade fångsten, 1979–2008 (•). (b) Trender hos juvenila (•) och adulta (°) individer under den standardiserade fångsten.*

# Bluethroat passage

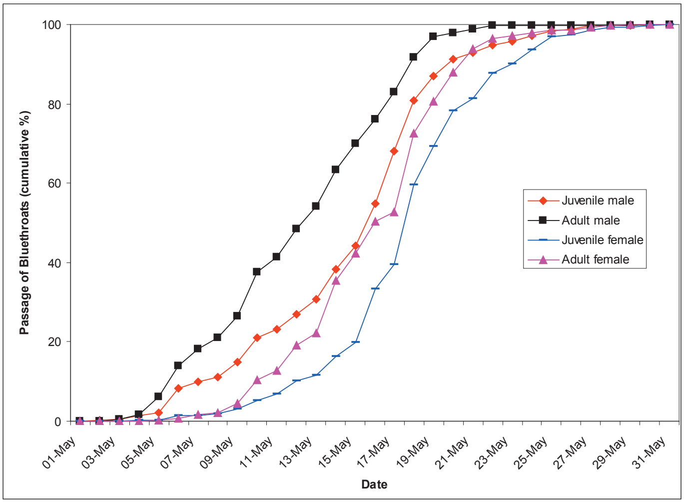

Figure 4. Cumulative passage of Bluethroats for each sex and age category that passes Ottenby in May during the period 1955–2008, e.g 50 % of the adult males have passed Ottenby before the 13 May.
*Kumulativ passage av blåhake för varje köns och ålderskategori som passerar Ottenby i maj under tidsperioden 1955–2008, t.ex. 50 % av samtliga adulta hanar passerar Ottenby innan den 13 maj.*

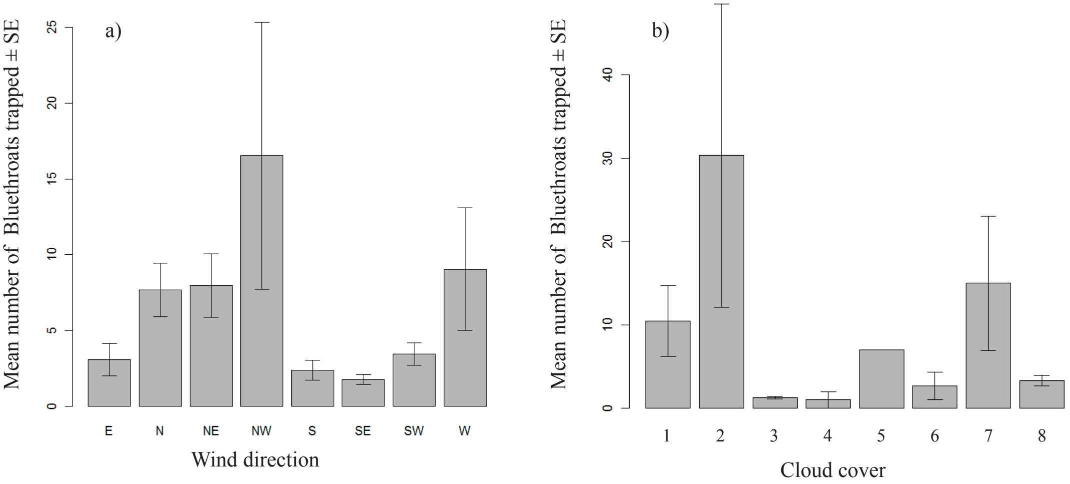

Figure 5. (a) Mean number of Bluethroats trapped between 1976–1995 under different wind directions and (b) different cloudiness on a scale 1–8, 1 describing a clear sky and 8 a sky 100 % cloud covered.
*(a) Medelantal dagligen fångade blåhakar under olika vindförhållanden och (b) molnighet på en skala 1–8, där 1 beskriver en klar himmel och 8 en helt täckt himmel.*

of birds trapped at Ottenby most strongly (Figure 5a; d.f. = 56, F = 5.45, P = 0.023). Cloud cover also affected the number of birds trapped (Figure 5b; d.f. = 7, F = 2.18, P = 0.05), however temperature (d.f.= 56, F= 0.005, P = 0.943) and wind strength (d.f. = 56, F = 0.48, P = 0.828) did not. In total, there were 28 days with cloud cover categories 1 or 2 and in which Bluethroats had been trapped. Sixteen of these days were categorized as days with winds from the north sector and 12 days with winds from the south sector. However, looking at the number of trapped birds, the vast majority of 'clear blue sky' birds were trapped with winds from the north (t-test; T = -3.30, d.f. = 22, P = 0.015).

## Discussion

### *Trends in trapping numbers*

The trapping scheme at Ottenby Bird Observatory is one of the longest uninterrupted time series on the abundance of migratory birds in Europe and has been used to study effects of climate variation on the phenology of migration (Pettersson 1993, Stervander et al. 2005, Jonzén et al. 2006). Here we used data gathered over 54 years (1955–2008) to study trends in trapping numbers and timing of spring passage of the Bluethroat. Within this period, the latter part from 1979 is characterized by a standardized trapping method, with nets and traps at fixed positions and a constant trapping effort. In the total time series (1955–2008), Bluethroat numbers increased significantly, whereas in the time series from the standardized period 1979–2008 it did not (Figure 3a). We cannot confidently tell whether the increase from the 1950s to today reflects an actual population size increase or not. Local microhabitat changes, such as fencing to keep grazing cattle and sheep outside the trapping area and an increased number of trees and bushes over time may have influenced trapping probabilities of staging birds. Restricting the dataset to only the standardized trapping period, there were no statistically significant trends in trapping numbers. This result is inconsistant with the findings by Ottvall et al. (2008) who used census data from Swedish surveys to estimate trends in the number of breeding birds in the country. They show that the Bluethroat population in the Swedish part of the Scandinavian mountain range has decreased in the long term period 1977–2006 with 10–29%, but has become more stable in the latter part of the period (1997–2006). Our data do however show a tendency for a negative trend in the number of trapped juvenile birds.

The Scandinavian mountain range is one of the least exploited habitats in Sweden, with commercial reindeer husbandry being the strongest anthropogenic disturbance. However, changing climate is a threat. For instance, Moen et al. (2004) have shown that the tree line limit can advance upward by 233–667 m over a 100-year time frame. An advancing tree line will likely result in loss of suitable breeding habitat (birch and willow shrubbery) for Bluethroats, thereby negatively affect the population size. A recent study by Van Bogaert et al. (2011) shows that reindeer husbandry has a much stronger impact on the tree line than previously assumed, with a significant negative correlation between tree establichment at the tree line and reindeer population density. As migration pathways and wintering areas are poorly known, it is at present not possible to say how changes in these areas could affect the Scandinavian population of the Bluethroat. Clearly, elucidating wintering areas and migration routes would be of great importance for a long-term conservation of the species.

### *Timing of spring passage*

The Bluethroat has a remarkably short and condensed spring migration period at Ottenby. Normally, the majority of birds pass the site within 10 days. Despite the brevity of passage, there are clear differences between age and sex groups. Adult males pass first, followed, in turn, by younger males, adult females and last by younger females (Figure 4). The GLM analysis also showed significant effect of interactions between sex and year, and age and year, likely explained by variation between years in weather conditions affecting the timing of migration. Males generally pass Ottenby ~3 days before females (Table 1). This protandrous pattern is well known among migrating birds and other animal taxa (Rubolini et al. 2004, Tøttrup & Thorup 2008) and is consistent with the earlier study of Pettersson (1993) from Ottenby.

The fact that adults precede younger birds during migration is a common and widespread pattern among passerines (Stewart et al. 2002). The earlier accumulation of fat by adults at stopover sites, which is correlated with earlier departure (Ellegren 1991), could explain differences in time of arrival. However, differences could also depend on differential onset of migration from the wintering grounds.

### *Local weather and numbers of Bluethroats trapped at Ottenby*

Both cloud cover and wind direction affected the numbers of trapped individuals (Figure 5). Northerly and westerly head winds during the migration period increased the number of caught individuals, likely as a consequence of increased costs of migration causing birds to be more prone to stopover. However, neither wind strength nor the interaction between wind strength and wind direction affected the numbers trapped.

Interestingly, cloud cover significantly affected trapping numbers in a bimodal pattern. Most birds were caught with more or less clear sky (cover 1 and 2) or at near complete overcast (cover 7). Complete overcast should be related to rainfall and low pressure weather systems likely to affect the propensity for stopover instead of continued migration. The ‘clear blue sky’ effect is less straightforward, but we hypothesize that this is related to wind direction in N and NW, i.e., rather an effect of head winds.

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## Sammanfattning

I Skandinavien förekommer blåhaken i form av rasen *L. s. svecica*. Arten häckar i fjällbjörkskogar samt i tätvuxna videbestånd ovanför trädgränsen. Data från häckfågeltaxeringar visar att blåhaken har genomgått en långsiktig minskning med 10–29 % mellan 1977 och 2006, men att utveckling varit mer stabil från 1997 och framåt. Blåhaken är en av få svenska långdistansflyttare som flyttar i en sydostlig riktning under hösten. Även om antalet återfynd är få pekar dessa på troliga övervintringsområden i Pakistan och Indien.

Under våren passerar flyttande blåhakar östra Sverige på sin väg till häckningsområdena i fjällen. De flesta fågelstationer i Sverige har sin huvudsakliga fältperiod under hösten, och av de få som bedriver vårfångst är det endast ett fåtal som fångar några större antal blåhakar. I vår studie analyserar vi data från Ottenby fågelstation mellan 1955 och 2008, en tidsserie om totalt 54 år.

Sedan 1970-talet har temperaturen under våren ökat på det norra halvklotet. Utvecklingen mot ett varmare klimat i norra Europa har påverkat årstidsspecifika aktiviteter hos både växter och djur. På en evolutionär tidsskala har flyttfåglar anpassat sin ankomst till häckningsområdet till att överrensstämma med en god tillgång på föda. En snabb förändring i klimatet skulle kunna leda till att flyttfåglar förlägger tidpunkten för häckning fel i förhållande till tillgången på föda, och kan därmed orsaka populationsnedgångar. Flertalet studier har fokuserat på hur en generellt tidigare vår i Europa påverkar flyttfåglarna, och den sammantagna slutsatsen är att ankomsten blir allt tidigare. I de flesta studier har North Atlantic Oscillation index (NAO) använts för att korrelera ankomst av flyttfåglar med klimatvariabler. Genom att analysera fångstdata från Ottenby fågelstation kunde exempelvis Stervander m.fl. (2005) visa att ankomstdatum för blåhaken, i motsats till många andra arter som övervintrar i västra Afrika eller Europa, inte var korrelerat med NAO. Dock kunde man visa att ankomsten av blåhaken till Ottenby successivt tidigarelagts med i medel 0,062 dagar/år.

Det faktum att blåhaken har en annorlunda flyttriktning jämfört med de flesta Skandinaviska långdistansflyttarna, uppvisar en långsiktig minskning av populationen inom häckningsområden, samt häckar i en miljö som är under förändring p.g.a.

klimatet, gör det befogat med en ingående studie av långsiktiga trender inom arten. Här analyserar vi både trender i antal under våren samt trender i ankomstdatum över mer än 50 års fångstdata.

### *Studieområde och data*

I denna studie använde vi ringmärkningsdata från blåhake från Ottenby fågelstation (56°12´N, 16°24´E) mellan åren 1955–2008. Vårfångsten vid Ottenby pågår mellan 15 mars och 15 juni. Fångsten påbörjas 30 min innan solens uppgång och avslutas 11:00. Ringmärkningsdata innan 1955 uteslöts från studien p.g.a. bristande täckning under den tid då arten flyttar. Efter att ha uteslutit 8 fåglar av rasen *L. s. cyanecula* (en sällsynt gäst) bestod våra data av 1922 ringmärkta individer. Under maj månad har fångstinsatsen vid Ottenby varit konstant under hela perioden 1955–2008 förutom under 1966 och 1967 då fångstinsatsen var 17% respektive 60%.

### *Resultat och diskussion*

Blåhakar har fångats under varje år perioden 1955–2008 (Figur 1) vid Ottenby fågelstation och passerar huvudsakligen under maj månad (Figur 2). För att analysera eventuella trender i antal ringmärkta blåhakar vid använde vi oss av två olika tidsperioder: dels hela tidsserien 1955–2008 och dels tiden för standardiserad ringmärkning, 1979–2008. Våra resultat visar att blåhaken har ökat signifikant i antal sett över hela perioden 1955–2008, men inte under perioden 1979–2008 (Figur 3a). Vi kan inte utesluta att ökningen mellan 1955–2008 beror av förändringar i habitatet i fångsträdgården eller fångstansträngningen. Att vi inte fann någon trend under perioden 1979–2008 överrensstämmer inte med resultat av Ottvall m.fl. (2008) som kunde visa på en minskning i antal mellan 1977–2006 med 10–29%, men med en stabil utveckling under den senare delen av studietiden (1997–2006). Artens häckningsområde i den Skandinaviska fjällkedjan är en av människan minst påverkade områden i Sverige. Habitatet förmodas dock påverkas negativt av den pågående klimatförändringen. Under en hundraårsperiod kan trädgränsen komma att förflyttats uppåt med 233–667 m. Denna trend påverkar troligen blåhaken negativt då arealen av häckningsområdet minskar. Även renskötseln påverkar trädgränsen genom en negativ korrelation mellan trädföryngring och rentäthet. Då informationen om flyttvägar och övervintringskvarter är bristfällig är det svårt att analysera hur eventuella förändringar i dessa områden skulle kunna påverka den Skandinaviska populationen.

Normalt passerar majoriteten av blåhakar Ottenby under en kort men intensiv tiodagarsperiod. Trots den relativt korta perioden så finns det en tydlig skillnad i passage beroende på kön och ålder (Tabell 1; Figur 4). Vuxna individer anländer tidigare än yngre individer, vilket är vanligt förekommande bland tättingar och har föreslagits kunna bero av tidigare upplagring av fett av vuxna på rastplatser vilket är korrelerat med tidigare avfärd. En anan förklaring skulle kunna vara skillnader i avfärd från övervintringskvarteren. Att hanar passerar tidigare än honor är också vanligt förekommande bland fåglar.

Blåhaken uppvisar även en stor skillnad i mediandatum för ankomst till Ottenby under 1979–2008. Perioden delades upp i tre 10 års perioder och resultatet visar att ankomsten till Ottenby har tidigarelagts med 5 dagar under den senaste 10-årsperioden jämfört med föregående period (Tabell 1).

Vid Ottenby fågelstation förs dagbok över bl.a. vindriktning, temperatur och fångstantal. Genom att använda oss av dagboken kunde vi analysera inverkan av vindriktning, vindstyrka och molnighet på antalet fångade blåhakar. Både molnighet och vindriktning påverkar antalet individer som fångas vid Ottenby (Figur 5). Nord- och västliga motvindar ökar fångsten av blåhakar, antagligen som en effekt av ökad energiåtgång på grund av motvind under sträcket. Förvånande nog så påverkade vindstyrkan inte antalet fångade individer. Flest individer fångades antingen under väldigt låg molnighet (täckningsgrad 1 och 2) eller vid nästan total molnighet (täckningsgrad 7). Total molnighet är relaterat med nederbörd och lågtryck vilket troligtvis ökar fåglarnas benägenhet att rasta under sträcket.

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# Breeding biology of Purple Sandpipers *Calidris maritima* on the Hardangervidda, southern Norway

## *Häckningsbiologin hos skärsnäppa* Calidris maritima *på Hardangervidda, södra Norge*

RAB RAE, MIKE NICOLL, RON SUMMERS, STUART RAE & KEITH BROCKIE

### Abstract

Breeding Purple Sandpipers *Calidris maritima* were studied within an area of approximately 32 km$^2$ on the Hardangervidda, southern Norway during 1978 to 1986. The minimum average density was 1.0 pairs per km$^2$ in 1984. Clutch sizes were 3–4 (mean = 3.74), and egg sizes were small, reflecting the small size of the females compared to other populations. Hatching was in late June and clutch survival was 75%. The eggs in one nest were believed to have been trampled by a Reindeer. Chick growth was described for two broods. Broods were mostly attended by males. Only 8% (2 of 24 broods) were attended by females. Adult masses declined during the breeding season, supporting the theory that brood desertion by Arctic-breeding sandpipers could be related to loss of condition in the breeding adults. However, females, who usually desert the brood, did not decline in mass any faster than males. Birds from one pair were faithful to mate and site; the birds wintered apart (the female was seen in winter) and the pair re-united on the breeding territory.

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### Introduction

The Purple Sandpiper *Calidris maritima* is an Arctic-breeding sandpiper that nests in Canada, Greenland, Iceland, Fennoscandia, Svalbard and Russia (Cramp & Simmons 1983). Its breeding range extends south as far as Hudson Bay, Canada, and the mountains of southern Norway and Scotland. Most information on the bird's breeding biology is from the high Arctic, particularly Svalbard where there is a high nesting density (Løvenskiold 1964, de Korte 1972, Bengtson 1975, Pierce 1997, Summers & Nicoll 2004). Less is known about the southern populations (e.g. Scotland, Smith & Summers 2005). Swanberg (1945) made a series of observations in the Swedish mountains and the only study of breeding Purple Sandpipers in the Norwegian mountains was by the 1978 Cambridge University Expedition (Innes 1979, Cane 1979). One of our group (KB), took part in this trip and we then continued to visit the same area and extended the observations during 1980 to 1986. Results from these studies have described adult biometrics (Nicoll et al. 1991), incubation scheduling (Cresswell & Summers 1988) and their migration using ringing recoveries (Rae et al. 1986). This paper complements these by describing the breeding biology of Purple Sandpipers on the Hardangervidda; in particular the nesting density, time of breeding, clutch and egg size, hatching success, chick growth, and fidelity to mate and site.

### Study area and methods

The study area was approximately 32 km$^2$ on the Hardangervidda (60°N, 7°E), a mountain plateau (c. 1200 m altitude) in southern Norway (Figure 1). The habitat was mainly dry heath (*Vaccinium* and *Empetrum* species) on raised ground, and mires (comprising *Carex* and *Salix* species and mosses)

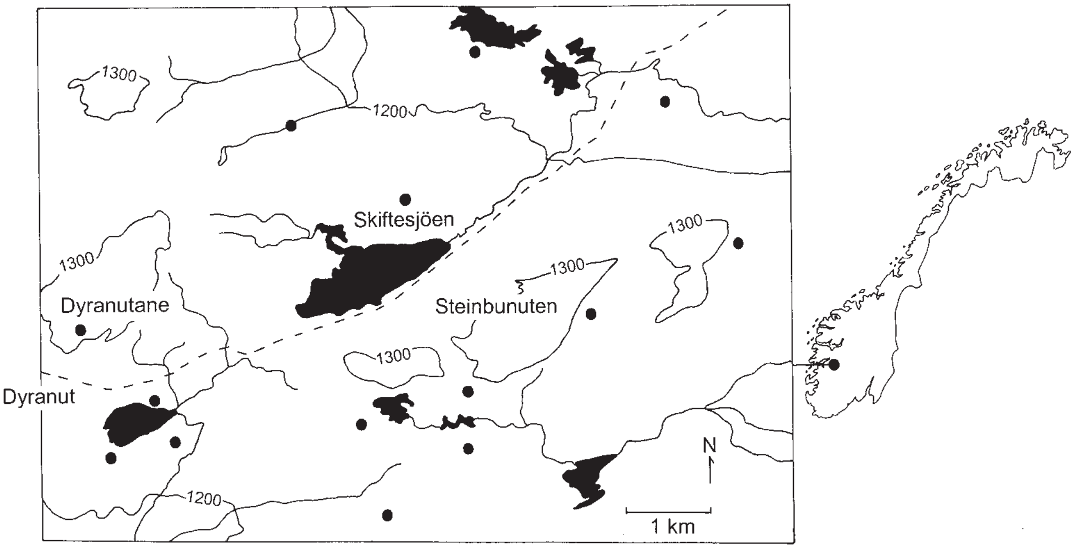

Figure 1. The study area on the Hardangervidda, south Norway. ● locations of nests and broods in 1984. The dashed line is a road, the black areas are lakes and the numbers are contour heights in metres.
*Undersökningsområdet på Hardangervidda i södra Norge. ● platser för bon och kullar 1984. Den streckade linjen är en väg, de svara områdena sjöar och talen höjder i meter.*

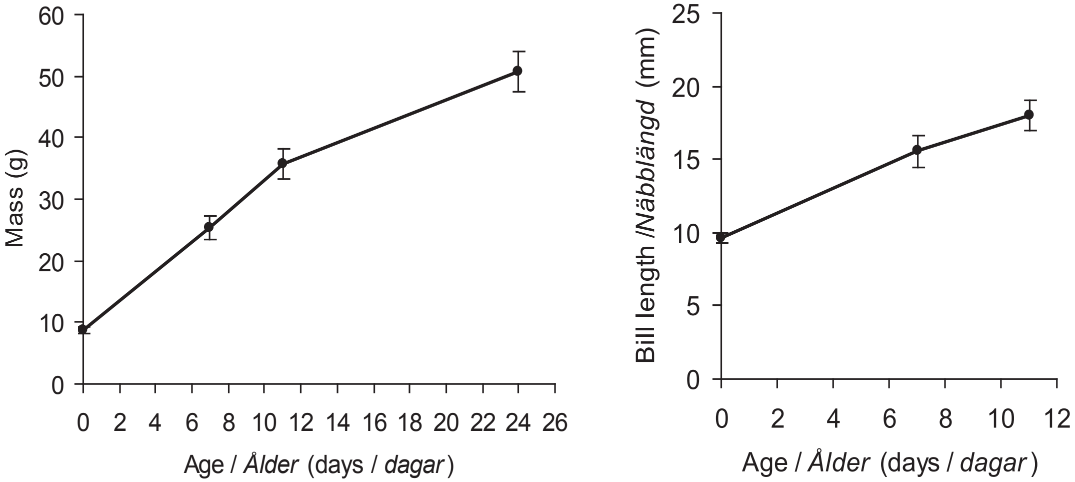

Figure 2. Growth of five Purple Sandpiper chicks from two broods on the Hardangervidda. Vertical lines show standard deviations from the means.
*Tillväxten för fem skärsnäppeungar från två kullar på Hardangervidda. Vertikala linjer visar stadardavvikelser från medelvärdena.*

Table 1. Timing of visits to the Hardangervidda and hatch dates of the Purple Sandpipers. There were significant differences between years in hatch dates ($F_{4,33} = 5.6$, P = 0.001.).

*Besökstider på Hardangervidda och kläckdatum för skärsnäppor. Det var signifikant skillnad mellan år för kläckdatum ($F_{4,33} = 5{,}6$, P = 0,001).*

| Year | Dates | No. of observers (man-days) *Antal observatörer (man-dagar)* | Mean hatch date (range) *Medeldatum kläckning (spridning)* | No. of nests and broods *Antal bon och kullar* |
|---|---|---|---|---|
| 1978 | 7 June–26 July | 2 (100) | 5 July (26 June–16 July) | 9 |
| 1980 | 29 June–10 July | 7 | 23 June (14–28 June) | 4 |
| 1981 | 13–24 June | - | 24 June (19 June–9 July) | 6 |
| 1982 | 25 May–2 July | 5 (81) | - | - |
| 1983 | 30 June–9 July | 4 (39) | - | - |
| 1984 | 14 June–8 July | 6 (54) | 29 June (25 June–5 July) | 16 |
| 1985 | 11 June–9 July | 7 (108) | 29 June (27 June–1 July) | 3 |
| 1986 | 27 – 30 June | 2 (8) | - | - |

in dips and hollows (Cresswell & Summers 1988). The vegetation types and climate have been described by Lien et al. (1974), Byrkjedal (1989) and Østbye et al. (2002).

The study area was visited in late June and/or early July each year during 1978 to 1986, apart from 1979 (Table 1). Breeding density was calculated from the mean nearest-neighbour distance between nests and/or broods. Ground clear of lying snow was searched for nests and areas around nest sites of previous years were searched thoroughly. As incubating Purple Sandpipers do not flush readily from their nests, a branch (c. 1.5 m long) was swept from side to side in front of the observer to disturb birds. However, because few nests were found, breeding density was assessed more on broods located. Adult birds attending chicks alarmed at the approach of observers (from 50–200 m). Brood density gave only a minimum estimate of nesting density because we may not have found all of them. However, we did account for lost nests in this estimate.

The length and breadth of eggs were measured with dial callipers, and egg mass recorded with a Pesola spring balance. Mean sizes were determined for all eggs within each clutch before calculating the averages for all clutches. Time of hatching was based on regular visits to nests and also from back-calculating hatching dates of chicks whose age was estimated from growth (see Figure 2). Bill lengths of chicks were measured with dial callipers to 0.1 mm, foot length with a stopped ruler to 0.5 mm (Anderson 1975), and mass with a Pesola spring balance to 0.1 g.

Clutch success was calculated following the Mayfield method (Mayfield 1975, Johnson 1979). The number of clutch losses was divided by the total nest days of observation to give the daily rate of loss, which was subtracted from 1 to give the daily success rate. This was then raised to the power of 25 (the laying plus incubation period) to estimate the probability of a clutch hatching.

Adults were captured with mist nets at nests or when with broods. Measurements taken were: maximum wing length to 1 mm, foot length to 0.5 mm with a stopped ruler, bill length to 0.1 mm with dial callipers, and mass to 1 g with a Pesola balance. Purple Sandpipers are strongly dimorphic with respect to bill size; females have longer bills than males (Cramp & Simmons 1983). Therefore, one can sex most individuals on bill length (Hallgrimsson et al. 2008). In an earlier analysis of Purple Sandpipers from the Hardangervidda, Nicoll et al. (1991) classed those with bill lengths less than 27.5 mm as male and those with bills over 27.4 mm as female. All birds were individually marked with metal rings and different permutations of coloured rings.

Nest attendance was recorded at one nest with an automatic camera, which took photographs every half hour through day-light hours, approximately 17 hours per day (03:00–24:00 hours). The percentage of photographs with an incubating bird was taken as a measure of nest attendance. The area within 1 m of five nests was photographed and the surrounding vegetation was subsequently described by the proportionate cover of each plant species, lichens or bare ground.

Table 2. Biometrics of breeding Purple Sandpipers on the Hardangervidda.
*Biometri för häckande skärsnäppor på Hardangervidda.*

| | Males *Hanar* | | | Females *Honor* | | |
|---|---|---|---|---|---|---|
| | Mean (SD) | Range | Sample size (*N*) | Mean (SD) | Range | Sample size (*N*) |
| Bill length (mm) | 24.7 (0.98) | 22.5–27.2 | 49 | 29.2 (0.97) | 27.7–30.5 | 18 |
| Wing length (mm) | 125.7 (2.5) | 118–131 | 49 | 129.7 (3.3) | 125–135 | 18 |
| Foot length (mm) | 47.6 (0.6) | 46.5–48.5 | 16 | 49.7 (1.3) | 48–51.5 | 5 |
| Mass (g) | 55.2 (4.9) | 49–67 | 36 | 64.2 (6.9) | 51–78 | 14 |

## Results

Twenty-three nests were found, including the seven nests found in 1978 (Cane 1979). The only year when the hatching period was adequately covered to estimate the minimum nesting density was 1984 (Table 1). Three nests and 11 broods were found within approximately 32 km$^2$. Chicks from the nests were ringed at hatching in the nests, thereby preventing double-counting of broods. Combining nests and broods, the mean nearest neighbour distance was 1.24 km (SD = 0.58, range = 0.5–2.3 km), equivalent to a density of 0.8 pairs per km$^2$ (Figure 1). Given that there was a 25% nest loss (see below), and broods accounted for 79% of the density estimation, we adjusted the initial estimate of 0.8 pairs per km$^2$ to 1.0 pairs per km$^2$, thereby accounting for nest losses.

Nest sites were varied in their location, and often placed adjacent to a small rock or on top of a moss (*Racomitrium*) hummock. The nests were always in dry sites although wet ground was usually nearby; the mean distance from nest to nearest mire was 110 m (n = 6, SE = 40). Plant cover was short, allowing the incubating bird an uninterrupted view all around. The mean percentage cover of plants and other features within a metre of five nests was: 22% *Carex*, 17% rock, 16% *Empetrum*, 12% *Vaccinium*, 12% *Salix*, 8% lichens, 8% grass and 5% bare earth. The mean width of the nest cups was 86 mm (n = 9, SE = 1.9) and depth was 33 mm (n = 9, SE = 1.1). Nests were usually lined with lichen *Cladonia* spp., willow *Salix herbacea* leaves, and occasional leaves of Cloudberry *Rubus chamaemorus* and Dwarf Birch *Betula nana*. Most nests (55%) were set on slopes with a northeast aspect. The prevailing wind is from the southwest, so northeast slopes are more sheltered. Other aspects were north (1 nest), east (2) and southeast (1). There was no instance of a pair re-using a nest scrape in a subsequent year for their clutch.

The average clutch size was 3.74 (SD = 0.44, range = 3–4). The mean length of the eggs was 36.2 mm (n = 8 clutches, SD = 0.7, range = 35.3–37.3 mm) and the mean breadth was 25.8 mm (SD = 0.3, range = 25.5–26.3 mm). The mean mass of three eggs from one clutch was 11.9 g (range = 11.1–12.6 g, n = 3) when freshly laid. Thus, a clutch of four eggs would have a mass of 47.6 g. As breeding females have a mean mass of 64.2 g (Table 2), a typical clutch would represent 74% of a female's mass. Eggs lose mass during incubation and in one clutch the mean mass dropped from 11.7 g when the last egg was laid to 10.5 g at the end of incubation (Figure 3).

Hatching dates were known or calculated for 38 clutches and broods. Most chicks hatched in late June although the mean dates varied from 23 June to 5 July among years (Table 1). Twelve clutches were monitored for a total of 89 days, during which there was one nest failure. The daily survival rate was 0.9887 (SE = 0.0112), which gave a clutch success of 75%. The failure was believed to have

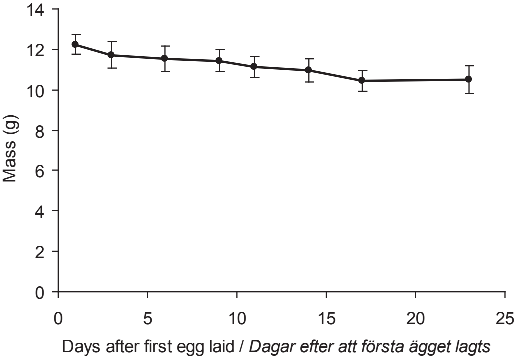

Figure 3. Changes in the mass (g) of three Purple Sandpiper eggs in one nest on the Hardangervidda. Vertical lines show standard deviations from the means.
*Förändringen i massa (g) för tre ägg av skärsnäppa i ett bo på Hardangervidda. Vertikala linjer visar standardavvikelsen från medelvärdena.*

been caused by a Reindeer Rangifer tarandus trampling the eggs because there were fresh Reindeer droppings and hoof prints close to the broken eggs in the nest.

The masses of chicks in seven broods were recorded at hatching and the mean mass was 8.2 g (SD = 0.3 g). For one brood measured at hatching the mean bill length was 9.9 mm, and foot length was 44.8 mm. After hatching, the chicks were led from the dry ridges and slopes where the nests were to nearby mires. The growth of chicks is shown in Figure 2.

Sixty-seven breeding birds were trapped and the bill length distribution was bimodal, with modes at 25 mm (males) and 30 mm (females) (Figure 4). Only two birds were in the overlap zone where sex was questionable. One had a bill length of 27.2 mm and the other 27.7 mm. The bird with the bill at 27.2 mm was mated to one with a bill of 29.1 mm, so were assumed to be male and female respectively. By contrast, the bird with the bill length of 27.7 mm was mated to one with a bill of 24.9 mm, so they were assumed to be female and male respectively. Using 27.5 mm as the point of separation for the sexes, their biometrics were described (Table 2).

A total of 220 photographs were taken of an incubating pair during 21 to 27 June 1985. Birds were present incubating on 214 of these, giving a nest attendance of 97.3%. Observations from a hide found that incubating birds walked off the nest once or twice during an incubation shift to feed in the immediate area of the nest for several minutes at a time. The masses of both sexes dropped during the breeding season and there was no evidence that females declined more than males (Figure 5). However, when the sexes were analysed separately, only the mass of the males declined significantly (*P* <0.001), whilst the females did not (*P* = 0.18).

Most females, or occasionally the male, deserted the brood at hatching. Thereafter, a single adult, usually the male (22 out of 24 broods) attended the brood. The adults with broods classed as female had bill lengths of 30 mm and 28.9 mm, so were well within the female mode (Figure 4). One of the females was found with small chicks (they still had the egg tooth), so it is possible that she departed later, leaving the male to attend the brood. Broods were taken up to 200 m from the nest, often to mires dominated by Bottle Sedge *Carex rostrata* with no standing water. Other brood habitats were moss-dominated tundra where the chicks often hid in spaces under rocks if alerted to danger by the attendant adult. The attendant adult usually stood on

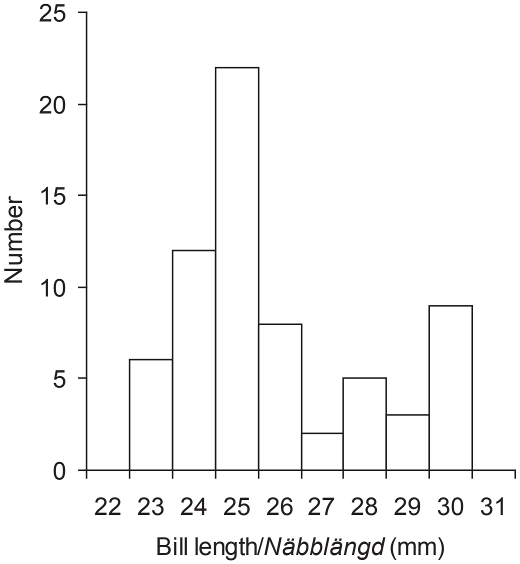

Figure 4. Frequency distribution of bill lengths of 67 breeding Purple Sandpipers from the Hardangervidda.
*Fördelning av näbblängderna för 67 häckande skärsnäppor från Hardangervidda.*

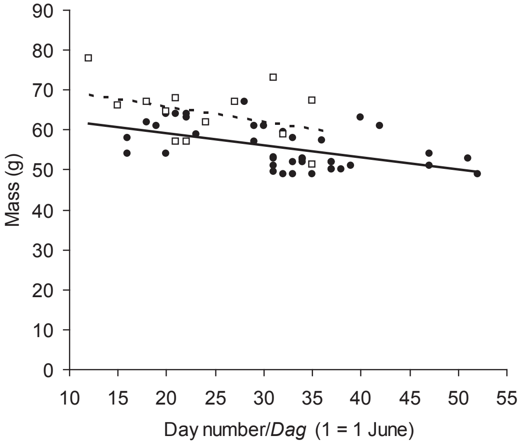

Figure 5. The changes in mass of male (●) and female (□) Purple Sandpipers during the breeding season. The regression equation was: Mass = 65.5 (se = 2.8) – 0.31 (0.08) Day number + 6.42 (1.8) Sex (female = 1 and male = 0). The P values for day number and sex were <0.001. There was no significant interaction between day number and sex, P = 0.71 (i.e. no difference in the slopes).
*Förändringen i massa hos hanar (●) och honor (□) av skärsnäppa under häckningstid. Regressionen var: Massa = 65,5 (se = 2.8) – 0,31 (0,08) dagsnummer + 6,42 (1,8) kön (hona = 1 och hane = 0). P-värdena för dagsnummer och kön var <0,001. Det fanns ingen signifikant interaktion mellan dagsnummer och kön, P=0,71 (dvs. ingen skillnad i lutning).*

Table 3. Observations of a pair of Purple Sandpipers on the same territory over five years. All observations were within an area of approximately 6 ha. The female was seen on the Isle of May, Fife, Scotland in autumns 1982, 1983 and 1984.
*Observationer av ett par av skärsnäppa i samma revir under fem år. Alla observationer inom ungefär 6 ha. Honan sågs på Isle of May, Fife, Scotland höstarna 1982, 1983 och 1984.*

| Year | Male *Hane* | Female *Hona* |
|---|---|---|
| 1980 | Caught on nest<br>*Fångad på bo* | - |
| 1981 | Seen at nest<br>*Sedd vid bo* | Caught on nest<br>*Fångad på bo* |
| 1982 | Seen with mate<br>*Sedd med maka* | Seen with mate<br>*Sedd med make* |
| 1983 | Caught on nest<br>*Fångad på bo* | Caught on nest<br>*Fångad på bo* |
| 1984 | Caught with chicks<br>*Fångad med ungar* | - |

a prominent rock or hummock, looking out for any impending danger.

It was not possible to accurately quantify return rates of breeding adults each year during our short visits. However, some birds were recorded in subsequent years and were faithful to breeding sites and mates. The birds in one pair nested within the same area in three years, and the male was present in five (Table 3). All the nests of this pair were within 100 m of the original nest site, and two were within 20 m of the previous years' nest sites.

## Discussion

In many respects, the breeding biology of Purple Sandpipers in south Norway is similar to that described elsewhere, in Svalbard (Bengtson 1975, Pierce 1997), Franz Josef Land (Tomkovich 1985) and Iceland (Summers & Nicoll 2004). The main difference from those of more northern populations is that the egg sizes are smaller, reflecting the small size of birds on the Hardangervidda (Table 2, Summers & Nicoll 2004).

The average nesting density of 1.0 pairs per km$^2$ was typically low (Summers & Nicoll 2004). This estimate was based largely on locating broods, but was adjusted to account for clutch loss. Elsewhere on the Hardangervidda, the mean density was estimated at 0.83 pairs within a 1 km$^2$ plot during 1967–1972 at Finse (Lien et al. 1974). This and our value are low compared to the density of 2–3 pairs per km$^2$ given for an unspecified but small part of the same study area on the Hardangervidda by Cane (1979), and 1.85 pairs km$^2$ (range 0–5.6 pairs per km$^2$) in an alpine area at Nedal, central Norway (Moksnes 1973). However, because these higher values refer to only small areas on the Hardangervidda and at Nedal (a 0.18 km$^2$ plot), they are probably not representative of these general areas.

Nest (clutch) success was similarly high to that found elsewhere in the breeding range of Purple Sandpipers (Summers & Nicoll 2004). The one nest believed to have been trampled by Reindeer is an example of a chance phenomenon. A large herd of Reindeer roams the Hardangervidda and each year some nests of ground-nesting birds would likely be trampled. The generally high hatching success may be linked to the long incubation spells (only two change-overs per day; Creswell & Summers 1988) and close sitting by incubating birds, thereby minimising the chance of predators detecting the birds and their nest.

Nest attendance was high (97.3%), similar to other monogamous *Calidris* sandpipers, e.g. Dunlin *Calidris alpina* (97.5%) and Baird's Sandpiper *C. bairdii* (96.5%). This contrasts with that of polygamous species where the female incubates alone, e.g. White-rumped Sandpiper *C. fuscicollis* (82.5%) and Pectoral Sandpiper *C. melanotos* (85%) (Norton 1972).

Brood desertion by female Purple Sandpipers has been observed in most studies, as have instances of male desertion (Pierce 1997, Summers & Nicoll 2004). Several possible reasons for brood desertion have been put forward. One prominent theory is that loss in condition during the breeding season jeopardises future breeding attempts if birds remain with brood, particularly for the female who invests more (through egg production) in nesting (Ashkenazie & Safriel 1979). Although there was a decline in the mass of both sexes (Figure 5), the females did not decline in mass at a faster rate than males. Also, when analysed alone, there was no statistically significant decline for females, though the sample size was smaller and time span shorter than for males. Therefore, our data were insufficient to reject Ashkenazie & Safriel's (1979) hypothesis.

One pair was faithful both to partner and site, breeding close to the previous year's nest site (Table 3). They arrived separately with the male arriving first. At the time of their arrival, there can be 95% snow cover, so food could be in short supply and nest sites limited. We suggest that pairs return to an area they know to be suitable for nesting and rearing young, via experience, and then wait for suitable nest sites to become available when the snow melts. Such a strategy would allow an immediate start to breeding once the thaw begins and increase their likelihood of rearing young by laying early (Perrins 1970). In a year of late thaw, birds were seen scraping through thin snow into the heath. Several nest scrapes can be made although only one is lined and laid in.

The female of this pair (Table 3) was found outside the breeding season on the Scottish east coast (Isle of May, Fife) in August, September and November 1982. The female continued to return to the Isle of May, being recaptured on the island in August 1983 and seen in April and August 1984 (Rae et al. 1986). The male was not seen. Therefore, this pair wintered apart and re-united on the breeding territory.

Overall, the Purple Sandpipers that nest on the Hardangervidda fit the pattern of conservative monogamous sandpipers. Their fidelity to site and mate optimises their chances of breeding success because they can nest earlier by omitting time spent searching for either afresh each year.

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## Sammanfattning

Skärsnäppan studerades åren 1978–1986 inom ett 32 kvadratkilometer stort område på Hardangerviddas fjällhed i södra Norge (Figur 1, Tabell 1). Denna sydliga population är mindre välstuderad än andra, särskilt i jämförelse med den på Spetsbergen. I tre tidigare analyser av materialet från Hardangervidda har de adulta fåglarnas biometri (Nicoll m.fl. 1991), deras ruvningsschema (Cresswell & Summers 1988) och återfynden av märkta fåglar (Rae m.fl. 1986) redovisats. I denna uppsats kompletterar vi med ytterligare uppgifter om häckningsbiologin.

Totalt påträffades 38 bon och kullar, varav 23 bon. Ett år, 1984, var inventeringen tillräckligt noggrann för att beståndstätheten skulle kunna beräknas. Baserat på funna bon och kullar var tätheten 0,8 par per kvadratkilometer men efter kompensation för boförluster och några missade par bedömdes tätheten ha varit 1 par per kvadratkilometer.

Medelkullstorleken var 3,74 ägg. Äggen var i medeltal 36,2 mm långa och 25,8 mm breda (8 kullar). Färskvikten låg på 11,9 g i tre kullar. En normalkull om fyra ägg skulle således väga 47,6 g vilket är 74% av honans vikt på 64,2 g (Tabell 2). Äggen förlorade i vikt under ruvningen; i ett bo som studerades från 11,7 g till 10,5 g (Figur 3).

Kläckningsdatum (observerat eller beräknat) låg olika år i medeltal mellan 23 juni och 5 juli (Tabell 1). Tolv kullar bevakades under sammanlagt 89 dygn och med hjälp av Mayfields metod kunde häckningsframgången beräknas till 75% av kullarna. Ungarnas tillväxt studerades i sju kullar. Medelvikten vid kläckningen var 8,2 g och ökade sedan enligt diagrammen i Figur 2.

Näbben mättes hos sextiosju adulta fåglar (Figur 4). De två topparna vid 25 och 30 mm motsvarar hanar respektive honor. Bara två fåglar låg i den tveksamma zonen 27 mm. Den ena hade en tyngre och den andra en lättare partner och var därför sannolikt av olika kön. Med 27,5 mm näbblängd som gräns torde de flesta skärsnäppor i södra Norge kunna könsbestämmas. Fåglarna vägdes också (Figur 5) vilket visade att vikten minskade under säsongens lopp. Separat analys visade dock att det bara var hanarnas viktminskning som var signifikant.

Hemorts- och partroheten kunde inte bestämmas kvantitativt, men en del fåglar kunde konstateras återvända och bilda par med varandra igen. Ett exempel ges i Tabell 3. Hanen återvände fem år och honan tre år och de häckade tillsammans inom 100 meter från boplatsen de hade det första året, och två häckningar låg bara 20 meter från året före. Genom observationer kunde man konstatera att fåglarna i detta par tillbringade vintern på olika ställen. Hanen återvände före honan till reviret, men båda så tidigt att 95% av reviret var snötäckt.

Hardangerviddas skärsnäppor var mindre i storlek än i nordligare populationer och hade därför också mindre ägg. Häckningsframgången var god, vilket kan bero på att fåglarna ruvade hårt och var svåra att upptäcka för predatorer. De ruvade över 97% av tiden, vilket är typiskt för mongama och klart mer än för polygama *Calidris*-vadare som ruvar bara 80–85% av tiden. Häckningsbiologin för skärsnäpporna på Hardangervidda skiljde sig inte från vad man funnit i andra studier. Skärsnäpporna på Hardangervidda får betraktas som typiska representanter för de monogama vadarnas strategi att återvända tidigt till kända revir som de av tidigare erfarenhet vet kommer att hålla den kvalitet som behövs för framgångsrik häckning.

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# Field notes on the breeding biology of the Dotterel *Charadrius morinellus* in arctic Norway

## *Fältnoteringar om häckningsbiologin hos fjällpipare* Charadrius morinellus *i arktiska Norge*

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### Abstract

From 2002 to 2010 twenty-four Dotterel nests were observed on Varangerfjell plateaus near Batsfjord. Females definitely took part in incubation in 18 cases. However, shared incubation could not be ruled out for the remaining 6 nests. One female defended the chicks against her own partner before they left the nest. Another lone female was seen leading 3 chicks for 5 days in a very small section of the study area, to our knowledge the only case of a female with chicks outside the nest ever recorded. Several nests were found less than 100 m apart. One bird laid eggs in the same nest in 2 consecutive years. These findings complement previously published observations and hypotheses.

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### Introduction

Dotterel females have been known to be polyandrous for a long time (Berg 1917, Géroudet 1982, Cramp & Simmons 1983, Owens et al. 1995), deserting their males after egg-laying in order to lay more clutches (normally three eggs) with other males. Females may maintain a loose relationship with the incubating male, especially to warn the male of potential dangers. Otherwise, very little is known about the role of females; only a few authors (Géroudet 1982, Cramp & Simmons 1983, Nethersole-Thompson 1973) mention that some females may occasionally take part in incubation, the only precise proportions recorded so far being 9 out of 27 nests on Hardangervidda in southern Norway (Kalas & Byrkjedal 1984) and 4 out of 32 nests on Värriötunturi in Finland (Pulliainen & Saari 1997). However, there are no records of females attending chicks after leaving the nest, or double-clutching (male and female incubating two clutches, which occurs with Mountain Plover *Charadrius montanus* (Cramp & Simmons 1983) and certain *Calidris* species (Maynard Smith 1978).

Site fidelity is believed to be weak (Cramp & Simmons 1983, Hable 1975), but each year we systematically tried to find the location of old nests in order to see how faithful Dotterel are to former nesting territories.

Population density does not exceed 17 nests/100 hectares (6 nests and 4 broods on 58 ha) on mountain tops with restricted suitable habitat surface (Pulliainen, Saari & Tunkkari 1992, Nethersole-Thompson 1973, Piersma & Wiersma 1996, Cramp & Simmons 1983). Dispersal of chicks after hatching is believed to be fast and over large distances (Géroudet 1982). Generally, Dotterel are thought to be extremely confiding. Some authors (Cramp & Simmons 1983, Géroudet 1982, Hable 1975) give the impression that sexing of adult birds is extremely difficult, even from a short distance.

The Dotterel seems to be common all over the Varanger peninsula on uninhabited plateaus and slopes which are not too steep, between 320 and 420 m. above sea level. More than 1800 km$^2$ of the area is now a national park with strict protection of this species. It is one of the largest virtually treeless areas in Fennoscandia, home to endangered species like Gyrfalcon *Falco rusticolus* and Arctic Fox *Alopex lagopus*, as well as an important moulting site for Bean Geese *Anser fabalis* (Aarvak & Øien 2009). Here the Dotterel reaches the northernmost fringe of its distribution. Unfortunately, even these seemingly virgin habitats might be threatened by indirect effects of climate change. Lemming peaks have become scarce and irregular (Kausrud et al. 2008), and some of their traditional predators like skuas have to forage on wader or grouse chicks and eggs. Red foxes *Vulpes vulpes* hunt at higher altitudes, endangering both arctic foxes and breeding birds in these fell habitats.

One of our research motivations was the fact that the number of Dotterel have decreased dramatically since the 1950–1970s (Saari 1995) and figure as "near threatened" on the Finnish Red List (Rassi et al. 2010). In spite of its decline the Dotterel is still a species of least concern for IUCN (Birdlife International 2009) since the world-wide population is estimated to be somewhere between 49,000 and 210,000 birds (Wetlands International 2002). Nevertheless our first priority was conservation and we always tried to disturb the birds as little as possible.

In the Varanger type of habitat Dotterel nests are to be found in the vicinity of nests or territories of Ptarmigan *Lagopus mutus*, Ringed Plover *Charadrius hiaticula*, Golden Plover *Pluvialis apricaria*, Purple Sandpiper *Calidris maritima*, Temminck's Stint *Calidris temminckii*, Turnstone *Arenaria interpres*, Shorelark *Eremophila alpestris*, Northern Wheatear *Oenanthe oenanthe*, Lapland Bunting *Calcarius lapponicus* and Snow Bunting *Plectrophenax nivalis*. Potential predators of eggs and chicks, such as Arctic Skua *Stercorarius parasiticus* and Long-tailed Skua *Stercorarius longicaudus*, may breed within 400 m of the nearest Dotterel nest.

Other occasional or rare threats include Gyrfalcon, very rare, Merlin *Falco columbarius* and Rough-legged Buzzard *Buteo lagopus*, both rare above the tree-line, Golden Eagle *Aquila chrysaëtos*, rare, and Snowy Owl *Nyctea scandiaca*, only recorded in July 2003. Raven *Corvus corax* and Herring Gull *Larus argentatus* are no threat to adult Dotterel. We observed Red Fox three times above 320 m. a.s.l., Arctic Fox was recorded only once, and Stoat *Mustela erminea* were not seen annually; they are rare except during Lemming peaks (which we only noticed in 2008 before mid-June). Once we found fox sp. droppings in a nest that had been used a year earlier. On the other hand, Reindeer *Rangifer tarandus* can be quite numerous in July (a trampled Dotterel nest was found in 2008).

The main questions we wanted to answer in our study were:

- How common is female participation in incubation in this area?
- How long do females participate in incubation?

Our observations led us to four more issues:

- Are females also able to take care of chicks during and after hatching?
- Could double-clutching be proved?
- Do all Dotterel have the same confiding attitude near their nests?
- Was there any evidence of site fidelity between years?

## Material and methods

### *Study areas*

Our study areas were less than 1800 m from road 891 which leads from Gednje T-junction to Batsfjord at 70°32'N / 29°22'E. Nests were found between 320 and 420 m. a.s.l. in only inch-high vegetation of *Salix glandulosa, Salix herbacea, Loiseleuria procumbens, Silene acaulis, Arctostaphylos uva-ursi, Cladonia rangiferina* and *Vaccinium myrtillus*. Frequently eggs are laid next to a house brick-sized stone, covered with *Rhizocarpon geographicum* and other lichens. The approximate size of the three areas where nests were found is 35 + 75 + 25 (= 135) hectares, to which we may add another 60 ha of identical habitat that was systematically searched but with no success.

### *Data collecting*

When we first met in early July 2002, Siegfried and Bärbel Kraatz had started observing their second Dotterel clutch where male and female were sharing incubation. We found four more such pairs in 2004 and Siegfried, in spite of his declining health, found two more in 2005. Shortly before his premature death he wrote his second article on incubation-sharing female Dotterel (Kraatz & Kraatz 2004, 2006). From 2007 to July 2010 Bärbel Kraatz and I returned to our study areas each year to extend our knowledge of this practice. The length of our 10 stays went from 6 to 43 days (mean: 26,5 days; see Table 1).

Throughout the study period sampling was difficult and irregular. In six years we only arrived after the 27 June when most clutches had been laid. In seven years we had to leave by 25 July, before the last clutches had hatched. Thus, we could not check if females continued or resumed their participation until or after hatching. In 2004 and 2005 Siegfried's health problems did not allow him to study the birds regularly. Weather conditions made field work often difficult, as snow storms or showers occurred even in June or July, as well as thick coastal fog and 25 m/sec gales, which made stand-

Table 1. Observation periods, and data on participation by the different sexes in chick attendance.
*Observationsperioder samt data om deltagande i omvårdnaden av ungarna för de olika könen.*

| Year | Observation period (no. of days)<br>*Observationsperiod (antal dagar)* | Nests with female participation (no. of days with female on nest)<br>*Bon med hona deltagande (antal dagar med honan på boet)* | Nests with no proved female participation<br>*Bon utan bevisat deltagande av honan* | No. of cases with chicks attended by male from unknown nest<br>*Antal fall med ungar vårdade av hane från okänt bo* | No. of cases with chicks attended by female from unknown nest<br>*Antal fall med ungar vårdade av hona från okänt bo* |
|---|---|---|---|---|---|
| 2001 | 13 Jun–8 Jul (26) | 1 (10) | | | |
| 2002 | 6 Jun–9 Jul (34) | 1 (13) | | | |
| 2003 | 7–11 and 29 Jul (6) | | 1 | 1 | |
| 2004 | 27 May–8 Jul (43) | 4 (1,6, 8, 8) | 1 | | |
| 2005 | 28 Jun–8 Jul (11) | 1 (8) | 1 | | |
| 2006 | 5–13 Jul (9) | | | | |
| 2007 | 28 Jun–22 Jul (25) | 1 (1) | 2 | | |
| 2008 | 18 Jun–22Jul (35) | 3 (6, 9, 16) | | 1 | |
| 2009 | 26 Jun–25 Jul (30) | 3 (3, 3,11) | 1 | 1 | 1 |
| 2010 | 28 Jun–31 Jul (34) | 4 (1, 1, 3, 8) | | 3 | |
| Total | 265 days | 18 (116 days) | 6 | 6 | 1 |
| Mean | 26.5 days | 6.42 days | | | |
| Range | 6–43 days | 1–16 days | 1–2 | 1–3 | |

ardized sampling just impossible. Only when the weather was dry, the wind moderate or light, and temperatures above 5°C, we tried to identify the sex of the birds on each nest, if possible twice a day, using 8–10× binoculars or 20–60× telescopes from a safe distance. Since Siegfried had already noticed in 2002 that females could be found on a nest at *any* time, we did not even try to check the nests at the same hour every day; we depended too much on the extremely variable weather. In order to avoid disturbance during periods of poor weather, we frequently had to stop monitoring nests for several consecutive days.

Except during hatching periods L.L. never observed the same nest for more than 60 minutes. But in 2002 S. & B.K. found a clutch 125 m from their camping car. They stayed in the vicinity of the nest for up to 22 consecutive hours and were even able to check it every 15 minutes and every night when visibility was good enough. We never used hides but stayed at a distance of at least 4 m so that the incubating birds were not too much stressed. At the end of each period of observation we left a few mealworms in the hope that the birds might associate our coming with food and of no threat. After the first visits this often seemed to work; more than 50% of the birds remained in an upright position or almost fell asleep in our presence once they had got used to it. We never tried to touch the birds like Berg (1917) or Arendt & Schweiger (2007).

We did not attempt to find more than 4 nests each year, preferring to concentrate on a small number instead of losing a lot of time looking for more. On 3 occasions we observed feeding males in July for 2½ to 3½ hours before they finally flew away, quickly disappearing behind some low hump so that we could not find their clutch. Indeed, incubation-sharing means that the relieved bird can go and feed far away from its nest for prolonged periods. This may be an advantage for breeding birds in arctic weather conditions but it makes nest-searching more difficult.

Sexing of incubating birds appeared straightforward in good viewing conditions from mid- June to late July. It never took us long to tell which of the two birds was incubating. In all cases we found that breeding females in this area have a set of distinctive diagnostic features. Their extremely white cheeks have very few or no dark streaks, and the rear part of the crown is blackish with very few or no light brown streaks (Figure 1). The female's dark belly patch is much larger than that of the male. Hable (1975) is the only one to say that it is the patch of the male that is largest, and this is

Figure 1. Male (left) and female (right) Dotterel from three different pairs.
*Hanen (vänster) och honan (höger) från tre olika par av fjällpipare.*

wrong. The majority of males have a number of light feathers showing well in this dark patch, perhaps a sign of early contour feather moult. In general they look less colourful than females. When both birds were standing close to each other the difference in size as well as their positions during copulation confirmed the the sexing characters that we used. In August, however, the sex differences tend to disappear rapidly, which makes it impossible to sex migrating adults.

## Results

All nests were found either on dry, flat terraces and plateaus or on slightly inclined slopes, never on a hilltop or a summit ridge. Only one nest was virtually surrounded by small rivulets coming from a huge melting snowdrift. Hatching dates (n=8) went from 4 to 27 July; replacement clutches may have been laid as late as 9 July so that a few chicks may have hatched in early August. From June 2002 to July 2010 we found 24 nests, 18 (= 75%) of which were definitely incubated by two different birds *after* completion of egg-laying on 1 to 16 consecutive days, the average being 6.42 days (Table 1). The remaining 6 nests (with males only) could never be observed long enough to completely rule out female participation. Either those nests were found too late, abandoned, robbed or destroyed, or we had to leave the area before hatching. (We did not take into account a 25th nest which was robbed within less than 24 hours.) As for the 18 females, 7 were found sharing incubation only during the first week, 4 only during the last week; we did not find a consistent pattern. In two cases the female was only seen on the nest one or two days before hatching. One nest in 2004 may have been a replacement clutch of a pair whose nest had been robbed. The photographs we had made of the parents at both nests looked very much alike but the birds were not colour-banded. We never found more than 4 nests per season; in 4 years we only found 1 nest (Table 1). Moreover, we witnessed 8 hatchings in four years; only on two occasions the female was present.

In July 2002, S. & B.K. found a nest near their camping car so that they could virtually monitor it round the clock. They found that the female stayed on the nest between 60 min. and 26 consecutive hours, assuming approximately 55% of incubation until hatching (Kraatz & Kraatz 2004). S.K. was probably the first person to publish a photograph of a female incubating chicks during hatching (Figure 2). When the second chick had hatched, the female disappeared and the male took over.

Contrary to the common belief that Dotterel are very confiding, the incubating birds on 3 different nests were so shy that they left the nest when we were between 80 and 300 m away, rarely or never allowing us to identify their sex. On 30 June 2009 we observed from a distance of about 100 m a male Dotterel going back to its nest. When we approached the bird ran away and disappeared. Over the next 15 days we only once managed to see an unidentified bird on this clutch; each time we arrived it left the nest so early that we had no chance to spot and/or sex it. Twice, its eggs seemed to be so cold that we started to believe that the nest had been abandoned. However, on 16 July we discovered a confiding female incubating two chicks and an egg in this nest! When the third chick had hatched, the male bird arrived and attempted to take over, trying to brood the firstborn chick which was looking for food about 4 m. from the nest. However, he was violently driven away by the female (Figure 3 and Appendix). These skirmishes with leap-frogging and shrill calls were repeated 6


Figure 2. First case ever recorded of a female Dotterel that is sitting on the clutch during hatching of the chicks.
*Första observationen någonsin av en fjällpiparhona som ruvar kullen under kläckningen.*


Figure 3. A female Dotterel (right) drives away its mate to prevent him from inculating the chicks.
*En fjällpilparhona (höger) driver bort sin make för att hindra honom från att värma ungarna.*

Figure 4. A female Dotterel with one of three chicks that were several days old.
*En fjällpiparhona med en av tre ungar som var flera dagar gamla.*

times over for 3½ hours; the female won each time. We stopped observing at 16h40m because temperature dropped sharply and the chicks remained under the female to stay warm. The next morning we found the male at 10h55m, still brooding the chicks in the nest, nearly 24 hours after the last chick had hatched; but we failed to find the female.

Over the years and always after 4 July we came across 8 families from unknown nests (Table 1); in 7 cases the chicks were being led by an adult male. But on 18 July 2009, we found two adult birds leading 3 chicks each, about 400 m from each other. One male, not far from a nest that had hatched a few days earlier, and a female (Figure 4)! The birds were in a small area, situated between the new Batsfjord road, the parallel old road, a creek and an impenetrable area with boulders that were too big for small chicks. The female stayed there for 5 days, the male for a week. We never observed them coming close to each other. The chicks were about the same size.

In 2004 we spotted a clutch in the very same depression where we had found one in the previous year, a phenomenon that to our knowledge is quite rare in any *Charadriidae* species! In 2009, a nest was found only about 20 metres from one used in 2008. But since we had no permit for colour banding, it was not possible to prove that the incubating birds were the same as in 2008. So we only have one case that proves that site fidelity does exist.

From 2004 to 2010 we found 3 loose "neighbourhoods", that is pairs of nests which were less than 100 m apart. In 2008 both nests were incubated by different females and males, which means that close vicinity is not necessarily a consequence of serial polyandry (one female laying several clutches for at least two males). By photographing the birds we were able to prove that there were two different males and two females. On three occasions the male of nest 1 approached the breeding male on nest 2 until the latter chased him away. In 2010 we found a cluster of three nests in an area of less than 15 hectares. But in spite of great efforts, we were unable to find any other nests nearby in similar optimum habitat.

When Dotterel approach the nest to relieve their

Figure 5. Normally the incubating Dotterel leaves the nest well in advance when its mate arrives to take over attendance of the nest. Here a rare case when both birds were observed together less than one meter apart. The male to the left.
*Normalt lämnar den fjällpipare som ruvar boet i god tid innan maken anländer för att ta över. Här ett sällsynt fall där båda fåglarna observerades mindre än en meter från varandra. Hanen till vänster.*

incubating partner, the latter normally leaves the clutch well before the other bird arrives. Only once we managed to see (and photograph) both birds less than 1 m apart (Figure 5).

## Discussion

Although our sample (n= 24 nests) is rather small, a percentage of at least 75% of shared incubation seems to show that this practice may be more frequent at the northern fringe of this species' breeding range than in subarctic and southern Fennoscandia. L. Saari (Pulliainen & Saari 1996 and L. Saari written comm.) suggests that most females on Värriötunturi (N 67° 41' ) in Finland leave the area in mid-June after egg-laying, perhaps in order to look for more males further up north. It is a fact that they can lay up to 5 clutches (Holt et al. 2002), so if the sex ratio in one area is sufficient to allow *all* males to have a clutch, why not go elsewhere to maximize reproductive success? Such a female's last male partner may have better survival chances in the harsh climate of the high arctic if shared incubation allows him to feed more often and for much longer periods. The hypothesis of females covering large distances between two clutches might one day be studied using telemetry and colour-banding. But catching an egg-laying female is not easy and it may even make the bird leave the nest and jeopardize the success of the clutch. It may be ethically defendable though to catch one of the incubating females during the last days before hatching. At this stage it seems least likely that both birds abandon the clutch in a case of major disturbance. However, the probability of a satellite-tagged bird flying back to an accessible part of the Arctic where its behaviour and partner(s) can be studied further in the following year seems weak if the hypothesis of low site fidelity is correct.

To our knowledge female Dotterel that successfully defend their hatching chicks against their partners have never been reported before. We do not have an explanation for this behaviour; the male bird had only been identified once on the nest before hatching. Since we only found one single case, more research during hatching periods would be necessary to assess if this pattern is more frequent, and how it can be explained.

One of the major difficulties of our work was the simple fact that Dotterel are so elusive. The only areas with a greater chance to find nests were near the reindeer fences parallel to road 891, as well as along two dirt roads. 10 of our 25 nests were less than 50 metres from one of these conspicuous lines, among which there were 6 nests that were no more than 25 metres away. It may be easier for the bird to locate its nest if there is some prominent land mark in an otherwise featureless landscape.

The question that concerns the very shy birds we happened to find is: are these individuals exceptions or more frequent than we think? Perhaps the majority of nests we found belonged to confiding birds which might *not* be as common as we believe; the real number of breeding birds in a given area may be much higher than the few nests we managed to find. And why do some pairs breed in close vicinity when no other nests can be found anywhere else in the same habitat? We think that Dotterel densities are underestimated in vast areas like the Varanger plateaus. Ringed Plovers and Golden Plovers may only seem to be more numerous because they are easy to spot. Dotterel are altogether far less visible than all other fell breeding wader species. To assess the true density of this species in this type of habitat, larger teams of searchers would be needed.

As for the unlikely but in our view not impossible occurrence of double-clutching, our observation of a lone female with several day-old chicks remains at least very odd. As far as we know this behaviour has not been previously reported. It is true that Kalas (1986) had once removed a breeding male from a nest and showed that the female managed to take care of eggs and chicks. Predation of "our" female's partner is not unthinkable but we believe that this risk is unlikely, as the number of potential predators that could catch an adult Dotterel in good health seems extremely low in this area. We have indeed never witnessed an attack on adult Dotterel in more than 200 days of monitoring and were once surprised at how relaxed a brooding bird remained in spite of a gyrfalcon and an attacking skua that flew over its nest at high speed. Since Dotterel on Varangerfjell breed during the midsummer night sun period on flat, open terrain, no predator can approach their nests unseen. As the chicks accompanied by the neighbouring male were about the same size, a case of double-clutching between *these* two birds seemed to be unlikely. But there may have been a second male there, with whom the female might have paired up. Among the hundreds of Dotterel pairs that have been watched by scientists so far, no other chick-leading females have ever been recorded to our knowledge. But does this mean that double-clutching in Dotterel can be totally ruled out? If not, it must be a rare phenomenon but we do not think it is impossible. If there was evidence that Dotterel sometimes or systematically use this strategy near the birds' northernmost frontier in the Arctic region, this would probably mean that they thus try to boost their breeding success as much as possible.

Since an unknown proportion of Dotterel pair up in their winter quarters and therefore may breed thousands of kilometres from last year's site (Géroudet 1982, Cramp & Simmons 1983), we were not surprised to find little evidence of site fidelity. The frequency of this phenomenon could also be explored by further research. By satellite tagging birds in their winter quarters it might also be possible to find out if it is the males that pair up before or during spring migration and take their partners to the nesting site or if the latter decide where they will breed.

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## Postscript added in August 2011: Additional observations made in 2011

We (L.L., B.K. and J.-M. Lustrat) studied the birds in our two areas from 22 June to 31 July 2011. All our findings confirm our hypotheses made since 2002.

We found 9 nests, two of which might have belonged to the same pair. One very late clutch (completed on 9 July) was abandoned, most of the other nests must have been robbed by Arctic Skuas after a lemming peak crash. Only two clutches, perhaps three, hatched for sure. Five clutches were checked for at least five days. Four (80%) were found with females that incubated at least one day well after egg-laying. One female incubated at least from 5 to 27 July, before the second chick hatched. This is the fourth time we found a female Dotterel with at least one chick. (Video on http://www.youtube.com/watch?v=CKAQLKhhdi4).

We found at least 11 other families, only 2 or 3 of which might have been counted twice or belonged to a known nest. On 31 July we found 5 different families in an area of less than 50 hectares within 1 hour and 40 minutes, which seems to prove that Dotterel on Varangerhalvöya are actually quite common. They are just extremely difficult to detect when incubating (which corresponds to the period when most birdwatchers try to find them, thus believing that they are much less common than other Plovers). Again, four of the 9 nests were less than 20 metres away from man-made structures (fence, road, track or ditch).

The most surprising occurrence this year: the very same nest scrape that had been used in 2003 (male) and 2004 (male and female) was used again this year (by male and female). To our knowledge such a phenomenon has never been found in any Charadriidae species. (Photo proof on https://picasaweb.google.com/117170977024927019906/Lapland2011#5628159771688284242

This sheds new light on the supposedly "weak" site fidelity of this species. One may speculate that the males tend to be extremely faithful to their once chosen breeding place whereas females may pair up in their winter quarters, and then, after laying a first clutch, wander across large parts of Fennoscandia and Russia. This would explain the birds (of unknown sex) that were ringed in Europe and found or killed in central or eastern Siberia (Hable 1975, Géroudet 1982). About 80 m from this nest scoop, there was another clutch, only a few metres away from nests discovered in 2004 and 2006.

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## Sammanfattning

Fjällpiparen är polyandrisk och det är känt sedan länge att honorna ofta lämnar äggen och partnern efter läggningen för att söka upp en ny hane och lägga nya ägg. Ett löst förhållande till den första hanen kan dock bestå, exempelvis att varna för faror. Att honor i viss utsträckning kan delta i ruvningen är känt. Däremot har man aldrig observerat honor som tagit hand om ungar. Ortstroheten anses vara svag. De huvudfrågor vi studerade var om honorna deltog i ruvningen och hur länge de i så fall ruvade. Andra saker vi studerade var om det fanns honor som tog hand om ungar efter kläckningen, om det förekom att en hona och en hane ruvade varsin kull (förkommer hos en del vadare), om alla fjällpipare hade samma tillitsfulla beteende vid boet samt om det fanns tecken på ortstrohet mellan åren.

Åren 2002–2010 följde vi 24 fjällpiparbon i Varangerfjällen nära Båtsfjord i norra Norge (Tabell 1). Vi fann att honorna med säkerhet deltog i ruvningen i minst arton fall, och deras deltagande kunde inte uteslutas i de övriga sex fallen. Figur 2 visar det troligen första fotot av en hona som ruvar under kläckningen. En hona försvarade sina ungar mot sin partner innan ungarna lämnat boet. En annan ensam hona sågs leda tre ungar under fem dagar inom ett mycket litet område. Detta är enligt vad vi vet det första fall som någonsin observerats av en hona med ungar utanför boet. Könsbestämningen hade vi inga problem med vid gott ljus. I detta område hade de ruvande honorna mycket ljusa kinder med få eller inga mörka streck, bakre delen av hjässan var svartaktig med få eller inga bruna streck och honans buk hade klart mera svart än hanens (Figur 1).

Vi fann att alla fjällpipare inte var så orädda som man oftast upplever dem. Vid tre bon var fåglarna så varska att de flög iväg redan på 80 till 300 meters håll, vilket innebar att vi inte kunde eller hade svårt att könsbestämma den ruvande fågeln. I ett fall trodde vi till och med att boet var övergivet, men då fann vi ändå en orädd ruvande hona på två nykläckta ungar och ett ägg. När det tredje ägget höll på att kläckas anlände hanen och försökte lägga sig och värma den först kläckte ungen som sökte föda fyra meter från boet. Men honan jagade aggressivt iväg honom (Figur 3 och Appendix). Nästa dag fann vi hanen värma ungarna i boet men kunde inte finna honan. Det normala vid ruvningsbyte var att den ruvande fågeln lämnade boet i god tid innan den andra fågeln anlände. Bara en gång såg vi båda fåglarna mindre än en meter från varandra (Figur 5).

Det faktum att en del fjällpipare är skygga och lämnar boet långt i förväg när en observatör närmar sig kan innebära att inventeringar som baserar sig på bofynd eller bobeteende underskattar beståndstätheterna. Det kan vara så att det mestadels bara är de oskygga fåglarna som man registrerar. I vårt studieområde bedömde vi att tätheten var ungefär tio par per kvadratkilometer, vilket indikerar att fjällpiparen är rätt vanlig på Varangerhalvön.

Under årens gång, och alltid efter 4 juli, fann vi sammanlagt åtta familjer från för oss okända boplatser (Tabell 1). I sju fall var det en hane som hade hand om ungarna. Men vid ett tillfälle kom vi på två gamla fåglar som ledde vardera tre ungar ungefär 400 meter från varandra. Den ene var en hane, inte långt från ett bo som hade kläckts ett fåtal dagar tidigare, och den andra en hona (Figur 4). Honan vistades på platsen under fem dagar och hanen en vecka. Vi såg dem aldrig vistas riktigt nära varandra. Ungarna var av samma storlek. Detta var det närmaste vi kom en möjlig indikation på att en hona kan ha lagt en kull åt hanen och en annan åt sig själv inom ett begränsat område.

Flera bon hittades mindre än 100 meter från varandra och en hona lade ägg i samma bogrop två år i rad. Dessa observationer kan tyda på ortstrohet, men eftersom vi inte hade några märkta fåglar kan vi inte avgöra om det vara samma eller nya fåglar som återkom till reviren.

## Maastohavaintoja keräkurmitsan Charadrius morinellus pesimäbiologiasta arktisessa Norjassa

Vuosina 2002–2010 seurattiin 24 keräkurmitsan pesää Varankitunturin ylätasangolla Båtsfjordin lähistöllä Pohjois-Norjassa. Naaras osallistui haudontaan vähintään 18 tapauksessa, eikä naaraan osallistumista voitu poissulkea lopuissa kuudessakaan. Eräs naaraista puolusti poikasiaan puolisoaan vastaan sekä kuoriutumisen aikana että sen jälkeen. Toinen yksinäinen naaras nähtiin johdattavan kolme poikastaan viiden päivän aikana hyvin suppealla alueella tutkimusalueen sisällä. Useita pesiä löytyi alle 100 metrin etäisyydellä toisistaan. Eräs naaraista muni samaan pesäkuoppaan kahtena peräkkäisenä vuotena. Muutamat näistä havainnoista täydentävät aiemmin julkaistuja havaintoja ja tukevat aiemmin esitettyjä hypoteesejä keräkurmitsan pesinnästä.

## Appendix

A rare video document: a male and a female fighting for parental care of the chicks.
http://www.vimeo.com/7435068

ORNIS SVECICA 21: 119–122, 2011

# Records of brown plumage aberration in the Common Buzzard *Buteo buteo*

## *Fynd av brun dräktavvikelse hos ormvråk* Buteo buteo

MICHAŁ CIACH, ANNA KWARCIANY & DARIUSZ ŚWITAŁA

### Abstract

The Common Buzzard *Buteo buteo* presents high plumage variation, but individuals in aberrant plumage are recorded extremely rarely. In August 2005, near Templewo (western Poland), a dead Common Buzzard with aberrant plumage was found. Another individual with aberrant plumage was observed on 14 August 2011 near Minoga (southern Poland). Both birds were beige in most parts of the body with a retained light brown and orange feather pattern. This is the brown mutation, an exceptionally rare plumage aberration in the Common Buzzard.

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The Common Buzzard *Buteo buteo*, having several morphs, presents high plumage variation (Ulfstrand 1977, Dittrich 1985). Three distinct colour morphs (dark, intermediate, and light), with individuals having predominantly white, brown, or mixed plumage on the underside and underwing, have been distinguished in this species. However, extremely pale-coloured individuals, as well as almost entirely dark brown morphs have been recorded (Lontkowski 1985, Forsman 1999). Yet all of these plumage polymorphisms, as a result of changes in colour intensity – melanism and erythromelanism (Thiollay 1994, Schreiber et al. 2001) – present natural plumage variation in this species.

Along with plumage variation, birds with abnormal coloration are recorded. Plumage aberrations in birds are relatively rare, and they usually attract the observer's attention. However, in most species of Falconiformes, records of abnormal coloration are exceptional. Among unusual records are the melanistic Osprey *Pandion haliaetus* (Clark 1998), the melanistic Northern Harrier *Circus cyaneus* (Howell et al. 1992), and the albino Australasian Harrier *Circus approximans gouldi* (Hedley 1983). Based on this, records of aberrant Common Buzzards are interesting.

After mid-August 2005, on the road near Templewo (52°26'N, 15°22'E, western Poland), a dead Common Buzzard with untypical coloration was found. That bird was a victim of collision with a car. All plumage was clearly beige (Figure 1). The head was all light beige. Underparts were two-toned: a beige breast, with a slightly lighter U-shaped breast band, changing into somewhat darker rusty flanks and thighs. The undertail had almost invisible narrow bars, whereas the tail on the upper side had a slightly more visible feather pattern. The tail, upper tail coverts, rump, and plumage of the tibia had a tinge of carrot orange. The outer primaries (P8–P10) had light brown tips. The rest of the primaries and secondaries had bars with a light coffee colour. The upper wing coverts with a slightly ochre shade differed from the underwing coverts, which were darker and had a bigger amount of carrot orange tinge. As a result of that coloration, the bird appeared more copper from below. Individual mantle feathers and underwing coverts had a visible darker feather pattern with different shades of orange. Bare parts were normally coloured – yellow legs and a black beak with a yellow cere.

On 14 August 2011, in the mosaic of fields and abandoned grounds near Minoga (50°15'N,

Figure 1. Common Buzzard *Buteo buteo* with the brown mutation at Templewo, western Poland, August 2005.
*Ormvråk av den bruna mutationen vid Templewo i västra Polen, augusti 2005.*

Figure 2. Common Buzzard *Buteo buteo* with the brown mutation at Minoga, southern Poland, August 2011.
*Ormvråk av den bruna mutationen vid Minoga i södra Polen, augusti 2011.*

19°54'E, southern Poland), another Common Buzzard with untypical coloration was recorded. All plumage was clearly beige (Figure 2). The pattern and coloration of plumage was very similar to that in the first record. The head was all light beige. Underparts were two-toned: a beige breast, with a distinctly lighter U-shaped breast band, changing into somewhat darker rusty flanks and thighs. All primaries and secondaries had a clear feather pattern with visible barring. The upper wing coverts were rather uniform-light beige with a slightly darker trailing edge. The underwing coverts, which were darker than the upper wing, had a visible dark feather pattern and were coloured with a more carrot orange tinge. As a result of the coloration, the bird appeared darker from below. Bare parts were normally coloured – yellow legs and a black beak with a yellow cere. Pale tips to remiges and rectrices indicate fresh juvenile plumage. The observed bird soared with three Common Buzzards in typical plumage and an immature Golden Eagle *Aquila chrysaetos*. After several minutes of observation, chased by the other Common Buzzards, the aberrant bird flew away.

The described birds had features of brown aberration, which is defined as a qualitative reduction of eumelanin (van Grouw 2006). In this mutation, the amount of pigment remains unchanged, but the appearance of the eumelanin is changed. As a result of an inherited incomplete oxidation of eumelanin, black feathers become dark brown. Feathers with a qualitative reduction of eumelanin are very sensitive to sunlight and bleach quickly and strongly (van Grouw 2006). This may explain the contrast between the underparts and upper parts of both birds. In this mutation, phaeomelanin is unaffected. The information on brown individuals has not been published yet. However, three specimens of the Common Buzzard showing brown mutation are preserved in the collections of museums in Germany, Austria, and Great Britain (H. van Grouw, pers. comm.).

Similar in appearance to brown aberration is dilution. This mutation is defined as a quantitative reduction of melanins. Clark (1999) reported that two dilute-plumage birds are preserved in collections of museums in England and Italy. This aberration has been described in other species of the *Buteo* genus: in the Roadside Hawk *Buteo magnirostris* (Aguilar-Rodríguez 1993), the Swainson's Hawk *Buteo swainsoni*, and the Red-tailed Hawk *Buteo jamaicensis* (Clark & Wheeler 2001). Moreover, in the Common Buzzard, albinism and leucism have been recorded so far (Sage 1962, Bělka 2003). As it is shown in this note, in the Common Buzzard, not only the plumage coloration varies extensively, but plumage aberrations also influence individual variation.

## Acknowledgements

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## Sammanfattning

Ormvråken är känd för att ha en fjäderdräkt som varierar kraftigt i färg, från riktigt mörkbrun till nästan vit. Denna stora variation är en normal polymorfism som uppkommer genom stor variation hos de anlag som styr de olika melaninernas uttryck i färg och färgintensitet. Mycket sällsynt förekommer varianter som inte ligger inom detta variationsmönster. Här rapporterar jag två sådana fall.

Under senare delen av augusti 2005 påträffades en trafikdödad ormvråk nära Templewo i västra Polen. Hel dräkten var beige (Figur 1). Hela huvudet var ljust beige. Undersidan var tvåtonad: ett beige bröst, med ett något ljusare U-format bröstband, som övergick i något mörkare rostfärgade flanker och lår. Stjärtens undersida hade nästan osynliga smala band, medan ovansidan hade något tydligare mönster. Stjärten, övre stjärttäckarna, övergumpen och fjädrarna på tibian hade en anstrykning av morotsorange. De yttre handpennorna (P8–P10) hade ljusbruna spetsar. Resten av handpennorna och armpennorna lätt kaffefärgade band. De övre vingtäckarna hade en lätt ockraton och skiljde sig från de undre vingräckarna som var mörkare med mer morotsorange anstrykning. Denna färgsättning gav intryck av mera kopparton underifrån. Individuella ryggfjädrar och undre vingtäckare hade synliga mörkare mönster i olika toner av orange. Obefjädrade kroppsdelar var normalt färgade med gula ben, svart näbb och vaxhud.

Den 14 augusti 2011 fotograferades en ormvråk med otypisk färg nära Minoga i södra Polen (Figur 2). Den liknade mycket den nyss beskrivna. Huvudet var ljusbeige. Undersidan var tvåtonad: beige bröst, med ett tydligt ljusare U-format bröstband, som övergick i något mörkare rostfärgade flanker och lår. Alla handpennor och armpennor var tydligt bandade. Övre vintäckarna var ganska enfärgat ljusbeige med något mörkare bakkanter. Undre vingtäckarna, som var mörkare än de övre, hade synliga mörka teckningar och var mera morotsorange. Obefjädrade kroppsdelar var normalt färgade. Denna individ kretsade tillsammans med tre normalfärgade ormvråkar och en kungsörn.

Jag har tolkat den beskrivna variationen som den bruna mutation som van Grouw (2006) nämner som orsakad av en kvalitativ reduktion av eumelanin, då mängden pigment är oförändrat men dess färguttryck förändrats. En färgvariant som kallas utspädning, och som är mycket lik den bruna mutationen, finns också och skall bero på en kvantitativ reduktion av melaninerna. Den bruna mutationen har inte tidigare publicerats, men exemplar finns på muséer i Tyskland, Österrike och Storbritannien. Även exempel på varianten utspädning har rapporterats från muséer i England och Italien.

ORNIS SVECICA 21: 123–132, 2011

# Talgoxens *Parus major* antal och häckningsbiologi – resultat av 25 års holkstudier

## *Numbers and breeding biology of the Great Tit* Parus major *– results of a 25 year nest-box study*

JAN-ERIC NILSSON

### Abstract

A nest-box population of Great Tits *Parus major* was followed in 1986–2010. Maximum number of breeding attempts was three times higher than the minimum number but there was no significant trend through 2005. The number of nest-boxes declined from 94 to 55 during the last five years making it difficult to interpret the recent trend but most likely there was an increase. 17% of the first breeding attempts failed and resulted in replacement clutches. The number of second clutches was 13% of the number of first clutches. There was no correlation between population size and winter temperature. There was no significant advancement of laying date in spite of the fact laying date was correlated with April temperature and that local April temperature showed a significant positive trend during the study period. Mean clutch size was 9.2 eggs. The number of fledglings was 4.65, which is low compared to other studies. Replacement and second clutches produced 4.37 fledglings. Both clutch size and number of fledglings declined during the study period.

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## Inledning

Den första delen av min studie av det holkhäckande fågelbeståndet i Linderås (Tranås kommun, Jönköpings län) har tidigare redovisats (Nilsson 2008). Den omfattade, förutom en allmän presentation av undersökningsområdet också en biotopbeskrivning, den metodik som använts, samt en redovisning av samtliga häckningar under de 20 åren 1986–2005. Huvudinnehållet bestod dock av en redovisning och analys av de häckningsbiologiska data som insamlats för den svartvita flugsnapparen *Ficedula hypoleuca*.

Denna rapport omfattar motsvarande uppgifter för talgoxen *Parus major* och när det gäller de grundläggande uppgifterna om undersökningsområdet och metoderna hänvisar jag till den första uppsatsen. Studien avslutades i sin fulla omfattning 2005, men jag har fortsatt att följa häckningarna i ett reducerat antal holkar. Jag har därför valt att här även ta med vissa data från de följande åren, 2006–2010. Detta gäller uppgifter om äggläggningsdatum, kullstorlek och häckningsutfall eftersom jag anser att dessa inte påverkats nämnvärt av reduktionen av antalet holkar.

Mycket har skrivits om talgoxens häckningsbiologi, men jag har i denna uppsats i huvudsak begränsat mig till jämförelser med två liknande studier, den ena i Värmland (Råda) under nästan samma tidsperiod, 1985–2004 (Borgström 2007), den andra i Örebrotrakten under åren 1948–2008 (Schölin 2009). I den fortsatta framställningen hänvisar jag till dessa som Råda- resp. Örebrostudierna.

Talgoxens häckningsbiologi är klart besvärligare att få grepp om än den svartvita flugsnapparens. Den sistnämnde har inga andrakullar och omläggningar är extremt ovanliga. Talgoxen är däremot mycket störningskänslig och omläggningar sker ofta. Antalet andrakullar är relativt få, men kan vissa år vara mer frekventa. Gränsdragningen mellan omläggningar och andrakullar är ibland svår. Här delar jag Borgströms uppfattning, d.v.s. att ringmärkningen måste vara det enda helt säkra kriteriet. Liksom i Råda-studien har min strävan därför varit att ringmärka så många honor som möjligt för att på detta sätt fastställa huruvida det är fråga om en omläggning eller en andra kull. Under perioderna 1996–1999 och 2006–2010 har dock ingen ringmärkning av honor skett, varför fördelningen mellan omläggningar och andrakullar grundar sig på en mer subjektiv bedömning. Ambitionen att ringmärka honorna krockar stundom med strävan att inte störa dem under senare delen av äggläggningen eller under den första ruvningsveckan, då de erfarenhetsmässigt är extremt störningskänslig.

Den följande redovisningen omfattar således i huvudsak åren 1986–2005, där beståndsutvecklingen avser de 94 holkar som satt på samma plats under de 20 åren. Uppgifter insamlade i ytterligare 39 holkar som fanns åren 1986–2000, och som ingick i Nilsson (2008), har inte använts i föreliggande uppsats. Sedan det egentliga projektet avslutades 2005 har holkantalet reducerats ytterligare och ambitionsnivån sänkts något. Antalet holkar sjönk stegvis till 55 stycken år 2010. Vid en jämförelse av resultat och slutsatser från de andra studier jag refererar till finns stora överensstämmelser, men också en del avvikelser. Dessa kommer att diskuteras i den fortsatta framställningen.

## Resultat och diskussion

### *Det holkhäckande beståndet*

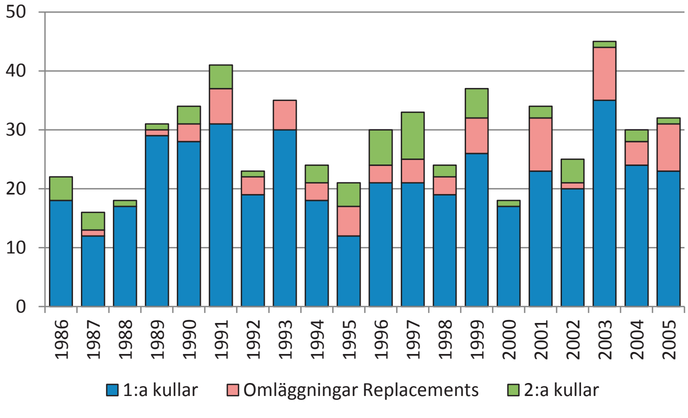
En jämförelse med Råda-studien visar en mindre avvikelse när det gäller artsammansättningen hos det holkhäckande beståndet i de två områdena. Borgström anger andelarna till 50% för den svartvita flugsnapparen, 35–40% för talgoxen och 10–15% för övriga arter. Mina siffror visar en högre andel flugsnappare (57%), en lägre andel talgoxar (31%) och ungefär samma andel övriga arter (12%). Att siffrorna varierar något har säkert sin förklaring i att holkarna varit uppsatta i olika biotoper med varierande konkurrens från andra arter, födotillgång eller andra orsaker som inte går att säkert fastställa.

### *Beståndsutveckling*

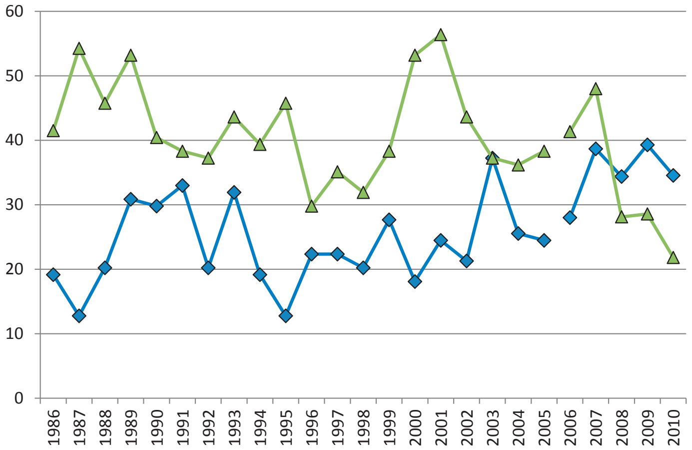
Som framgår av Figur 1 varierar antalet häckande talgoxar i de 94 holkarna ganska kraftigt under undersökningsperioden, ett faktum som är likartat även i övriga studier. Mina siffror visar en variation mellan bottenåren 1987 och 1995 med 12 påbörjade häckningar och toppåret 2003 med 35 stycken, d.v.s. en tredubbling. Motsvarande siffror från Värmland varierar mellan 23 par (1985) och 72 par (1992) och i Örebro mellan 13 par (1975) och 41 par (2007), även här en ungefärlig tredubbling mellan minimum och maximum. En jämförelse av beståndsutvecklingen i mitt område under enskilda år med de övriga studierna visar ingen samstämmighet, tvärtom ser det ibland ut som goda år i Småland motsvaras av ganska dåliga i Råda/Örebro och vice versa.

En fråga som jag närmare ville studera var, huruvida vinterns stränghet påverkade antalet häckande par den kommande säsongen. Avvikelser från medeltemperaturen vid Jönköpings flygplats (SMHI, månaderna december–februari) jämfördes med det häckande beståndet, men inte heller här kunde någon samvariation konstateras. Samma slutsats drogs i Örebrostudien, där motsvarande jämförelse gjordes. Mycket tyder därför på, att talgoxens häckningsfrekvens är lokalt betingad och främst beror på att arten är ganska stationär och därför påverkas av varierande lokalklimat, födotillgång m.m.

I medeltal påbörjade talgoxen 23 förstakullar per år och någon tydlig tendens till ökning eller minskning kan inte ses. Endast sex procent av variationen kan förklaras av regressionen för antal par mot årtalet ($R^2$=0,06). Noterbart är möjligen, att efter flera goda år (1989–1991), beståndet tydligen nått



Figur 1. Antal kullar av olika kategorier åren 1986–2010 med 94 holkar varje år.
*Number of clutches of different categories (1st, replacement and 2nd clutches) in 1986–2010 with 94 nest-boxes every year.*



Figur 2. Procent holkar besatta av talgoxe (blå) och svartvit flugsnappare (grön). 1986–2010 fanns 94 holkar, därefter stegvis sjunkande till 55 år 2010.
*Percent nest-boxes used by Great Tit (blue) and Pied Flycatcher (green). 94 nest-boxes in 1986–2010, then stepwise reduced to 55 in 2010.*

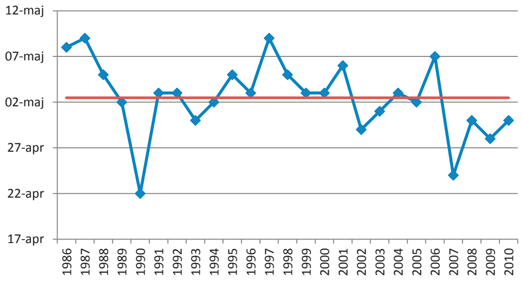
någon form av maximum. Både hösten 1990 och 1991 fick jag nämligen rapporter om att av mig pull-märkta talgoxar kontrollerats på utsträck från Falsterbo fågelstation.

I Örebrostudien visar Schölin att talgoxen ökat relativt kraftigt under senare år. Eftersom antalet holkar varierat visar han detta genom att fastställa andelen förstakullar av talgoxe i procent av det totala antalet tillgängliga holkar. En motsvarande omräkning av mitt material framgår av Figur 2. Här framgår att beståndet av talgoxar var tämligen stabilt fram till 2000-talets början, då en ökning tydligt kan ses, precis som i Örebrotrakten. Ökningen är signifikant och trenden förklarar 27% av variationen. Tolkningen kompliceras dock av att antalet holkar stegvis reducerats mellan 2005 och 2010. Även antalet blåmesar *Cyanistes caeruleus* har ökat, men detta material är ännu inte bearbetat. Jag har valt att även redovisa utvecklingen hos den svartvita flugsnapparen i samma figur och kan konstatera, att denna art minskat under senare år efter att ha haft en ganska stabil förekomst under de första 20 åren. Vad orsaken kan vara till dessa fluktuationer eller trender är svårt att avgöra. Att talgoxens ökning skulle ske på den svartvita flugsnapparens bekostnad, d.v.s. att den senare skulle bli utträngd p.g.a. ökad konkurrens anser jag inte vara troligt, då det varje år funnits ett stort antal holkar som inte varit ockuperade (ca 35 %, variation 16–48%). En möjlig orsak till talgoxens och blåmesens ökning kan däremot vara den markanta minskningen av övriga mesar (entita *Poecile palustris*, talltita *Poecile montana* och svartmes *Periparus ater*) i området, innebärande att de förstnämnda kan ha fått ökat livsutrymme. Den svartvita flugsnapparen hade 2010 ett bottenår med endast 12 häckningar. Här är jag ganska säker på orsaken – brist på honor. Hanarna kom i normalt antal och besatte snabbt lämpliga holkar. I flera fall sjöng de oavbrutet i två till tre veckor, dock utan att en partner dök upp. Något hade tydligen hänt under honornas flyttning som gjorde att de aldrig kom fram till målet.

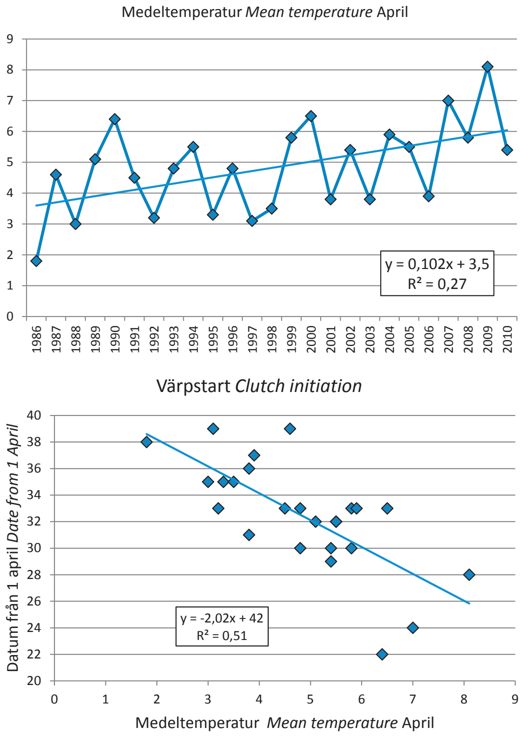
I Figur 1 redovisas också antalet omläggningar (74 st) och andrakullar (56 st) fördelade på de 20 häckningssäsongerna, vilka kommenteras längre fram i rapporten.

## *Äggläggningsstart*

I Figur 3 redovisas det årliga medelvärdet för värpstarten för talgoxens förstakullar under samtliga 25 år och omfattar 611 registrerade kullar. För hela pe-



Figur 3. Årligt medeldatum för läggningsstart hos förstakullar. Röd linje är medeldatum för hela perioden.
*Annual mean date of onset of laying of first clutches. Red line is mean date for the whole period.*



Figur 4. Medeltemperaturen för april i Norrköping (övre diagrammet) och värpstarten i förhållande till temperaturen (nedre diagrammet).
*Mean April temperature at Norrköping (upper diagram) and clutch initiation in relation to temperature (lower diagram).*

rioden blev medeldatum den 2 maj, med tidigaste medeldatum för läggstarten den 22 april (1990) och senaste den 9 maj (1987 och 1997). Även 2007 var ett år med tidig värpstart (medeldatum 24 april) vilket sammanfaller med Örebrostudien. Det tidigaste ägget någonsin hittades redan den 8 april under det extrema året 1990, hela två veckor före det årets medeldatum.

Som synes varierade tidpunkten för värpstart ganska kraftigt mellan de olika åren men ingen tydlig tendens till tidigare datum kan påvisas (trend=-0,18; $R^2$=0,11; ej signifikant). Inte heller Råda-studien visade någon tendens till tidigare datum, medan Örebrostudien visade en nästan signifikant sådan tendens. En jämförelse med studien i Råda visar att äggläggningen där i genomsnitt påbörjades en vecka senare (10 maj) och i Örebro den 6 maj, d.v.s. några dagar senare än i norra Småland. Det rådde en god samstämmighet mellan läggdatum i de tre studierna (p<0,001 i alla tre jämförelserna), något som inte är överraskande eftersom temperaturen varierar likartat mellan åren på alla lokalerna.

Både Borgström och Schölin visade på ett klart samband mellan medeltemperaturen i april och värpstarten. Även i min studie var sambandet mellan apriltemperaturen och värpstarten höggradigt signifikant. Värpstarten inföll i genomsnitt två dagar tidigare per grad högre temperatur (b=-2,02; p<0,0001; Figur 4). Så mycket som hälften av variationen i värpdatum kunde förklaras av apriltemperaturen ($R^2$=0,51). Apriltemperaturen i Jönköping ökade med i genomsnitt 0,1 grad per år (SMHI; $R^2$=0,26; p<0,01). Trots detta och trots det starka sambandet mellan apriltemperaturen och värpstarten uppvisade talgoxarna i Tranås inte någon signifikant reaktion på denna trend (Figur 3).

Att häckningarna påbörjas ca en vecka senare i Råda och i Örebro är väl inte så förvånande, då områdena ligger nordligare än mitt. Förbryllande är dock en jämförelse med det skånska materialet från åren 1969–1978 i Linnebjer (Källander 1983), där medeldatum för talgoxarnas första ägg var den 9 maj, d.v.s. ungefär samma som i Värmland. Om nord-sydteorin skulle gälla borde de skånska häckningarna i huvudsak starta i april, men så skedde bara i 4,3 % av fallen. En möjlig förklaring skulle kunna vara de olika klimattyper som råder i regionerna. Både Värmland, Örebro och norra Småland har vad vi kallar ett ganska utpräglat inlandsklimat, medan Skåne får anses ha ett mer typiskt kustklimat med något svalare vårar. Emellertid är en alternativ förklaring att läggstarten var avvikande sen just åren 1969–1978. Eftersom senare uppgifter från Linnebjer inte varit tillgängliga, har Hans Källander i brev meddelat att han på två andra lokaler (Revinge och Vombs fure) funnit att äggläggningen i genomsnitt började 8–10 dagar senare 1971–1974 jämfört med 1988–1996. Under den senare perioden var medeldatum i Revinge och Vombs fure 29 april. Samma år var medeldatum i mitt område 2 maj, alltså tre dagar senare. Det verkar därför som om nord-sydteorin trots allt håller även om skillnaden mellan Linderås och Skåne inte är särskilt stor.

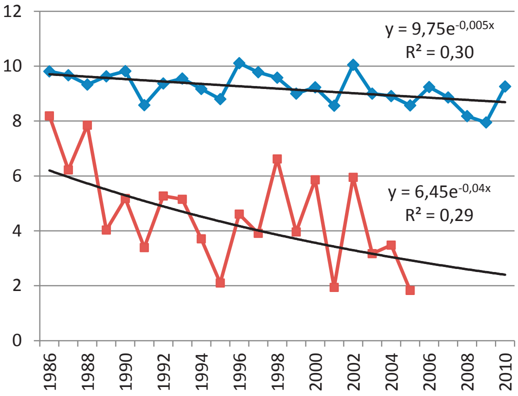
Som tidigare framgått (Figur 1) har 74 säkra omläggningar skett av spolierade eller övergivna förstakullar. Dessa har oftast skett i närliggande holkar som inte varit upptagna och relativt snabbt efter att den första kullen övergivits. Detta kunde ske under hela häckningscykeln, från slutet av äggläggningen till att ungarna kläckts. I det senare fallet var det oftast kyla och födobrist som var orsaken medan det i de tidigt övergivna kullarna nästan alltid var fråga om störningar av olika slag, t.ex. konkurrens. Datum för dessa omläggningar beror givetvis på när kullen överges och kan därför variera starkt från mitten av maj till första veckan i juni. Borgström bedömer att ca 25% av förstahäckningarna misslyckas och att en omläggning sker. I mitt material blev andelen ca 17%.

Som andrakullar har jag liksom i övriga studier räknat kullar där talgoxeparet fått ut minst en unge i förstakullen. Det har diskuterats huruvida andrakullar är vanliga eller sällsynta. I mitt material anser jag att det sistnämnda gäller, endast 56 säkra andrakullar kunde registreras (12,6 % av förstakullar). Värpstart i dessa kullar varierade med tidpunkten för den första kullens avslutande, men skedde i allmänhet i mitten av juni (10–25 juni, i medeltal 15 juni). Värpstarten i den senaste kullen i mitt material skedde den 1 juli och innebar att ungarna flög ut i början av augusti.

## *Kullstorlek*

Även denna redovisning avser samtliga holkar som undersökts under åren 1986–2010 och omfattar 628 förstahäckningar. Som framgår av Figur 5 varierar medelkullstorleken från 7,95 ägg/kull (2009) till 10,11 (1996) med ett medeltal på 9,20 ägg per kull. Medelkullstorleken visar en negativ trend under perioden med särskilt låga värden ett par av de senaste åren. Den genomsnittliga trenden är en sänkning med 0,04 ägg per år ($R^2$=0,29; p<0,01). Samma trend noterades dock i Örebro och Råda. För de gemensamma årens medelkullstorlekar var korrelationskoefficienten r=0,68 för Tranås–Råda, r=0,70 för Tranås–Örebro och r=0,60 för Råda–Örebro, samtliga signifikanta (p<0,01).

Orsaken till dessa variationer är svår att förklara, vilket också andra studier visar. Eftersom kullstorleken styrs av ett flertal faktorer som har behandlats av många talgoxforskare avstår jag från en närmare analys i denna uppsats.



Figur 5. Årliga medelvärden för äggkullstorleken (övre) och antal flygga ungar (nedre). Antal ungar 2006–2010 visas inte enär holkarna hade modifierats för att minska predationen och värdena därför inte är jämförbara med tidigare.
*Annual mean values for clutch size (upper) and number of fledglings (lower). Number of fledglings was not determined in 2006–2010.*

I Tabell 1 jämför jag mina data med fyra andra undersökningar såväl avseende medelkullstorleken som fördelningen av antalet ägg i kullarna. Medelkullstorleken ökar från söder mot norr. Den är således ca två ägg större i Skåne än i Uppland. En skillnad är de olika andelarna av små respektive stora kullar. Nästan 10% av kullarna i norr har 6 ägg eller färre, medan antalet stora kullar är mycket fåtaliga. I Skåne och Småland dominerar 10-kullar, i Råda och Örebro 9-kullar och i Uppland 8-kullar.

Det är intressant att notera att Källander och

Tabell 1. Kullstorlekens medelvärde och fördelning i procent på olika kullstorlekar i denna och andra studier.
*Mean clutch size and percentage of different clutch sizes in this and other studies.*

| Landskap | Medel | Kullstorlek *Clutch size* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Province* | *Mean* | <7 | 7 | 8 | 9 | 10 | 11 | 12 | >12 |
| Skåne[1] | 9,85 | 3 | 5 | 13 | 20 | **26** | 21 | 8 | 5 |
| Småland[2] | 9,20 | 5 | 7 | 14 | 24 | **30** | 14 | 4 | 2 |
| Närke[3] | 8,72 | 4 | 10 | 27 | **33** | 20 | 4 | 1 | 0 |
| Värmland[4] | 8,74 | 6 | 12 | 25 | **28** | 21 | 7 | 2 | 0 |
| Uppland[5] | 7,83 | 10 | 22 | **48** | 16 | 3 | 1 | 1 | 0 |

[1] 55°44' N, 13°18' E; 387 kullar *clutches*; 1970–1978; Källander (1983)
[2] 57°58' N, 14°15' E; 628 kullar *clutches*; 1986–2010: denna studie *this study*
[3] 59°14' N, 15°13' E; 1115 kullar *clutches*; 1948–2008; Schölin (2009)
[4] 60°00' N, 13°36' E; 950 kullar *clutches*; 1985–2004; Borgström (2007)
[5] 60°19' N, 16°56' E; 209 kullar *clutches*; 1952–1963; Johansson (1972)

Tabell 2. Kullstorlekens medelvärde för förstakullar med värpstart under olika tidsperioder i Tranås (denna studie) och i Råda, Värmland.
*Mean size of first clutches with onset of laying in different periods at Tranås (this study) and Råda, Värmland.*

| Tranås, Småland | | Råda, Värmland | |
|---|---|---|---|
| Period | Medel *Mean* | Medel *Mean* | Period |
| –15/4 | 9,67 | – | – |
| 16–20/4 | 10,00 | – | – |
| 21–25/4 | 9,98 | – | – |
| 26–30/4 | 9,55 | 9,36 | 24–28/4 |
| 1–5/5 | 9,36 | 8,87 | 29/4–3/5 |
| 6–10/5 | 9,14 | 8,87 | 4–8/5 |
| 11–15/5 | 8,68 | 8,74 | 9–13/5 |
| 16–20/5 | 8,17 | 8,77 | 14–18/5 |
| 21–25/5 | 8,33 | 8,39 | 19–23/5 |
| 26–30/5 | – | 8,08 | 24–28/5 |

Borgström kommit till olika uppfattningar om talgoxens tendens att lägga större eller mindre kullar beroende på värpstarten. Källander visar att de tidigare kullarna är minst och sedan ökar, medan Borgström i sitt siffermaterial konstaterar att det är tvärtom (9,36 ägg/kull i april och 8,08 i slutet av maj). Tyvärr har jag använt andra tidsintervaller än Borgström, men menar att resultatet sammanfaller med den trend han anger, d.v.s. äggantalet sjunker vid senare kullar. Mitt material presenteras i Tabell 2 och jämförs med resultaten i Råda (notera viss divergens i tidsintervallerna).

De 74 omläggningar som under åren 1986–2005 registrerades hade en medelkullstorlek på 7,73 ägg/kull, d.v.s. ca 1,5 ägg färre än i förstakullarna. I Råda-studien var medelkullstorleken för omläggningarna 7,74 ägg, exakt ett ägg mindre än i förstakullarna.

Antalet registrerade andrakullar är i denna studie 56 (12,6 % av förstakullarna) och medelkullstorleken blev här 7,09 ägg, d.v.s. 2,1 ägg färre än i förstakullarna. En intressant iakttagelse kan göras vid jämförelse av uppgifterna i Tabell 1 med angivna kullstorlekar hos andrakullar i de övriga studierna. I Skåne, som hade störst förstakullar, var den andra kullen 2,6 ägg mindre (7,26 ägg/kull), i min studie 2,1 ägg mindre (7,09 ägg/kull), i Värmland 1,4 ägg mindre (7,32 ägg/kull) och i Uppland 0,6 ägg mindre (7,18 ägg/kull). Trots att förstakullarna således varierade med ca 2 ägg från den sydligaste till den nordligaste studien visar det sig att andrakullarna varierade betydligt mindre (7,09–7,32 ägg/kull, d.v.s. 0,23 ägg). Vad orsaken är till detta fenomen är inte känt.

### *Häckningsutfall*

När det gäller häckningsutfallet (flygga ungar) hos den svartvita flugsnapparen visade det sig, att det låg ca 25% lägre än i de andra studier jag jämförde med. Jag kan nu notera att i stort samma förhållande gäller för talgoxen. I Tabell 3 och Figur 5 redovisas utvecklingen under perioden 1986–2005 och materialet bygger på 515 häckningar. Att jag inte medtagit åren 2006–2010 beror på, att jag efter projektets slut modifierade holkarna med djupare ingångshål, som reducerade bl.a. mårdens möjligheter till predation. Därmed skulle inte materialet vara fullständigt jämförbart. I medeltal för hela tjugoårsperioden blev antalet flygga ungar endast 4,65 per kull, klart mycket sämre jämfört med 6,81 flygga per kull i Råda och 5,76 per kull i Örebro. Det är svårt att hitta orsaken till skillnaderna både när det gäller talgoxens och den svartvita flugsnapparens dåliga resultat just i mitt område. Skillnaden i äggkullstorlek (Tabell 1) är inte tillräcklig. Kanske är våra studier genomförda i skilda naturmiljöer, med olika väderfaktorer och födotillgång, men jag tror att det är predationstrycket som är mest avgörande. Mården har under vissa år orsakat stora förluster i mitt område och så även de kalla perioder som ofta förekommer på det småländska höglandet och ibland sammanfaller med talgoxens matningsperiod. Jag kan givetvis inte heller utesluta att min ambition att ringmärka så många honor som möjligt, trots tidigare nämnda försiktighetsåtgärder, bidragit till att några kullar övergetts.

Schölin visar att häckningsframgången minskat markant under senare år (från 8,01 ungar/kull under åren 1948–1957 till 6,19 åren 1998–2008). Detta gäller även för denna studie, där medeltalet under den första 5-årsperioden (1986–1990) var 6,29 flygga ungar per kull och under de sista fem åren (2001–2005) endast 3,27 ungar/kull. Som synes av tabellen kan vissa år betecknas som riktiga ”katastrofår” (1995, 2001 och 2005), medan andra varit mer framgångsrika. Noterbart är också att undersökningens första år (1986) var det bästa med 8,19 ungar per kull och att det sista året (2005) var det sämsta med 1,83 flygga ungar per kull.

Talgoxens omläggningar och andrakullar lyckades relativt sett något bättre om hänsyn tas till att kullarna redan från början var mindre. Utfallet blev för omläggningarna 4,04 flygga ungar/kull och för andrakullarna 4,37 ungar/kull.

Tabell 3. Häckningsresultat för talgoxe 1986–2005.
*Breeding performance of the Great Tit in 1986–2005.*

| År | Kullar<br>*Clutches* | Ägg<br>*Eggs* | Kläckta<br>*Hatched* | % kläckta av lagda<br>*% hatched of laid* | Flygga<br>*Fledged* | % flygga av kläckta<br>*% fledged of hatched* | Flygga/kull<br>*Fledged/brood* | % flygga av lagda ägg<br>*% fledged of laid eggs* |
|---|---|---|---|---|---|---|---|---|
| 1986 | 21 | 206 | 172 | 83 | 172 | 100 | 8,19 | 83 |
| 1987 | 18 | 174 | 151 | 87 | 112 | 74 | 6,22 | 64 |
| 1988 | 27 | 252 | 217 | 86 | 212 | 98 | 7,85 | 84 |
| 1989 | 35 | 337 | 199 | 59 | 141 | 71 | 4,03 | 42 |
| 1990 | 45 | 442 | 340 | 77 | 233 | 69 | 5,18 | 53 |
| 1991 | 38 | 326 | 217 | 67 | 129 | 59 | 3,39 | 40 |
| 1992 | 30 | 281 | 199 | 71 | 158 | 79 | 5,27 | 56 |
| 1993 | 33 | 315 | 236 | 75 | 170 | 72 | 5,15 | 54 |
| 1994 | 24 | 220 | 145 | 66 | 89 | 61 | 3,71 | 41 |
| 1995 | 10 | 88 | 52 | 59 | 21 | 40 | 2,10 | 24 |
| 1996 | 18 | 182 | 106 | 58 | 83 | 78 | 4,61 | 46 |
| 1997 | 23 | 225 | 163 | 72 | 90 | 55 | 3,91 | 40 |
| 1998 | 24 | 230 | 182 | 79 | 159 | 87 | 6,62 | 69 |
| 1999 | 28 | 252 | 161 | 64 | 111 | 69 | 3,96 | 44 |
| 2000 | 22 | 203 | 158 | 78 | 129 | 82 | 5,86 | 64 |
| 2001 | 18 | 154 | 75 | 49 | 35 | 47 | 1,94 | 23 |
| 2002 | 20 | 201 | 124 | 62 | 119 | 96 | 5,95 | 59 |
| 2003 | 35 | 315 | 185 | 59 | 111 | 60 | 3,17 | 35 |
| 2004 | 23 | 205 | 121 | 59 | 80 | 66 | 3,48 | 39 |
| 2005 | 23 | 197 | 97 | 49 | 42 | 43 | 1,83 | 21 |
| Total | 515 | 4805 | 3300 | M=69% | 2396 | M=73% | M=4,65 | M=50% |

Av Tabell 4 framgår under vilka skeden i talgoxens häckningscykel förlusterna skett. Endast knappt 20% av kullarna lyckades helt, d.v.s. att alla ägg i kullarna kläcktes och resulterade i flygga ungar. Huvuddelen av förlusterna skedde under ruvningstiden och den vanligaste orsaken var att ett eller flera ägg inte kläcktes (43% av samtliga kullar). Oftast (72%) handlade det om att ett eller två ägg förblev okläckta, men även större antal har noterats (5–9). I många fall tog den svartvita flugsnapparen snabbt över holkar som talgoxen av olika anledningar övergett (predation, ringmärkning, kyla etc.). Jag har hittat såväl döda talgoxar som flugsnappare (flest hanar) i holkarna. Konkurrensen mellan de två arterna har debatterats i flera andra studier och olika resultat och slutsatser har redovisats. Mitt underlag medger ingen säker slutsats om förekomst av direkta strider eftersom dessa försiggår i holken och inte lätt kan observeras.

När det gäller förluster under matningsskedet är bilden något annorlunda. I några enstaka fall har även här den svartvite flugsnapparen lyckats överta holken. De flesta orsakerna är dock noterade som predatorers framfart, främst mård (18 fall), okänt djur (28), större hackspett (3) men också dåligt väder (15). I övriga fall är orsaken okänd. Här är det därför rimligast att anta att flugsnapparen tagit holken i besittning efter en misslyckad talgoxhäckning. Även för kullar där några av ungarna klarat sig var mården, andra predatorer och kylan de dominerande orsakerna till förluster. I mina kontroller av holkarna har jag vid flera tillfällen kommit strax efter ett angrepp av mården och kunnat ta bort de borester som täckt ingångshålet. Föräldrarna har då fortsatt mata de ungar som hamnat på holkens botten och fått dem på vingarna. I Tabell 4 redovisas även de kullar, där en eller flera ungar lämnats att dö, medan övriga blivit flygga. Här torde matbrist (kyla) vara huvudorsaken.

En analys av häckningsutfallet och orsakerna till förluster i omläggningar och andrakullar visar i stora drag samma bild som vid förstahäckningarna.

### *Ringmärkning och kontroller*

Ringmärkning av de holkhäckande fåglarna inom undersökningsområdet avslutades 2005, med uppehåll under åren 1996–1999 och omfattade 293 honor och 2651 ungar. Talgoxen var i huvudsak en stannfågel, men vissa år genomfördes längre flyttningsrörelser. I mitt material finns tre sådana noterade, alla efter de goda reproduktionsåren i början av 1990-talet. Såväl 1990 som 1991 kontrollerades en av mig tidigare under året som unge ringmärkt talgoxe vid Falsterbo fågelstation, båda troligen på väg att lämna landet. År 1994 återfanns en annan som unge märkt fågel i Dala-Floda i Dalarna (ringmärkt i maj 1992). Materialet är litet, men indikerar att även talgoxens ungfåglar vissa år helt lämnar hemtrakterna och ger sig av långa sträckor. I övrigt har bara en som unge märkt fågel återfunnits utanför holkområdet, i Vireda (ca 2 mil söder om Linderås). Vid analys av motsvarande material för den svartvita flugsnapparen kunde konstateras, att årsungarna sällan återkom till hemtrakten, medan detta oftare förekom hos honor som tidigare häckat i området. Av Tabell 5 framgår att 34 kontroller gjordes av ringmärkta ungar av talgoxen och som väntat återfanns de flesta året efter märkningen, varefter antalet kontroller snabbt avtog. Om jag antar att hälften av 2651 märkta boungarna var honor, motsvarar de 34 kontrollerna endast 2,6%. När det gäller honor som märkts som 2K+ var antalet kontroller mycket högre, 68 av 293, dvs. 23,3% Intressant är att notera att 65% av dessa gjorts inom samma holkgrupp (inom ca 200 meter) och i flera fall i samma holk. Hos de honor som kläckts året innan finns inte samma tendens, de verkar sprida ut sig i hela holkbeståndet (200–1000 meter från födelseplatsen).

Tabell 4. Antal kullar som drabbats av olika slags förluster och andra missöden under olika skeden av häckningscykeln åren 1986–2005. Antalet störningar är i många fall flera än antalet kullar, då flera utsatts för flera förluster och missöden.
*Number of clutches affected by different kinds of losses during different phases of the breeding cycle in 1986–2005. In several years the number of losses is larger than number of clutches because some clutches were affected by more than one kind of disturbance.*

| | Antal kullar | Ruvningsperioden *Incubation period* | | Matningsperioden *Nestling period* | | Döda ungar efter utflygning | Utan förlust |
|---|---|---|---|---|---|---|---|
| | *No. of clutches* | Del av kullen *Part of clutch* | Övergiven plundrad *Deserted depredated* | Hela kullen *Whole brood* | Del av kullen *Part of brood* | *Dead young after fledging* | *Without loss* |
| 1986 | 21 | 6 | 2 | 0 | 0 | 0 | 13 |
| 1987 | 18 | 9 | 1 | 3 | 1 | 2 | 5 |
| 1988 | 27 | 13 | 2 | 0 | 2 | 0 | 11 |
| 1989 | 35 | 15 | 12 | 4 | 0 | 0 | 5 |
| 1990 | 45 | 13 | 7 | 9 | 6 | 1 | 12 |
| 1991 | 38 | 8 | 9 | 8 | 3 | 5 | 8 |
| 1992 | 30 | 13 | 7 | 3 | 3 | 1 | 5 |
| 1993 | 33 | 14 | 6 | 6 | 4 | 0 | 8 |
| 1994 | 24 | 19 | 4 | 6 | 0 | 1 | 0 |
| 1995 | 10 | 3 | 4 | 3 | 0 | 0 | 1 |
| 1996 | 18 | 1 | 8 | 2 | 0 | 0 | 6 |
| 1997 | 23 | 9 | 5 | 4 | 5 | 2 | 2 |
| 1998 | 24 | 14 | 2 | 3 | 0 | 1 | 6 |
| 1999 | 28 | 12 | 7 | 6 | 0 | 1 | 3 |
| 2000 | 22 | 12 | 3 | 1 | 1 | 4 | 4 |
| 2001 | 18 | 7 | 7 | 4 | 0 | 0 | 1 |
| 2002 | 20 | 12 | 2 | 0 | 0 | 0 | 3 |
| 2003 | 35 | 17 | 10 | 7 | 2 | 2 | 2 |
| 2004 | 23 | 10 | 6 | 5 | 0 | 0 | 4 |
| 2005 | 23 | 12 | 7 | 8 | 0 | 0 | 1 |
| Summa | 515 | 219 | 111 | 82 | 27 | 20 | 100 |
| % | | 64 | | 21 | | | 19,4 |

Tabell 5. Kontroller av ringmärkta honor av talgoxe under perioden 1986–2005.
*Number of females that were controlled in the period 1986–2005.*

| | Kontrollerade i *Controlled in* | | | Summa |
|---|---|---|---|---|
| | samma holk *same box* | samma holkgrupp *same box group* | övriga holkgrupper *other box groups* | |
| Honor märkta som 2K+ och kontrollerade som *Females ringed as 2K+and controlled as* | | | | |
| 3K+ | 3 | 25 | 23 | 51 |
| 4K+ | 6 | 7 | 1 | 14 |
| 5K+ | 0 | 3 | 0 | 3 |
| Summa | 9 | 35 | 24 | 68 |
| % | 13 | 52 | 35 | 100 |
| Honor märkta som pulli och kontrollerade som *Females ringed as pulli and controlled as* | | | | |
| 2K | 0 | 1 | 22 | 23 |
| 3K | 0 | 5 | 4 | 9 |
| 4K | 0 | 0 | 2 | 2 |
| Summa | 0 | 6 | 28 | 34 |
| % | 0 | 18 | 82 | 100 |

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## Summary

This study is a part and continuation of a long-term study of birds breeding in nest-boxes that I started in 1986. The study area and the methods that I have used were described in a previous paper where the numbers and breeding biology of the Pied Flycatcher *Ficedula hypoleuca* in 1986–2005 were described (Nilsson 2008). In this study on the Great Tit *Parus major* I am using another five years in the analyses so that it covers the period 1986–2010.

The study area is at Linderås (57° 59' N; 14° 48' E), near the town of Tranås in the county of Jönköping. The number of nest-boxes suitable for tits and flycatchers was 94 in 1986–2005. The number was then reduced in steps to 55 in 2010. This means that the data from the last five years are not fully comparable with those from the first twenty years. However, it is unlikely that this had much effect on date of breeding, clutch size or breeding success. But the proportion of different species may partly depend on the number of nest-boxes. I compare the results with those from two other sites, located 140–240 km to the north (Örebro and Råda), sites that have many years in common with my study.

The number of Great Tits in the 94 boxes in 1986–2005 varied between 12 and 35 (Figure 1) without any significant long-term change. The relationship between minimum and maximum was almost identical with those found at Råda and Örebro (23–72 and 13–41). This means that the relation was 1:3 in all three studies. No correlation of numbers could

be found between the three studies for the common periods. Winter temperature seemed to have little effect as there was no correlation between number of breeding Great Tits and average winter temperature (December–February). There was no significant change of percent occupancy in 1986–2005, but the percentage increased in 2006–2010 so that the positive trend became significant for the whole 25 year period (Figure 2). This was not an effect caused by the adjustment of numbers in relation to the number of nest-boxes as the average absolute number of breeding Great Tits remained about the same (mean 22.2 in the former and 22.6 in the latter period) in spite of fewer nest-boxes.

The mean date of onset of laying varied between years (from 22 April to 9 May) but without any significant trend and with a mean for all 25 years of 2 May (Figure 3). The studies at Råda and Örebro showed the same absence of significant trends. However, there was strong correlation between laying dates when the three sites were compared which was in accordance with the close similarity of spring temperatures. Start of egg laying was closely correlated with April temperature (Figure 4). In spite of this the Great Tits did start to breed significantly earlier. However, this discrepancy may be spurious as the most recent years affect the trends particularly much.

Clutch size declined with on average 0.04 eggs per year during the study period (Figure 5). Similar trends were recorded at Råda and Örebro, and annual clutch size was well correlated between the three sites. Clutch size increased from north to south as demonstrated by the comparison between five sites in Table 1. The earliest clutches were larger than those that were lade later in the season and this was also the case in the Råda study (Table 2).

Fledging success is shown in Table 3. Average number of fledglings was 4.65 which is significantly lower than at Råda (6.81) and Örebro (5.76). I cannot explain this difference but note that also the Pied Flycatcher has a similar low breeding success in my area. Table 4 shows when during the breeding cycle that the losses occur. Only 20% of the breeding attempts were completely successful, that is that all eggs hatched and all young fledged. The most common kind of loss was that one or two eggs did not hatch. Losses of nestlings were mainly caused by predation or bad weather.

Ring recoveries showed that only 2.6% of the female nestlings returned to breed in my nest-boxes. Females that were ringed as adults returned to breed at a rate of 23.3%.

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# Dynamics and reproduction of a nest-box breeding population of Pied Flycatcher *Ficedula hypoleuca* in a subalpine birch forest in Swedish Lapland during a period of 46 years

## *Beståndsvariation och häckningsresultat hos holkhäckande svartvit flugsnappare i fjällbjörkskog i Lappland under 46 år*

N. ERIK I. NYHOLM

### Abstract

A nest-box breeding population of Pied Flycatcher *Ficedula hypoleuca* in subalpine birch forest at Ammarnäs in northern Sweden was studied in 1965–2010. The population showed on average a significantly decreasing trend during the initial 25 years, after which it remained on a static level. The yearly variation of the population size was significantly correlated with breeding result in preceding years, which in turn was affected by e.g. nest predation, adverse climatic factors, clutch size, and incidence of defective egg shell formation. It is also suggested that the population decline during the initial 10–15 study years followed from over-establishment of the breeding habitat. The average breeding result was 2.3 fledglings per pair, which is far below the number needed for the population to be self-reproducing. The occurrence of unusually high rates of nest predation and defective egg shells seems to be passing phenomena, predicted to approach zero after about 30 and 60 years, respectively, after the start of the study. But even with these factors eliminated and with other conditions remaining unchanged, the Ammarnäs population will continue to be a sink population.

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## Introduction

The Pied Flycatcher *Ficedula hypoleuca* is certainly one of the most studied European passerine bird species and the lots of publications deal with different aspects of its life (for an overview see Lundberg & Alatalo 1992). However, studies on the breeding biology of the species at the periphery of its range in Scandinavia as in subalpine habitats are few. Here environmental factors, as weather conditions, are relatively unpredictable and much variable within and between breeding seasons, and put the possibilities of the Pied Flycatcher to accomplish successful breeding to the test. Long-term studies are needed to identify influencing factors and evaluate the degree of their effect during the breeding course.

Besides the present study, long term studies on breeding conditions and population dynamics of the Pied Flycatcher in subalpine habitats are performed in northern Finland and Norway. Periods of harsh weather conditions may strongly affect the breeding result of pied flycatchers (Järvinen 1983, 1986, 1989a, Järvinen &Väisänen 1984, Thingstad 1997). In North Scandinavian breeding habitats there are cyclic populations of small rodents (e.g. Hörnfeldt 2008) and lepidopterans (e.g. autumnal moth *Epirrita autumnata* in the subalpine birch forest; Selås et al. 2001), which might indirectly or directly influence the life of the birds. The present study furthermore unveiled that birds breeding along lakes in the study area often were subjected to environmental problems which were suggested to be related to acidification (Nyholm & Myhrberg 1977, Nyholm 1981).

## Material and methods

The study was performed in the subalpine birch forest on the southerly facing slopes of the mountains Gaisatj and Valletjåkke, about five to ten kilometres west of Ammarnäs, Swedish Lapland (Figure 1). The approximate position of the nest-box area was 65°58´ N, 16° E, at 500 to 650 m.a.s.l. The habitat is a predominantly rich type of forest with luxuriant undergrowth of herbs ("meadow birch forest"). In dryer parts the forest turns into the heath type. The habitats of the nest-box plots

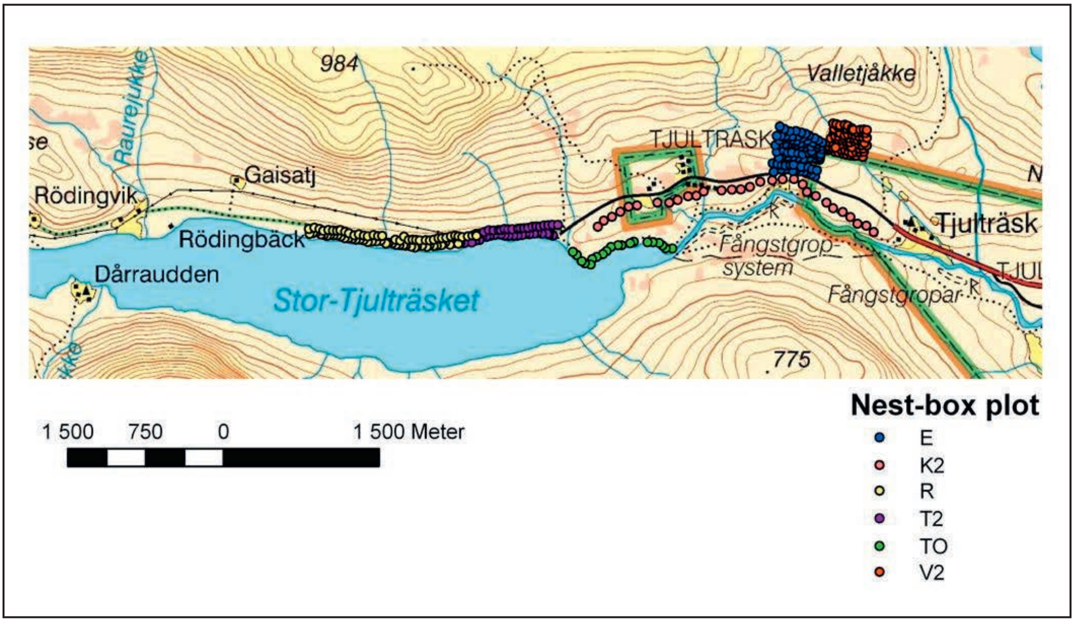

Figure 1. Localisations of the currently studied nest-box plots on the southerly facing slopes of the mountains Gaisatj and Valletjåkke.
*Lägena för de numera studerade holkgrupperna på sydsluttningarna av fjällen Gaisatj och Valletjåkke.*

Table 1. Nest-box plots and the number of nest-boxes 1965–2010. 78 and 58 nest-boxes of black plastic are included in the numbers for V1 1967–1981 and T1 1967–1979, respectively. Figures in brackets give number of nest-boxes per hectare. The currently used nest-box plots are marked by bold text.
*Holkområden och antal holkar1965–2010. Antal holkar för V1 1967–1981 inkluderar 78 av svart hårdplast och antal för T1 1967–79 38 sådana holkar. Siffror inom parentes anger antal holkar per hektar. De för närvarande studerade holkområdena markerade med fetstil.*

| Year | Nest-box plots *Holkområden* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *År* | F | G | K1 | K2 | V1 | V2 | E | T1 | T2 | TO | R | Total |
| 1965 | 44(1.8) | | | | 44(1.6) | | | 28(2.2) | | | | 116 |
| 1966 | 44 | | | | 44 | | | 28 | | | | 116 |
| 1967 | 44 | | | | 122(3.5) | | | 58(3.9) | | | | 224 |
| 1968 | 44 | | | | 122 | | | 58 | | | | 224 |
| 1969–1976 | 44 | 24(1.0) | 34(1.1) | | 122 | | | 58 | | | | 282 |
| 1977 | 44 | 24 | 34 | | 122 | | | 58 | | | **78(3.3)** | 360 |
| 1978 | 44 | 24 | 34 | | 122 | | | 58 | | | **78** | 360 |
| 1979 | 44 | 24 | 34 | | 122 | | | 58 | | **20(2.2)** | **78** | 380 |
| 1980 | | 24 | 34 | | 122 | | **80(3.3)** | | **44(3.4)** | **20** | **78** | 402 |
| 1981 | | | 34 | | 122 | | **80** | | **44** | **20** | **78** | 378 |
| 1982 | | | 34 | | | **80(5.3)** | **80** | | **44** | **20** | **78** | 336 |
| 1983–2010 | | | | **30(1.0)** | | **80** | **80** | | **44** | **20** | **78** | 332 |

have remained unchanged during the study period, and are similar to those of the mountain slope as a whole (cf. Enemar et al. 2004). The Pied Flycatcher occurs naturally as a relatively sparse inhabitant on these mountain slopes.

The nest-boxes were erected in separate plots (Table 1). Some of the plots had to be forsaken during the study period (F in 1979 and G in 1980) and others were established along Lake Stor-Tjulträsket (R in 1977 and TO in 1979). The positions of the currently studied nest-box plots K2, V2, E, TO, T2, and R are shown in Figure 1. The plots F and G were situated from about 0.3 to 1 km to the east of plot E. Plot V1 extended along the slope of Valletjåkko just to the north and east of plot V2, and plots K1 and T1 had about the same extension as K2 and T2, respectively. When estimating the sizes of the plots and the densities of nest-boxes (Table 1) the radius of the activity area of breeding Pied Flycatchers was set to 50 metres. Thus an area could also be calculated for K2, where the nest-boxes are situated in one 3 km long row, as 3 km x 100 metres (30 ha).

The inner bottom area of the nest-boxes measured 9x10 cm, the diameter of the entrance hole 32 mm, and the distance from its lower rim to the box base was 16 cm. The quality of the nest-boxes in plots V and T varied in 1967–1981 and 1967–1979, respectively, when nest-boxes made of a black plastic material, with the same diameter of the entrance hole but with somewhat smaller bottom area (VB and TB), were available besides the wooden ones. Since 1982 all nest-boxes were wooden and had uniform dimensions. The nest-boxes were originally placed at the height of some meters, and were then only reached by using a ladder. To facilitate the inspections all boxes, except the K-boxes, were moved to about 1.5 m in1988.

The nest-boxes were inspected regularly each season to get information on at least the breeding number, clutch size, period of egg laying (except in 2003), hatching success, and the final breeding result. Throughout the paper a breeding attempt means that at least one egg has been laid and a successful attempt means that at least one fledgling has been produced.

Eggs were also inspected for eggshell porosity (Nyholm & Myhrberg 1977, Nyholm 1981). Incidences of nest predation and other causes of nest desertion (e.g. disturbance by the investigators, Wrynecks *Jynx torquilla*, voles) were registered. Breeding birds were caught to be weighed and ringed (except in1982–1984). Females were usually caught when incubating, and males when feeding the nestlings. Nestlings were ringed when five days or older.

The K-boxes (K for control) were inspected showing special discretion to minimise disturbance of the breeding birds. Thus, ringing and measuring of the adults was restricted to the feeding period, the breeding phase at which they are least apt to be disturbed.

Nest predation, which was predominantly by small mustelids (least weasel *Mustela nivalis* and stoat *Mustela erminia*) and probably sometimes by martens *Martes martes*, occurred at any breeding phase (egg-laying, incubation, or nestling period). Where nests were preyed upon, occurrences of excess feathers and wings or legs that had been bitten off were looked for within and close to the nest-box to judge whether the breeding female or male was killed or not. A few nests were destroyed by Wrynecks (1975 and 1979) or small rodents.

The rate of predation by mustelids was related to the abundance of small rodents (bank vole *Myodes glareolus*, grey-sided vole *M. rufocanus*, field vole *Microtus agrestis*, and lemming *Lemmus lemmus*). These were censused during1983–1995 and 2000–2001 by means of the Small Quadrate Method (Myllymäki et al. 1971). Data from 1975–1982 (on the bank vole populations only) was obtained from Gustafsson (1983), and concerning all rodent species in 1996–1998 and 2001–2010 from Hörnfeldt (2011). Abundance of small rodents is presented as number of trapped animals/100 trap nights. The small rodent populations also reached high peak values in 1973 and 1974, but no figures can be presented from these years. As census methods and species selected were not quite uniform among the contributors of data the yearly population values given are not fully comparable, but since the amplitude is so large and species often synchronous they indicate the pattern and size of variation in the small rodent population density sufficiently well for this study.

Data on temperature and precipitation were obtained from the Swedish Meteorological and Hydrological Institute (SMHI). Most years the data refers to the local situation at Ammarnäs. In years when local measurements were lacking the meteorological data from other weather stations were used without adjustments. Thus, during one week in May or June in 1992–1995 data originated from Björkheden (30 km ESE of Ammarnäs) and all data from 2001–2010 are from the Boksjö weather station (35 km SSW of Ammarnäs). Overlapping temperature data from Boksjö and Ammarnäs during 15 May to 15 July in 1999 and 2000 showed

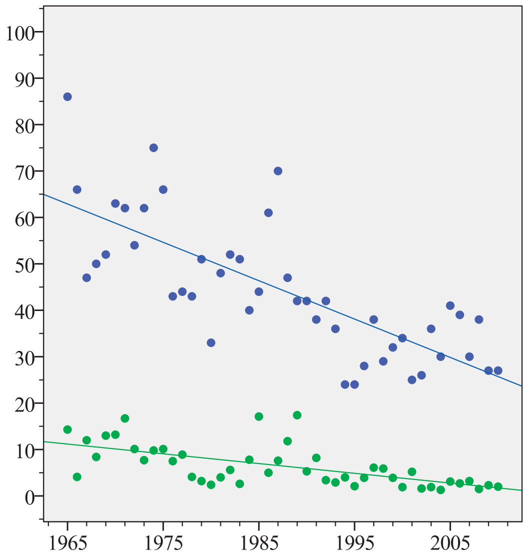

Figure 2. Variations and trends of the yearly occupancy (%) of the nest-boxes (blue), and density (territories/km$^2$) in the forest surrounding the nest-box plots for the Pied Flycatcher at Ammarnäs (green), 1965–2010.
*Variationer och trender hos beläggningsfrekens i holkarna (%) (blått) och hos tätheten för (revir/km$^2$) i björkskogen som omger holkgrupperna (grönt) för svartvita flugsnapparen, 1965–2010.*
Linear regression: Nest-box occupancy *Beläggning i holkarna;* $r^2 = 0.56$, $p<0.001$. Territory density *Revirtäthet;* $r^2 = 0.38$, $p<0.001$.

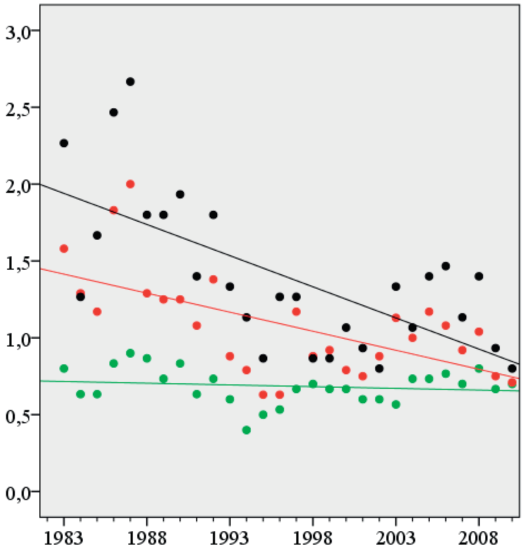

Figure 3. Trends (linear regression lines) of density of breeding Pied Flycatchers (pairs/ha) in the nest-box plots V2 (black), E (red), and K2 (green) over years 1983–2010.
*Trender hos tätheterna av häckande flugsnappare i holkgrupperna V2 (svart), E (rött) och K2 (grönt) över åren1983–2010.*

Linear regression: V2: $r^2 = 0.42$; $b = –0.041±0.009$; $p<0.001$
E: $r^2 = 0.35$; $b = –0.006±0.009$; $p<0.001$
K2: $r^2 = 0.00$; ns

Table 2. Correlation between yearly occupancy by Pied Flycatchers in the nest-box plots, 1983–2010.
*Samband mellan andelen holkar som beboddes av svartvit flugsnappare i holkgrupperna, 1983–2010.*

| Nest-box plot<br>*Holkområde* | K2 | R | T2 | TO | V2 |
|---|---|---|---|---|---|
| E | r = 0.63 *** | r = 0.74*** | r = 0.73*** | r = 0.83*** | r = 0.86*** |
| K2 | | r = 0.53** | r = 0.45* | r = 0.49** | r = 0.63*** |
| R | | | r = 0.73*** | r = 0.75*** | r = 0.79*** |
| T2 | | | | r = 0.82*** | r = 0.77*** |
| TO | | | | | r = 0.77*** |

similar mean value (0.6 °C higher at Ammarnäs). During the same period the rainy days at the stations were in close agreement, and gave as a mean 0.9 mm more precipitation at Ammarnäs.

Most of the calculations are based on time series, which means that the variables are not always independent because a value any given year is partly dependent on its value the preceding year. Correlation and regression tests (linear, quadratic, cubic, and exponential models) have nevertheless been applied as they are considered to be efficient and straightforward means to present the processes that have occurred in the study area. All significance tests (Pearson´s and Regression analysis) are two-tailed, and corrected $r^2$ values presented. The software PASW Statistics 18 was used.

## Results

### *Occupancy of nest-boxes*

Six bird species used the nest-boxes for breeding, among which the Pied Flycatcher constituted about

95% of the occupants (6162 cases). The other five species were Great Tit *Parus major* (250 cases), Redstart *Phoenicurus phoenicurus* (89), Wryneck (18), Siberian Tit *Parus cinctus* (6), and Blue Tit *Parus caeruleus* (1). The first two were breeders in all and forty of the forty-six years, respectively.

The yearly rate of nest-boxes occupied by breeding Pied Flycatchers varied between 24 and 86 percent, being highest in the first season, 1965, and lowest in the 1990s and 2000s. Occupancy showed a significantly declining trend during the study period (linear regression: $r^2 = 0.57$; $b = -0.83$; $p<0,001$) (Figure 2). Applying the cubic regression model, which indicated a stabilisation of the nest-box breeding population from early 1990s, gave, as did an exponential model, a somewhat better fit ($r^2 = 0.59$) than the linear model.

The yearly occupancy of the various nest-box plots co-varied in 1983–2010 (Table 2).

The three plots V2, E, and K2 were supplied with nest-boxes at different densities: plot V2 contained 5.3, E 3.3, and K2 1.0 nest-boxes/ha. When newly established, the densities of breeding Pied Flycatchers differed between the plots. Thus, in 1983 to 1987 on average 2.1 pairs/ha bred in plot V2, 1.6 in E, and 0.8 in K2. The trends of the population density over time varied between the plots, however, so that V2, with the highest initial breeding density, showed the most pronounced decline (Figure 3). The density in plot E likewise showed a significant decrease, while the density in plot K2 showed no trend. The best fit to describe the trends of the population densities in plot V2 and plot E was obtained by means of the cubic regression model (V2: $r^2=0.54$; E: $r^2=0.49$). This model indicates that the decreases in the plots V2 and E were most pronounced during about the first ten years. Later, in 1993–2010, the mean population densities in the two plots were similar (mean ± s.d.: 1.1 ± 0.21 and 0.9 ± 0.17 pairs/ha, respectively,). During the same period did on average 0.6 ± 0.10 pairs/ha breed in K2.

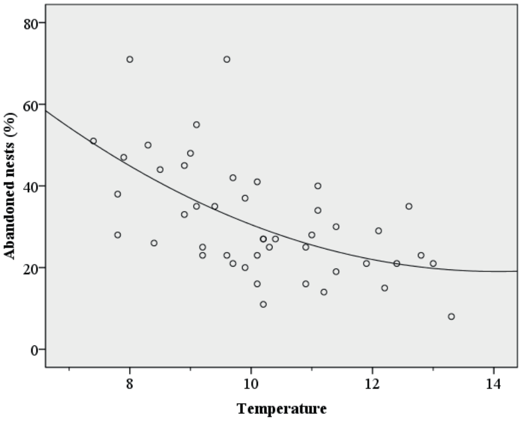

Figure 4. Regression (quadratic) of the yearly rate of abandoned nests (%) over mean temperature in June (C°).
*Samband mellan årlig andel övergivna bon och medeltemperaturen i juni.*
Pearson corr. r = –0.57; p<0.001.

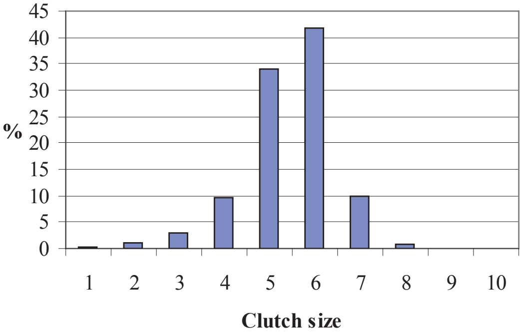

Figure 5. Distribution of clutch size, 1965–2010.
*Procentuell fördelning av kullstorlekar, 1965–2010.*
N = 4804 clutches.

*Breeding performance*

Breeding was interrupted in as much as 49.7% of the totally 6270 nests with complete or incomplete egg clutches in 1965–2010, for known reasons (nest predation 16%, disturbance by the researchers 1.9%, and female found dead 0.8%) or unconfirmed reasons (31%). The variation between years of the latter category was unrelated to predation rate, but strongly correlated with the mean daily air temperature in June (Figure 4).

The number of eggs in complete clutches varied between 1 and 10 eggs. Ninety-five percent of the clutches (without defect eggshells; see further below) contained four to seven eggs (Figure 5). A single clutch with ten eggs occurred. Such an extreme clutch size could be suspected to emanate from more than one contributing female. As, however, only one egg was laid per day (3–12 June 1974), one and the same female was observed to incubate the actual clutch, and hatching (6 young) occurred 15 days after the last egg was laid, all eggs were probably produced by that single female.

The average clutch size in 1965–2010 was 5.41 ± 0.356 s.d. eggs (clutches with defective eggshells excluded; See below!) (Appendix 1). The yearly

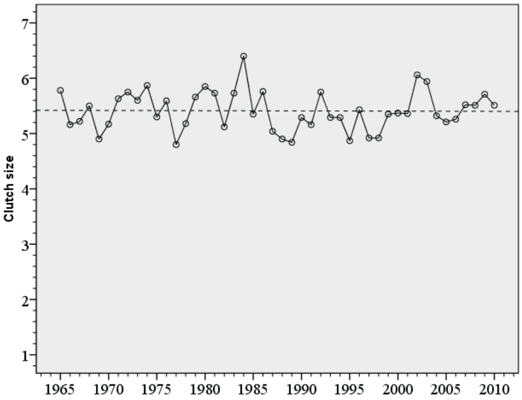

Figure 6. Variation and trend (linear regression line) of yearly mean clutch size, 1965–2010.
*Variation och trend hos årlig medelkullstorlek, 1965–2010.*
N = 4804 clutches.

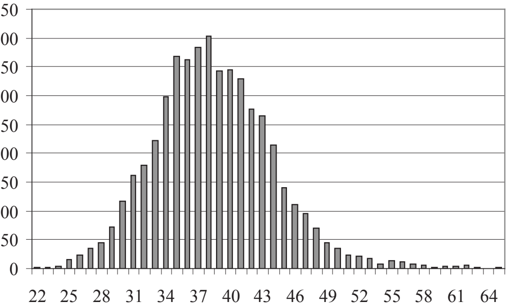

Figure 7. Distribution of date for start of egg laying 1965–2010 (except for 2003). Date from 1 May.
*Fördelning av datum för påbörjad äggläggning 1965–2010. (1 = 1 maj)*
N = 5009 clutches.

variation ranged from 4.80 to 6.40 eggs/clutch, and showed no trend over the years ($r^2 = 0.00$; ns) (Figure 6).

Clutch size was related to the date of laying, so that females that started later on average laid fewer eggs, that is the "calendar effect" (v. Haartman 1967). In 1965–2010 the laying started earliest at 22 May and latest at 4 July. Ninety-five percent of the clutches were initiated from 28 May to 18 June (Figure 7). The reduction rate of clutch size was 0.075 eggs for each successive day of delayed start according to the linear regression formula "Clutch size = 8.35–0.075*Date (from May 1st)" ($r^2$=0.95; $p<0.001$) (Figure 8). The yearly mean date of the start of egg-laying varied from 30 May (year 2000) to 15 June (1977) (Figure 9). Other years with early egg-laying were 1981, 1983, and 1984, while egg-laying was relatively late in 1991 and 1995. The yearly mean date of laying start was on average 7 June and showed no trend over the study period.

The yearly mean clutch size (normalised for laying date) was negatively correlated with population density in plots E (r=-0.23), V2 (r=-0.44), and K2 (r=-0.35.), though only significantly for the densest plot, V2 ($p<0.02$) (Figure 10).

Variation of clutch size with age was demonstrated by females that returned to breed one and/or two years after having been ringed as nestlings. Thirty-nine females at the age of one year started breeding on average on 9 June, one day later than the average date of the total population (8 June) and produced clutches of similar size (mean 5.33 eggs) as population average (5.40 eggs) the corresponding seasons. The mean laying date of the two years old females was on average four days earlier (2 June) than the population mean the corresponding seasons (6 June).The average clutch size of two years old females was 5.82 eggs (n=22) and the average for the total population was 5.52 eggs in the corresponding seasons. When standardised by the laying date, the mean clutch size of two years old females was similar to that of the total population (5,82–4*0.075 = 5.52), as was the average clutch size of the one year old females (5.33+7*0.075 = 5.86) to that of the two years old females.

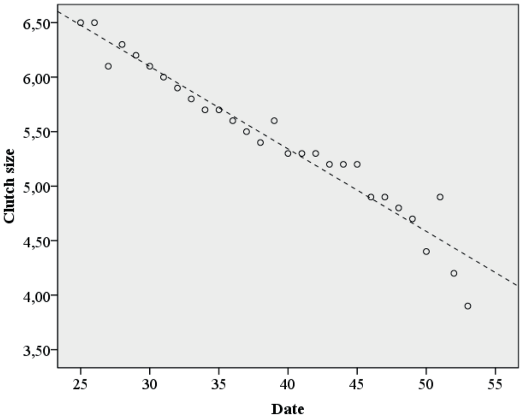

Figure 8. Average clutch size at different dates for start of laying, 1965–2010. Date from 1 May. (Clutches containing defective eggshells are excluded.)
Linear regression equation: Clutch size = –0.075 × Date + 8.35. N = 4106 clutches.
*Medelkullstorlek vid olika datum för värpstart. Datum från 1 maj. (Kullar med defekta äggskal är ej medtagna).*

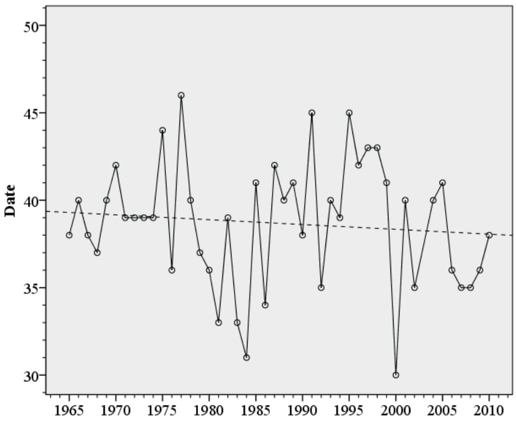

Figure 9. Variation and trend of the yearly mean date for start of egg laying 1965–2010 (except 2003). Date from 1 May.
*Variation och trend hos årligt medeldatum för värpstart, 1965–2010 (utom 2003) (1 = 1 maj).*

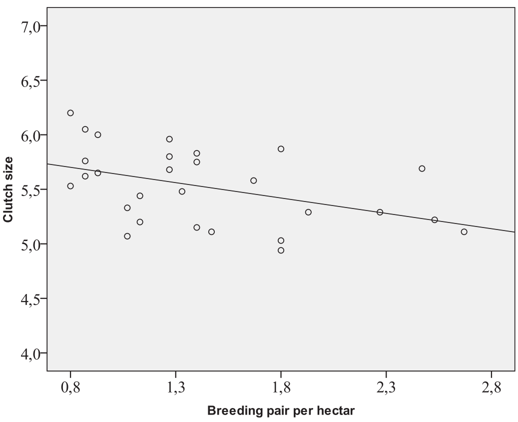

Figure 10. Linear relationship between clutch size (normalised for date of laying start) and density of breeding pairs in nest box plot V2, 1982–2010. Pearson correlation: r = 0.44; p<0.02.
*Samband mellan kullstorlek (normaliserad efter datum för värpstart) och täthet av häckande svartvit flugsnappare i holkgrupp V2, 1982–2010.*

Table 3. Rates of hatched eggs and surviving nestlings in different clutch categories, 1965–2010. All nest-box plots included.
*Andel kläckta ägg och överlevande boungar i olika kategorier av kullar, 1965–2010. Alla holkgrupper inkluderade.*

| Clutch category<br>*Kullkategori* | N | Hatched<br>*Kläckta*<br>Mean (%) | Fledged<br>*Flygga*<br>Mean (%) | Fledged/egg<br>*Flygga/ägg*<br>Mean (%) |
|---|---|---|---|---|
| All complete clutches<br>*Alla fullagda kullar* | 5216 | 62.8 | 75.2 | 48.4 |
| At least one hatchling<br>*Minst en kläckt unge* | 3811 | 86.0 | 75.3 | 65.2 |
| At least one fledgling<br>*Minst en flygg unge* | 3119 | 85.9 | 94.1 | 80.8 |

In the nest-boxes located nearest to Lake Stor-Tjulträsket (plots R, T2, and TO), and only occasionally in other boxes, a considerable number of the females produced eggs with defective shells (See further below!), usually combined with reduced clutch size. On average, 24% (N = 686) of the clutches in these boxes contained one to six defective eggs. The size of such clutches averaged 4.2 eggs (range 1–7 eggs). Eggs with defective shell were found in only nine (0.2%) of the clutches in the nest-box plots located distant from the lake. Also the mean size of the clutches with all eggs normal, was smaller in the plots along Stor-Tjulträsket than in the other nest-box plots, 5.19 eggs/clutch (1–8 eggs; 1488 clutches) and 5.56 (2–10 eggs; 3316), respectively (t-test: p<0,001), though the mean dates of laying start were similar (7 June).

Mean hatching rate of the eggs in complete clutches, 1965–2010, all plots included, was only 62.8% (Table 3). Hatching failed totally in 27% and partial hatching failure struck 18% of the clutches. Identified proximate causes for partial hatching failure were occurrence of unfertilised eggs, embryo mortality, and desiccation of the egg contents due to defective shell formation.

The rate of eggs which did not hatch varied much between years (range 14–77%; CV = 49%) (Figure 11).

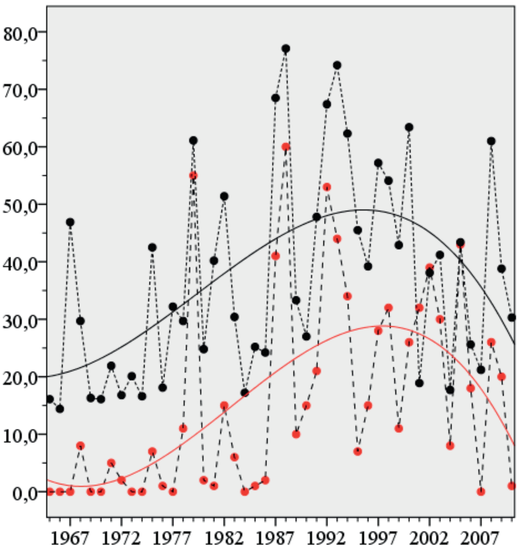

Figure 11. Variations in yearly mean rates of unhatched eggs in complete clutches (%) (black) and nest predation by mustelids (%) (red) are significantly correlated 1965–2010. (Pearson correlation: $r = 0.79$; $p<0.001$.)
*Variationerna av årliga andelen okläckta ägg i fullvärpta kullar (%) (svart) och bopredationen av mårddjur (%) (rött) är signifikant korrelerade1965–2010.*
Cubic regression lines over the study period are indicated.
*Kubiska regressionslinjer visas.*
Cubic regression: Hatching failure *Misslyckad kläckning* $r^2 = 0.34$; Predation rate *Andel prederade bon* $r^2 = 0.29$.

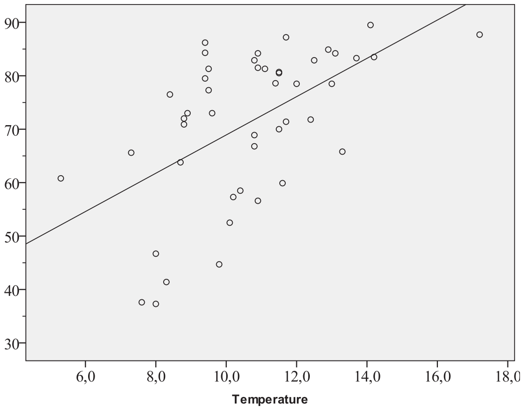

Figure 12. Linear regression of rate of hatched eggs (%) over daily mean temperature (C°) during the incubation period each year 1965–2010. (Clutches which were depredated or contained defective eggshells were excluded from the calculations.) $r^2 = 0.31$; $p<0.001$.
*Linjär regression av andel kläckta ägg (%) över daglig medeltemperatur (C°) under ruvningsperioden varje år, 1965–2010. (Kullar som var utsatta för predation eller som innehöll defekta ägg är undantagna från beräkningen.)*

Nest predation by mustelids and air temperature during the incubation period were the main factors that affected hatching rate. Together these factors accounted for 71% of the variation. Predation alone accounted for 62% of the yearly variation in hatching rate ($p<0.001$) (Figure 11). The best fit to describe the yearly variation in the hatching failure rate, as well as the predation rate, was obtained by the cubic regression model ($r^2 = 0.34$ and $r^2 = 0.29$, respectively). This model indicates that the rates of predation and hatching failure culminated in the 1990s.

Hatching success was about equally affected by predation in all nest-box plots. Typically the depredated clutches were totally destroyed. The yearly variation in hatching rate of the partially hatched clutches was insignificantly related to predation rate. The significant negative influence of low daily mean temperature during the incubation period on hatching success is illustrated in Figure 12.

The hatching rate varied between the nest-box plots if depredated clutches were excluded. The lowest hatching success was then in the plots located along Lake Stor-Tjulträsket, where eggs with abnormally porous shells were frequent. This was the main reason why only 26% of the eggs hatched in the clutches with eggshell defects (depredated clutches excluded) (Table 4).

Nest-box plots K1 and K2 showed the highest hatching rate. When losses due to depredation were excluded, the hatching rate of complete clutches in these plots amounted to 84.9% compared to 76.3% in the other plots distant from Lake Stor-Tjulträsket (F, G, E, V1, and V2) and 62.9% in the plots T1, T2, TO, and R. (Table 5).

The yearly nestling survival rate 1965–2010 varied considerably (range 27 to 98%; CV = 26%), and was on average 77.6%. Predation, air temperature, and outbreaks of autumnal moth larvae were factors studied for their influence on the nestling survival.

Nest predation caused the loss of about 6.0% of the nestlings in 1965 to 2010, and the yearly variations in nestling survival and predation rate were significantly correlated ($r = -0.30$, $p < 0.05$, $N = 46$). The nestling survival rate in 1965–2010 was on average 82% when depredated clutches were excluded from the calculations (Figure 13).

The yearly variation in mean temperature during the nestling period was not correlated to the nestling survival 1965 to 2010 ($r = 0.14$, $p=0.34$). In single years, however, bad weather caused reduced survival, e.g. in 1981, when low temperature (mean daily mean 10.6 °C) and continuous rain during

Table 4. Rates of hatched eggs and surviving nestlings in different categories of clutches with defective eggshells, 1965–2010. Depredated clutches excluded.
*Andel kläckta ägg och överlevande boungar i olika kategorier av kullar där något ägg hade defekt äggskal, 1965–2010. Prederade bon exkluderade.*

| Clutch category<br>*Kullkategori* | N | Hatched<br>*Kläckta*<br>Mean (%) | Fledged<br>*Flygga*<br>Mean (%) | Fledged/egg<br>*Flygga/ägg*<br>Mean (%) |
|---|---|---|---|---|
| All complete clutches<br>*Alla fullagda kullar* | 445 | 26.1 | 78.4 | 20.5 |
| At least one hatchling<br>*Minst en kläckt unge* | 188 | 53.6 | 78.4 | 42.1 |
| At least one fledgling<br>*Minst en flygg unge* | 151 | 50.6 | 94.7 | 48.4 |

Table 5. Rates of hatched eggs and surviving nestlings in three different categories of clutches in the nest-box plots K1, K2, plots F,G, E, V1, V2, and plots T1,T2,TO,R 1983–2010. Depredated clutches and those which contained defective eggshells are excluded.
*Andel kläckta ägg och överlevande boungar i tre olika kategorier av kullar i holkgrupperna K1, K2, grupperna F G, E, V1, V2 och grupperna T1, T2, TO, R 1983–2010. Kullar som rövats eller innehöll defekta ägg är exkluderade.*

| Clutch category<br>*Kullkategori* | Nest-box plots<br>*Holkområden* | N | Hatched<br>*Kläckta*<br>Mean (%) | Fledged<br>*Flygga*<br>Mean (%) | Fledged/egg<br>*Flygga/ägg*<br>Mean (%) |
|---|---|---|---|---|---|
| All complete clutches | K1+K2 | 638 | 84.9 | 91.8 | 77.9 |
| *Alla fullagda kullar* | F, G, E, V1, V2 | 1637 | 76.3 | 79.8 | 57.5 |
|  | T1, T2, TO, R, | 1269 | 62.9 | 84.5 | 51.6 |
| Succsessful *Lyckade* | K1+K2 | 592 | 91.3 | 91.8 | 83.7 |
| At least one hatchling | F, G, E, V1, V2 | 1409 | 88.3 | 79.8 | 70.5 |
| *Minst en kläckt unge* | T1, T2, TO, R, | 918 | 84.5 | 84.5 | 69.3 |
| Successful *Lyckade* | K1+K2 | 564 | 91.6 | 95.6 | 87.6 |
| At least one fledgling | F, G, E, V1, V2 | 1197 | 88.8 | 92.5 | 82.2 |
| *Minst en flygg unge* | T1, T2, TO, R, | 792 | 84.9 | 93.3 | 79.8 |

eleven days at the beginning of the nestling period was probably the main reason for the extremely low nestling survival rate that year. Also the low nestling survival in 1987 and 1990 coincided with periods of rainy weather combined with low mean temperatures (10.4 and 10.9 °C, respectively). The survival rate in 1988 was relatively high though the nestling period was equally rainy, but then the mean temperature was higher (15.3 °C). The low survival rate in 1977 was mainly due to high mortality during 12–15 July, which was a period with low air temperature (daily mean 6.6–10.7 °C) and predominantly young nestlings. Only a few clutches hatched before 5 July that season, due to late breeding start (Figure 9).

The yearly variation in nestling survival rate (after exclusion of depredated clutches) was correlated with the abundance (log) of autumnal moth larvae ($r_{1968–2010}= 0.36$, $p<0.02$). Abundance of autumnal moth larvae has varied a lot in the subalpine birch forest at Ammarnäs since 1968, when a standardised census program was started (Andersson & Jonasson 1980, Selås et al. 2001). Four outbreaks have occurred, 1973–1975, 1984–1986, 1993–1995 (relatively week), and 2003–2005 (http://www.luvre.org/insekter). In the years with outbreaks, especially high numbers of larvae were available as prey items for several bird species. As the periods with larvae usually lasted to about the first week of July these could be available as food items for the pied flycatcher nestlings. At three of the four outbreaks the nestling survival rates were

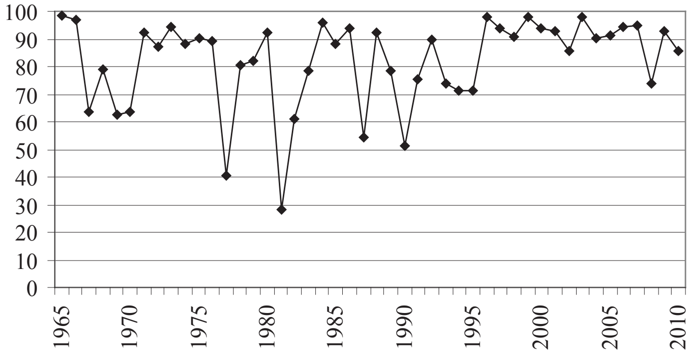

Figure 13. Variation in nestling survival (%) in 1965–2010. (Years with outbreak of *Epirrita* 1973–1975, 1985–1986, 1993–1995 (weak outbreak), and 2003–2005; from http://www.luvre.org/insekter.htm.) Depredated clutches excluded.
*Variation hos andel överlevande boungar 1965–2010. (År med utbrott av* fjällbjörkmätare *1973–1975, 1985–1986, 1993–1995 (svagt) och 2003–2005; hämtat från http://www.luvre.org/insekter.) Kullar som utsattes för predation är undantagna.*

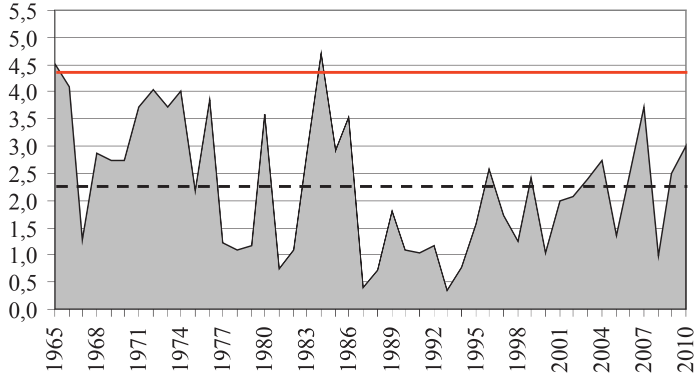

Figure 14. Variation in the number of fledglings per breeding pair 1965–2010. Broken line shows the total mean and red line indicates the number of fledglings needed to make the population self-reproducing.
*Variation hos antal flygga ungar per häckande par svartvit flugsnappare 1965–2010. Streckad linje visar medelantalet flygga ungar över perioden och röd linje anger det antal som behövs för att populationen skall anses vara självreproducerande.*

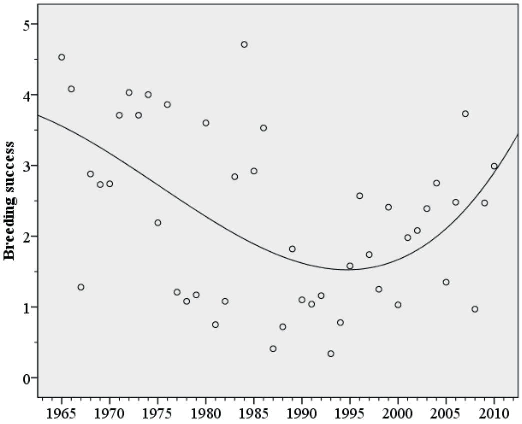

Figure 15. Variation in number of fledglings per breeding pair 1965–2010.
Line according to a cubic regression model; $r^2 = 0.27$.
*Variation hos antalet flygga ungar per häckande par 1965–2010.*
*Linjen enligt en kubisk regressionsmodell.*

higher than average (82%) (with depredated clutches excluded from the calculations) (Figure13).

Average nestling survival rate in 1969–2010 in nest-box plots K1 and K2 was higher (91.8%) than in the other plots distant from Lake Stor-Tjulträsk (79.8%), and in the broods along the lake (84.5%), when clutches being depredated and containing defect eggs were excluded from the calculations (Table 5). The survival of the nestlings from clutches which contained defective eggs was 78.4% (Table 4), i.e. at the same level as in the plots F, G, E, V1, and V2 (Table 5).

If depredated clutches were excluded from the calculation the average survival rate in plot K2 was similar during the periods 1983–1992 and 1993–2010 (91.2 and 92.0%, respectively), in contrast to varied survival rate in plots E + V2. Here, the nestling survival was lower during 1983–1992 (80.4%) than during 1993–2010 (92.5%). The lower survival rate in plots E+V2 during 1983–1992 resulted from total death in 15.6% of the broods (N

= 327) and partial death in 14.5% of the remaining clutches (N = 276). These rates were higher than during 1993–2010, when total death struck 5.4% (N = 296) and partial death occurred in 10.7% (N = 280) of the clutches. In plot K2 all nestlings died in 7.6% (N = 131) and 6.5% (N = 232) during 1983–1992 and 1993–2010, respectively, while partial death struck 9.9% (N = 121) and 6.9% (N = 217) of the clutches.

The breeding success, expressed as the yearly mean number of fledglings produced per breeding pair (i.e. all initiated clutches taken into account), was on average 2.26 fledglings (range 0.34–4.71) in 1965–2010 (Figure 14). The variation in the breeding success was best described by a cubic regression model ($r^2 = 0.27$) (Figure 15). This model indicates that the decreasing trend was broken in the 1990s and was followed by an increasing trend.

Linear regression analysis indicates that predation rate, clutch size, mean June temperature, and abundance of *Epirrita* larvae accounted for 62% of the yearly variation in mean breeding success. Predation rate tested alone explained 42% of the variation ($p<0.001$), clutch size 18% ($p=0.002$), mean June temperature 10% ($p<0.02$), and abundance of Epirrita 9% ($p<0.05$).

When all attempts were taken into account, breeding success in nest-box plot K2 (3.0 fledglings per pair) was better than in the other plots (1.8) in 1983 to 2010. Referring to successful broods only, the values were 4.2 and 3.1, respectively.

### *Eggshell defects*

Each year, 1965–2010, a number of Pied Flycatcher females breeding near the shore of Lake Stor-Tjulträsket laid eggs with defective shells. Typically, the shells were thinner than normal and more or less porous, or even, the eggs totally lacked a calcified shell. This anomaly was described by Nyholm & Myhrberg (1977). Nyholm (1981) suggested that the abnormality was associated with increased exposure of aluminium obtained by eating insects at the shore line. It was also proposed that the amount of aluminium available was enhanced due to increased release from the bedrock following environmental acidification.

The shell defects caused abnormal evaporation from the egg contents, which rapidly caused death of the embryos during incubation, and reduced hatching rate. However, the survival rate of nestlings that hatched in clutches with one or more defective eggs was not affected (cf. Tables 4 and 5).

The rate of females producing defective eggshells in the shore zone of Lake Stor-Tjulträsket increased during the study period (linear regression: $r^2=0.22$, $p<0.03$). A quadratic regression model, which gives a better fit ($r^2 = 0.47$, $p<0.001$), indicates that the rate increased during the first 25 years and then declined from the end of the 1990s (Figure 16).

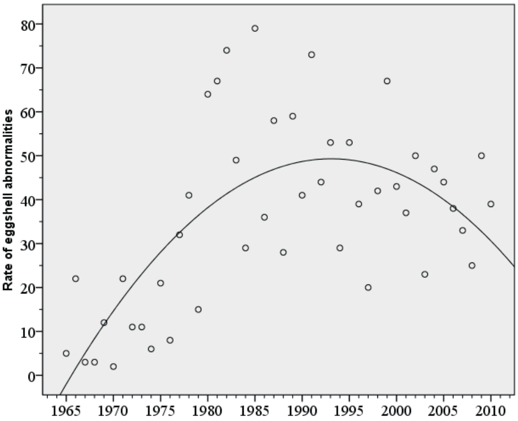

Figure 16. Variation in the rate (%) of pied flycatcher females who bred along lake Stor-Tjulträsket and produced defective eggshells 1965–2010. Regression line according to quadratic model; $r^2 = 0.47$.
*Variation hos andelen honor av svartvit flugsnappare som häckade vid Stor-Tjulträsket och värpte ägg med defekta skal. Regressionslinjen enligt en kvadratisk regressionsmodell;* $r^2 = 0.47$.

A two year study, 1975 and 1976, of the Pied Flycatcher clutches along the shore of Bissan, another lake in the Ammarnäs area, showed that 29% and 21% of the clutches, respectively, contained similarly defective eggs. Such eggs also occurred in nests of several other bird species breeding in the shore zone of Lake Stor-Tjulträsket: Common Sandpiper *Actitits hypoleucos*, Dunnock *Prunella modularis*, Bluethroat *Luscinia svecica*, Song-thrush *Turdus philomelos*, Redwing *Turdus iliacus*, Fieldfare *Turdus pilaris*, Willow Warbler *Phylloscopus trochilus*, Great Tit, Brambling *Fringilla montifringilla*, and Reed Bunting *Emberiza schoeniclus*.

The production of defective eggshells was only one of the obvious anomalies shown by Pied Flycatchers breeding along Lake Stor-Tjulträsket. Also a disproportionate part, 78% (39 out of 50), of the females found dead on their nests in 1965–2010, occurred in the nest-box plots by the lake, which constituted 41% of the total number of nests.

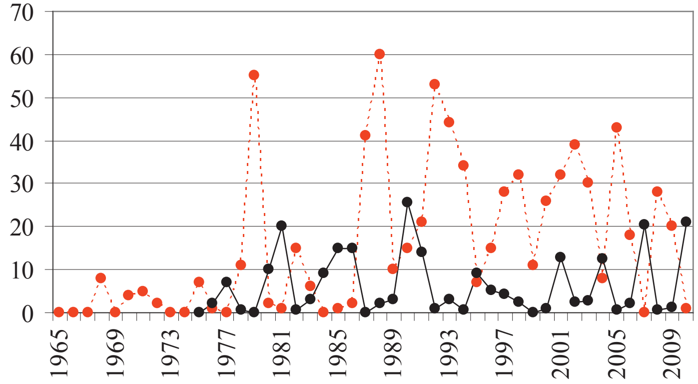

Figure 17. Variations of mustelid nest-predation rate (red) 1965–2010, and number of trapped small rodents (per 100 trap nights) (black) 1975–2010. Pearson corr. coeff. r= -0.50; p<0.002.
*Variationerna av andelen bon som rövades av vesslor (rött) 1965–2010, och antal smågnagare som fångades per 100 fällnätter (svart) 1975–2010.*

### *Nest predation*

Rate of nest predation varied significantly during the study period (range 0–56%). Small mustelids (stoats and least weasels) were by far the most frequent predators.

Nest predation by mustelids was almost absent during the initial twelve years, 1965–1986, and high only in 1979 in connection with collapses of the small rodent populations (Figure 17). Thereafter, however, the predation rate was frequently high and occurred yearly, i.e. during all phases of the small rodent cycles. Only in 2007 and 2010 it was again very low at dense small rodent populations. A cubic model of regression seems to show the overall pattern with a decreasing trend during the 2000s (Figure 18).

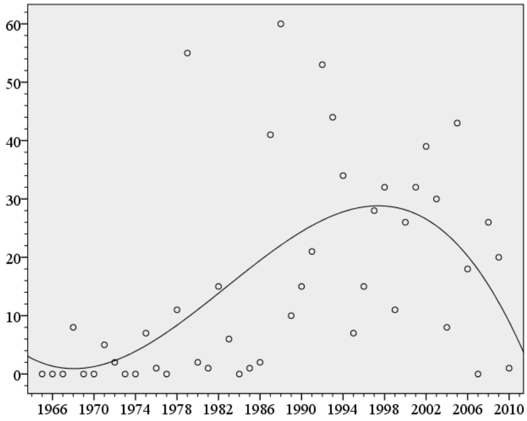

Figure 18. The yearly variation in the rate (%) of predation of pied flycatcher nests by mustelids 1965–2010. As illustrated by a cubic regression model (line): $r^2 = 0.34$.
*Den årliga variationen av andelen (%) bon av svartvit flugsnappare som prederades av mårddjur, presenterad med användning av en kubisk regressionsmodell;* $r^2 = 0.34$.

## Discussion

### *Population dynamics*

Pied Flycatchers are highly attracted to use suitable nest-boxes for breeding, as has been obvious in several studies carried out in a broad variety of forest habitats throughout the range of the species. In North-European habitats the introduction of nest-boxes may cause considerably increased local populations of different hole-nesting species, and predominantly Pied Flycatcher (e.g. von Haartman 1951, Meidell 1961, Campbell, 1968, Järvinen 1983, Sörensen et al. 1990, Nilsson 2008). This was true also in the sub-alpine birch forest at Ammarnäs, where on average 95% of the nest-box occupants were Pied Flycatchers and the remaining share was represented by five species.

The introduction of 116 nest-boxes in 1965, in the previously nest-box free forest, attracted 100 Pied Flycatcher pairs to breed within about 65 hectares, i.e. 155 pairs/km$^2$. That density was at that time more than ten times that in the surrounding 9 km$^2$ of similar forest surveyed by Enemar et al. (2004). The number of territories is known to closely equal the number of breeding pairs (Enemar et al. 1976). Thus, the introduction of the nest-boxes at once more than doubled the breeding Pied Flycatcher population on the mountain slopes. This suggests that the density of breeding pied flycatchers in the nest-box free part of the forest was restricted by lack of natural cavities suitable for breeding.

The yearly nest-box occupancy co-varied with the density of Pied Flycatcher territories in the birch forest outside the nest-box plots 1965–2010 (r = 0.55; p<0.001). Estimates of territory densities are available from 1963 to 2010 (years1963–1999: Enemar et al. 2004; years 2000–2010: Göran Paulson, in litt.).

Nest-box occupancy as well as territory density showed significant declining trends over the 46 years (Figure 2). The total population of Pied Flycatchers on the mountain slopes did thus decrease significantly during the study period. The indication that the decline of the nest-box breeding population was arrested from the 1990s (1990–2010: linear regression coefficient $r^2 = 0.00$; n.s.) was not found in the surrounding forest where the decline continued (1990–2010: linear regression coefficient $r^2 = 0.32$; $p<0.005$; Figure 2). The territory density of pied flycatchers outside the nest-box plots showed a relatively stronger decline than the population density in the nest-box plots. From 1983 to 2010, when the number and location of the nest-boxes were static (Table 1), an increasing share of the Pied Flycatchers on the whole mountain slope bred in nest-boxes (Figure 19). Thus, an allocation of breeding flycatchers to the nest-box plots from the surrounding forest took place without increasing the occupancy of the nest-boxes, but leaving potential breeding locations unoccupied in the surroundings.

The decreasing trend of the Pied Flycatcher population at Ammarnäs was syncronous with the large scale trend of other Swedish and European populations. These populations decreased 20–30% from the 1980s to 2009 (www.ebcc.info; Lindström et al. 2011; Ottvall et al. 2009). Several nest-box breeding Pied Flycatcher populations on the European continent showed decreasing trends since the 1970s (e.g. Coppack & Both 2002, Both et al. 2006), and in UK since 1990 (Goodenough et al. 2009), but others have reported increased populations (e.g. Winkel & Winkel 1998).

The declining trend of the nest-box breeding population at Ammarnäs was, however, also related to factors of more local character, of which the declining breeding success was the most significant proximate factor during the study period as a whole. The breeding success was significantly correlated to the nest-box occupancy in the two preceeding seasons (r= 0.55, p < 0.001 and r = 0.53, p<0.001, respectively). The rationale to test the influence of breeding success over two seasons is that a significant share of Pied Flycatchers does not breed until the age of 3K (Curio 1959, Harvey et al. 1985, Nyholm 1986). In turn, the yearly variation in breeding success was highly correlated with the rate of nest predation by mustelids. The variation in rate of nest predation 1965–2010 accounted for 45% of the variation in breeding success, and 37% of the variation in occupancy the subsequent year. The variation in breeding success was also significantly correlated with clutch size and June temperature. Together with nest predation rate they accounted for 74% of the variation. The variation in predation rate was the only of these factors that showed any significant trend over the years. The density of territories outside the nest-box plots was also significantly related to the predator activity (as judged from the predation rates in the nest-boxes) (linear regression: $r^2 = 0.13$, $b = -0.09$, $F = 6.1$, $p<0.02$), indicating that the predators operate similarly in the whole nine square kilometre study area.

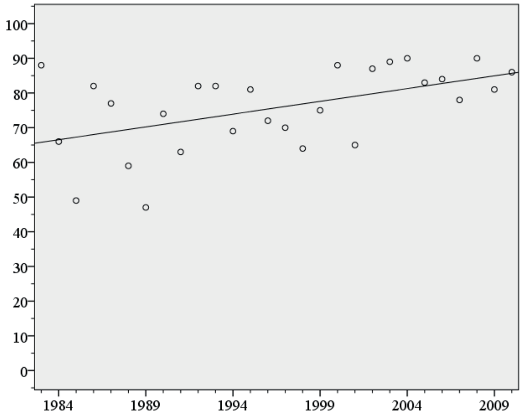

Figure 19. Linear regression over the years 1983–2010 of the share of the pied flycatcher population on the mountain slopes (9 km$^2$) which bred in the nest-boxes. ($r^2 = 0.23$;$b = 0.74$; $p<0.01$).
*Linjär regression av andelen av populationen av svartvit flugsnappare på fjällsluttningarna (9 km$^2$) som bodde i holkarna åren 1983–2010.*

On average about 92% of the breeding females were yearly recruited from outside the nest-box plots; only about 8% returned in the subsequent year (range 0–26%; N = 3775; 1966–2010) with no trend over time ($r^2 = 0.04$, $p = 0.19$). The mean return rate of fledglings was 1.1% (Nyholm 1986) and of breeding males at about 24% (Nyholm & Myhrberg 1983). The return rate of the females was negatively influenced by nest predation the preceding breeding season (Figure 20), which consequently also had some impact on the breeding population size.

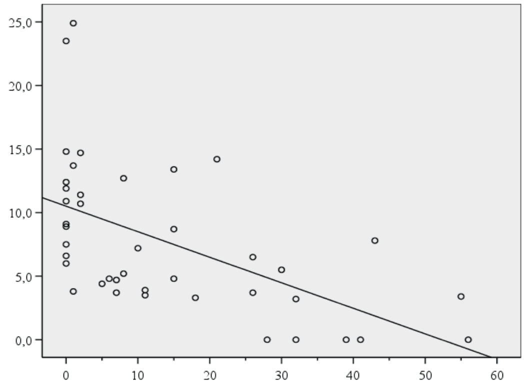

Figure 20. Linear regression of female return rate (%) year x+1 over rate of nest predation year x 1965–2009; $r^2 = 0.31$, $p<0.001$. Based on 4204 ringed females (47–178 per year). *Linjär regression av andelen (%) häckande honor som återvände år x+1 över andelen prederade bon år x 1965–2009;* $r^2 = 0.31$, $p<0.001$. *Baserat på 4204 ringmärkta honor (47–178 per år).*

Thus, to have a significant impact on the nest-box occupancy at Ammarnäs the affecting factors could not be only local but must have a concurrent impact in a larger area. That area could be very wide as judged from recoveries of ringed individuals. For example, two nestlings (females) ringed at Ammarnäs were recovered when breeding (2K) at Kilpisjärvi in northern Finland (about 400 km NNE), another nestling bred later at Tärnaby (46 km SW), and two individuals which were ringed at Gauto (50 km NNE) as nestling (male) and 2K female, respectively, bred at Ammarnäs the subsequent year. All these nestlings were born and recovered as breeders in subalpine habitats which indicates faithfulness to their birth habitat. The yearly rate of nest predation varied in relation to the phase of the small rodent population cycles, which, in turn, was synchronized over a wide subalpine area, extending hundreds of kilometres southwards and northwards of Ammarnäs (Hörnfeldt 2010).

In many long term nest-box studies (Table 6) it has been observed that the number of breeding Pied Flycatchers decreases during the initial one to two decades. In the present study, that was obvious in most of the study plots which were established in 1977–1983, i.e. plots E, V2, R, and TO. The decreasing trends in V2 and E (Figure 3) appeared to be density dependent as the decline rate was greater in V2, the initially most densely inhabited plot. In both plots the decreasing trends were discontinued after some ten years to get stabilised when the population densities had reached about 1 pair/ha (Figure 3). In comparison, the population density in plot K2 (on average 0.6 pairs/ha) did not show any trend during 1983–2010. A pattern similar to that shown by plots E and V2 can be visualised from data presented by Virolainen (1984). In two nest-box plots with an about three-fold difference in population density, the density decreased in the densest plot from about 2 pairs to about 1 pair per hectare during the twelve study years ($r^2 = 0.73$, b= -0.087; $p<0.001$) whereas in the less dense plot the trend was less accentuated (from about 0.7 to 0.5 pairs per hectare ($r^2 = 0.24$, b= -0.036; $p<0.05$).

This initial decrease of nest-box breeding popu-

Table 6. Linear regression of nest-box occupancy by Pied Flycatchers over years from the start of different studies: $r^2$ is the linear regression coefficient and b the regression slope.
*Linjär regression med andel holkar bebodda av svartvit flugsnappare över år från början av olika studier:* $r^2$ *är regressionskoefficienten och b regressionens lutning.*

| Reference | Period | $r^2$ | b | p |
|---|---|---|---|---|
| Campbell (1968) (GBR) | 1949–1964 | 0.58 | -0.83 | <0.001 |
| Källander et al. (1987) (S. Sweden) | 1962–1978 | 0.43 | -1.16 | <0.002 |
| This study (all nest-box plots) | 1965–2010 | 0.56 | -0,83 | <0.001 |
| This study (plots E, V2, R, TO) | First 20 years | 0.80 | -1.43 | <0,001 |
| This study (plots K2) | First 20 years | 0.19 | -1.05 | <0.03 |
| Schmidt (1986) "Optimaler Biotop" | 1971–1981 | 0.74 | -2.39 | <0.001 ¹⁾ |
| Schmidt (1986) "Pessimaler Biotop", M. Germany | 1971–1981 | 0.78 | -5.56 | <0.001 ¹⁾ |
| Virolainen (1984) (4 boxes/ha) (S. Finl.) | 1972–1983 | 0.79 | -2,50 | <0.001 |
| Virolainen (1984) (1 box/ha) (S. Finl.) | 1971–1983 | 0.24 | -2.05 | =0.05 |
| Thingstad et al. (2006) ( S. Norway) | 1986–2000 | 0.58 | -2,34 | <0.001 |
| Thingstad et al. (2006) (M. Norway) | 1986–2000 | 0.82 | -1,42 | <0.001 |
| Nilsson (2008) (S. Sweden) | 1986–2000 | 0.84 | -1.46 | <0.001 |

¹⁾ Based on number of breeding Pied Flycatchers. *Baserat på antal häckande svartvit flugsnappare.*

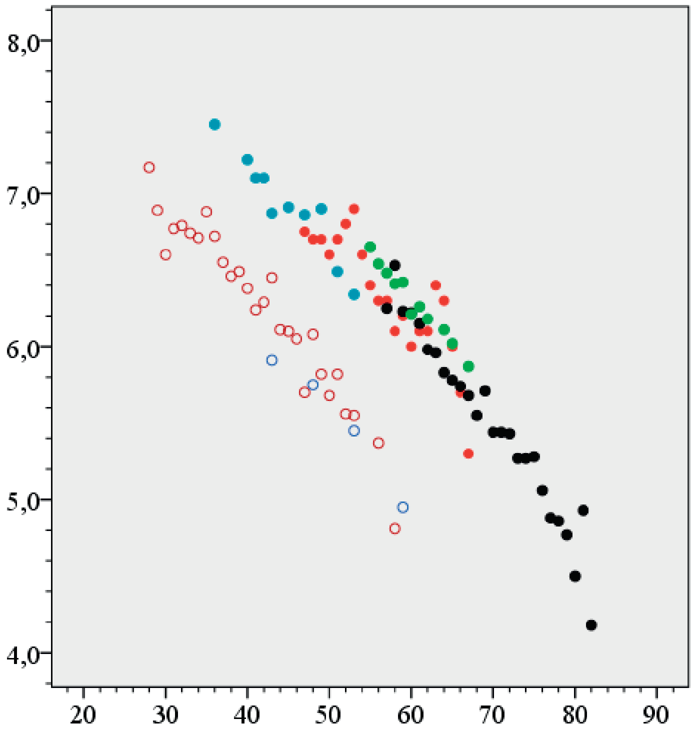

Figure 21. Average clutch size over date of laying start (1 = 1 April) of Pied Flycatcher at various geographic locations.
*Medelkullstorlek över datum (1 = 1 april) för värpstart hos svartvit flugsnappare på några geografiskt skilda platser.*

lations of Pied Flycatcher observed in many studies could tentatively be related to an over-establishment in relation to the carrying capacity of the habitat. The finding by Schmidt (1986), that Pied Flycatcher populations decreased more rapidly in pessimal than in optimal habitats, may support the idea that the initially decreasing density trends may be associated with depletion of food resources. That may also be supported by the observation in this study, that clutch size was smaller at higher population densities than at lower (V2; Figure 10), and that the nestling survival in the nest-plots E+V2 was lower during the first ten seasons, 1983–1992: on average 80% (n = 327 broods), when the population density was decreasing, than when the density had got stabilised at a lower population density, 1993–2010: 93% (n=296 broods). In plot K2, with stable low population density, nestling survival was 91% (n=131) and 92% (n=232), respectively, in the same periods. In all these cases depredated broods were excluded from the calculations.

As suggested from the rather stable population densities that the nest-box plots E and V2 reached after some ten seasons, a long term population density limit could be set to about one breeding pair/ha in the actual subalpine habitat (Figure 3). This density was about ten times higher than the mean territory density in the surrounding forest. Different habitats may carry different densities of breeding Pied Flycatchers, e.g. Winkel (1989) reports no trend (1957–1988) for a nest-box breeding population where the mean density was about 2 pairs/ha.

### *Breeding performance*

The primary ultimate factor that influenced clutch size was the time schedule of egg laying. The decrease rate of the clutch size with the progress of the breeding season at Ammarnäs was 0.075 eggs per day of delay, which agrees with that found in other studies on the Pied Flycatcher, on the European continent (Creutz 1955, Berndt & Winkel 1967, Zang 1975), in Britain (Lack 1966), and Fenno-Scandinavia (v. Haartman 1967, Järvinen 1980, Virolainen 1984, Lundberg & Alatalo 1992). But, the British and Fenno-Scandinavian populations lay larger clutches than the continental in relation to laying date (cf also v. Haartman 1967) (Figure 21).

The northern position and relatively high altitude of the study area, and accordingly an increased risk of hazardous weather in early spring, contributed to delayed breeding start (cf. Järvinen 1989b). This narrowed the margin between clutch size and the number of fledglings needed for self-maintenance of the population. That margin was on average less than one egg in more than half the number of the seasons (Figure 6) if on average 4.4 fledglings per pair are needed (Järvinen 1983).

Late female arrival and/or daily mean temperature below 5–6°C at end of May and beginning of June delayed the breeding start (Figure 22). The examples showing the situations in 1977 and 1991 illustrate delays caused by long periods with low temperatures. In 1975, some of the earliest arriving females were obviously triggered to start breeding during a mild period in the second half of May. A following period of colder weather probably temporarily hampered the egg laying and delayed the mean breeding start of the population. In 1995, the breeding start was late despite an extended mild period at the end of May and beginning of June. In that year the delay must be ascribed to late female arrival rather than unfavourable local weather. Early start of egg-laying (as in 1981, 1984, 1986, and 2000) occurred when the females arrived at a relatively early date and the weather conditions were favourable.

The average clutch size of one year old females was about 0.5 eggs smaller than that of two year old females, a difference which disappeared if clutch size was standardised by the laying date. Berndt & Winkel (1967) found the same difference but in contrast to the finding in the present study the difference still remained after taking account of a few days later breeding start of the one-year old females.

The breeding success varied much between years, but the number of fledglings was generally far below that needed for the population to be self-reproducing. That production was reached in only two of the forty-six seasons, and on average did only 2.26 fledglings leave the nests (Figure 14). In three of the seasons the production was less than one potential recruit per nest. During the study period, the nest-box breeding population at Ammarnäs has thus been a typical sink population, which had to be supplied with breeders from source populations elsewhere (Thingstad et al. 2006).

A number of factors contributed to low recruitment rate. A substantial factor was the high rate of total failures, almost 50% already during the laying phase, primarily due to nest predation, and abandoned nests during periods of low air temperature. Abandoned nests were especially frequent in the nest-box plots along Lake Stor-Tjulträsket. Other factors were poor hatching success and poor nestling survival. The variation in hatching rate was significantly correlated with nest depredation rate and mean air temperature during the incubation period, and these two factors explained 72% of the variation. In the nest-box plots R, T and TO, situated along Lake Stor-Tjulträsket, reduced hatching was also due to the occurrence of defective egg-shells.

Nest predation was also the primary single factor affecting nestling survival. More than a thousand nestlings (6%) were lost in that way. Depredation of nest-box populations by small mustelids, and its relation to density of small rodent populations, has since long been recognised in several areas in Europe (Dunn 1977, Järvinen 1990). The greatest variation in mustelid predation rate can be expected in geographic areas with cyclic populations of small rodents, as in northern Scandinavia, where mustelid populations can be built up during the high density rodent phases which typically appear every three to four years. The increased rate of nest-predation which occurred in the study area from mid-1980s to 2000s was probably related to increased mustelid populations as a consequence of reduced fox populations. An epizootic mange among foxes became prevalent in north-western Sweden in the early 1980s (Lindström et al. 1994). Increased mustelid (*Martes*) populations have been observed in consequence of decreased fox populations (Storch et al. 1990). Reduced fox populations and occurrence of cyclic small rodent populations, as in northern Scandinavia, should favour the build up of abnormally dense mustelid populations during the high rodent population phases. In these circumstances, subsequent crashes of the rodent populations may lead to abnormally high predation pressure on alternative prey species, and cause the extensive nest predation on Pied Flycatchers which occurred from the mid-1980s. Probably the observed "outbreak" of nest-predation by mustelids should be regarded as an episodic phenomenon, though long lasting, and that the relatively low predation rates in 2007–2010 as a return to the normal predation situation for the subalpine habitat (Figure 18). This implies that nest predation by mustelids is important only during the first breeding season after crashes of the cyclic small rodent populations, as seen in the present study in 1965–1986 and in the sub-alpine habitat at Kilpisjärvi 1966–1987 (Järvinen 1990). In a study of nest-box breeding flycatchers performed in a similar habitat about 20

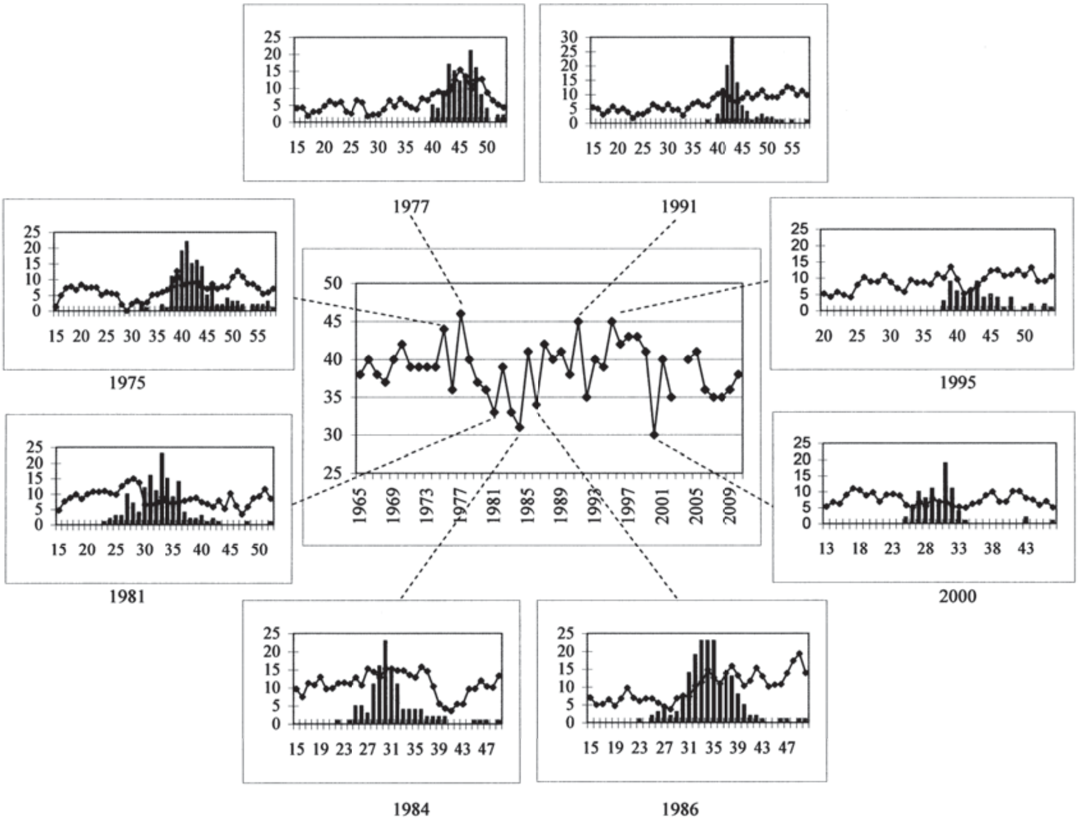

Figure 22. Variation in yearly mean date of laying start (1 = 1 May) 1965–2010, and some examples showing daily numbers of initiated clutches (bars) and daily mean temperature (line) (C°) (y-axis) from 15 May and onwards (x-axis). See text for further comments.
*Variation av medeldatum för värpstart (1 = 1 maj) 1965–2010, och några exempel som visar antal dagligen påbörjade kullar (staplar) and daglig medeltemperatur (C°) (y-axeln) från 15 maj och framöver (x-axeln). Se texten för vidare kommentarer.*

km SE of Ammarnäs was however no predation recorded during 1971–1985 (Svensson 1987).

Climatic factors, as low temperature and rainfall, contributed more or less to restrict the breeding success of the Pied Flycatchers by influencing breeding start, hatching success and nestling survival. The temperatures during female arrival, breeding start, incubation, and the nestling period, have varied between years without showing any trend over the study period. Järvinen (1983) states that egg formation is triggered at Kilisjärvi, in northernmost Finland, only after the daily mean temperature has reached about 6 °C. That limit seems to be valid also at Ammarnäs, where the first eggs of the year were laid about five days after that temperature limit was reached. These five days equals the time its takes for an egg follicle to ripen, ovulate, and the completed egg to be laid (von Haartman 1990). Relatively low temperatures, especially when combined with long rainy periods, could strongly affect the breeding result of Pied Flycatcher by forcing incubating females to leave their breeding cares for long periods (days), and even to abandon their nests, or by making it harder for the parents to feed their young properly.

The nest predation and the production of defective eggshells, two factors which had a strong negative impact on the breeding result of the Pied Flycatcher, occurred in the study area with the highest rates so far reported. The proximate cause why Pied Flycatchers and birds of other species breeding in the vicinity to Lake Stor-Tjulträsket produce defective eggshell was suggested to be environmental acidification (Nyholm 1981). An increas-

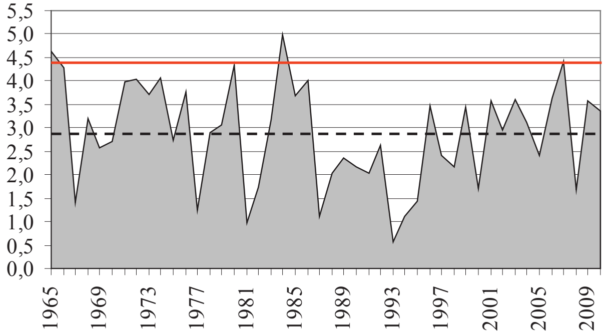

Figure 23. The variation in the numbers of fledglings per breeding pair 1965–2010, if clutches with defective eggshells and depredated clutches are excluded from the calculations. Broken line shows the total mean and the red line indicates the number of fledglings needed to make the population self-reproducing. *Variationen av antalet flygga ungar per häckande par 1965–2010 om kullar med defekta äggskal och kullar rövade av mårdjur ej var med i beräkningarna. Streckad linje visar det totala medeltalet flygga ungar och röd linje anger det antal som behövs för att populationen skall vara självreproducerande.*

ing share of the pied flycatcher females which bred along the lake became affected until mid-1980s, a share that subsequently decreased significantly during the following twenty years (Figure 16). This time schedule fits well with that of the variation in the sulphur deposition in Sweden, which has decreased to less than half of the levels recorded in 1970 (Fölster & Wilander 2002). Anonymous (2007) showed that the deposition of acidifying agents in 1980 strongly exceeded the critical load for lakes in northern mountain areas of Sweden, including the Ammarnäs area (>700 ekv/ha/year). The decreased deposition rate since then resulted in that no excess of the critical load for the lakes occurred in 2002–2004. This admits recovery from acidification in the lakes, which, as suggested by the decreasing rate of defective eggshell production observed in birds, also favours the terrestrial ecosystem in the vicinity of the lakes. With the indicated rate of recovery the incidences of defective eggs will disappear, i.e. return to the normal level, in some 15–20 years.

Besides in the shore zone along Lake Stor-Tjulträsket, occurrence of naturally breeding pied flycatchers which regularly produced defective eggshells have only been observed in severely heavy metal polluted environments (Nyholm 1995).

The tendency of improved breeding result of the pied flycatchers in the study area which was initiated in the 1990s (Figure 15) was strongly related to decreased predation pressure. In perspectives of a continuously declining predation rate to the situation before 1987 one could expect a significant concomitant improvement of the breeding performance of the pied flycatchers in the study area.

Still, if the predation of nests ceases completely, and the environmental problems indicated by the laying of defective eggs disappear, i.e. during more “normal” conditions, it seems probable that the nest-box breeding Pied Flycatcher population at Ammarnäs would produce too few fledglings to be self-reproducing, and thus remain a sink population (Figure 23 ) (Appendices 1 and 2).

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## Sammanfattning

Endast ett fåtal studier av svartvit flugsnappares häckningsbiologi har gjorts i fjällbjörkskogen, i periferin av artens utbredningsområde i norra Skandinavien.Väderförhållandena kan här vara speciellt kärva och varierande under och mellan häckningssäsongerna. Ogynnsamt väder påverkar häckningsresultaten kraftigt. Även de kraftiga cykliska populationsvariationerna hos smågnagare och fjällbjörkmätaren i fjällbjörkskogen påverkar fåglars häckning direkt eller indirekt. Det har påvisats häckningsstörningar hos svartvit flugsnappare och flera andra arter invid sjöar i undersökningsområdet vid Ammarnäs, sannolikt på grund av miljöförsurning. Långtidsstudier som denna behövs för att identifiera och utvärdera faktorer som långsiktigt påverkar fåglarnas häckning.

### *Metoder*

Studierna gjordes 1965–2010 huvudsakligen i rik fjällbjörkskog 500–650 m ö h, på sydsluttningarna av lågfjällen Gaisatj och Valle, ca 8 km väster om Ammarnäs. Holkar var uppsatta i separata grupper (Figur 1) med varierande holktäthet (Tabell 1). Varje säsong noterades antalet häckningar, datum för häckningsstart, kullstorlek samt antal kläckta och utflugna ungar. Kriteriet för häckning var att minst ett ägg värpts. Äggen inspekterades med avseende på skalkvalitet. Antal övergivna bon (t.ex. på grund av bopredation, framför allt av små mårddjur) noterades. Fåglarna ringmärktes, ungarna vid minst 5 dygns ålder. I holkgrupperna K1 och K2 (Kontrollgrupp) iakttogs speciell försiktighet för att minimera risken för störning av de häckande fåglarna. Ringmärkning gjordes t.ex. först under ung-perioden, då störningskänsligheten är minst. Smågnagare (främst sorkarter och fjällämmel) inventerades med ”småkvadrat-metoden”, vilken är standard. Väderuppgifterna avlästes vid SMHI:s stationer i Ammarnäs eller vid andra jämförbara stationer i regionen.

### *Beläggning i holkarna*

Svartvit flugsnappare utgjorde 95% av fåglarna som häckade i holkarna. Övriga arter var talgoxe, rödstjärt, göktyta, lappmes och blåmes. Beläggningen av svartvit flugsnappare i holkarna var högst (86%) under startåret 1965. Under 1965–2010 minskade beläggningen signifikant. Minskningen var speciellt påtaglig fram till 1990-talet. Därefter stabiliserades beläggningen till ca 25–40% av holkarna (Figur 2). Beläggningen i holkarna samvarierade med tätheten av flugsnapparrevir i den omgivande björkskogen 1965–2010. Även där visade revirtätheten minskande trend. Beläggningarna i de olika holkgrupperna samvarierade signifikant under åren (Tabell 2), men minskade olika kraftigt under studieperioden. I grupperna V2, E och K2 (etablerade i början av 1980-talet) hade beläggningens minskning samband med tätheten av häckande par. Ju tätare population, desto kraftigare var den (Figur 3). Efter ca 10–15 år var tätheten på samma nivå i V2 och E (medeltäthet 1993–2010: 1,1 par/ha i V2 och 0,9 i E). I K2 där tätheten av häckande par var lägst, på grund av lägst holktäthet (medeltäthet ca 0,6 par/ha) saknades trend. Även i flera andra långtidsstudier av holkhäckande svartvit flugsnappare kan man se att beläggningen i holkarna minskade, speciellt under de första 10–15 åren (Tabell 6).

Min hypotes är att tätheten hos dessa holkhäckande populationer i början blivit så hög att habitatet långsiktigt utarmats på födoresurser, med minskande populationer som följd. I K2, där ingen minskning skedde, underskreds det kritiska täthetsvärdet för utarmning i fjällbjörkskogen. Att döma av populationsutvecklingen i V2 och E var den kritiska tätheten ca 1 par/ha. Den tätheten är ca 10 gånger högre än revirtätheten för svartvit flugsnappare i den omgivande skogen (Figur 2).

Minskningen av den häckande populationen i Ammarnäs var synkron med minskningen av andra svenska och europeiska populationer (20–30% från1980-talet). Minskningen i Ammarnäs hade emellertid också samband med faktorer av mera lokal karaktär, framför allt sådana som påverkade häckningsresultaten. Häckningsresultatet under en säsong påverkade nämligen beläggningen signifikant, inte bara året efter, (r=0,55, p<0,001) utan även efter två år (r=0,53, p<0,001), beroende på att många individer häckar först som 3K. På grund av den låga ortstroheten för häckande honor och ungar, ca 8% respektive 1,1%, hade emellertid häckningsresultaten endast liten effekt på senare års beläggning i Ammarnäs. Det starka samband som fanns måste betyda att häckningsresultaten i holkarna återspeglade resultaten inom ett betydligt större område. Ringmärkning visar att de flugsnappare som för första gången häckar i Ammarnäs kan komma från områden som ligger hundratals kilometer bort.

### *Häckningsförlopp*

Svartvit flugsnappare hade stora problem att lyckas med häckning i fjällbjörkskogen. Hela 49,7% av 6266 häckningar avbröts av olika anledningar 1965–2010. Avbrutna häckningar var speciellt vanliga i holkgrupperna vid Stor-Tjulträsket. Den främsta kända orsaken till att häckningar inte fullföljdes var bopredation (16%), medan 31% övergavs av okänd anledning. Det fanns dock ett starkt samband mellan andel övergivna kullar och låga temperaturer under juni månad (Figur 4).

Kullstorlekarna varierade mellan 1 till 10 ägg (Figur 5), i medeltal 5,41 ägg (gäller kullar utan ägg med defekta skal; se nedan!). Variationen mellan åren, från 4,80 till 6,40 ägg, uppvisade ingen trend (Figur 6). Nittiofem procent av kullarna påbörjades under perioden 28/5 till 18/6 (Figur 7). Sen ankomst för honorna och/eller dygnsmedeltemperaturer under 5–6°C försenade starten för äggläggning (Figur 22). Kullstorleken minskade vid senare värpstart ($r^2$=0.95) (Figur 8). Ett-åriga honor började i genomsnitt värpa senare än de två-åriga. Om hänsyn tas till att kullstorleken minskade 0,075 ägg per dygn senare värpstart, värpte ett-åriga honorna lika stora kullar som två-åriga honor. Medeldatum för värpstarten varierade mellan åren utan att visa någon trend (Figur 9). I holkgrupp V2 hade kullstorleken signifikant negativt samband med populationstätheten (Figur 10).

I holkarna närmast Stor-Tjulträsket (i grupperna R, T2, TO) fanns ägg med defekta skal i 24% av kullarna (Se vidare nedan!). Defekta ägg fanns i endast 0,2% av kullarna i övriga holkar. Kullarna med defekta ägg var mindre (genomsnittligt 5,16 ägg) än de ”normala” kullarna (5,56 ägg). Totalt under åren kläcktes endast 62,8% av äggen i de fullagda kullarna (Tabell 3). I 27% av dessa kläcktes inga ägg alls, medan bara delar av äggkullarna kläcktes i 18%. Andelen okläckta ägg varierade mycket mellan åren (14–77%; Figur 11).

Kläckningsresultaten påverkades framför allt av bopredation av vesslor, men också av temperaturen under ruvningsperioden (Figur 12). Såväl andelar bon rövade av vesslor som misslyckade kläckningar kulminerade under 1990-talet (Figur 11). Bopredation drabbade alla holkgrupper lika mycket. Kläckningsresultaten var bäst i K1 och K2 (84,9% av äggen) och sämst i holkgrupperna vid Stor-Tjulträsket (62,9%) (Tabell 5) (exkl. bon som rövades eller innehöll defekta ägg).

Andelen ungar som blev flygga varierade avsevärt mellan åren och var i genomsnitt 77,6%. Bopredation var den enskilda faktor som mest påverkade överlevnaden hos boungarna (6% av ungarna förlorades). I de bon som inte rövades överlevde 82% av ungarna. Medeltemperaturen under ungperioden hade obetydlig påverkan på ungöverlevnaden. Dock orsakade kyligt och regnigt väder under tidig bounge-period stor dödlighet enstaka år, särskilt 1977 och 1981 (Figur 13). Ungarnas överlevnad var korrelerad med förekomsten av fjällbjörkmätarlarver (r=0,36, p<0,02). Vid de tre perioderna med kraftiga utbrott av larver nådde överlevnaden av ungarna de högsta nivåerna, ca 90% (Figur 13). Andelen överlevande boungar, i bon som inte rövades, var 91,8% i holkgrupperna K1 och K2. I grupperna närmast Stor-Tjulträsket överlevde 84,5% medan 79,8% överlevde i övriga grupper (Tabell 5).

Boungarnas överlevnad i holkgrupperna V2 och E varierade mellan olika perioder. Under 1983–1992, då tätheten hos de häckande bestånden var minskande (Figur 3) överlevde en mindre andel boungar (80,4%; bortsett från rövade bon) än under 1993–2010 då tätheten minskat till en betydligt lägre och stabil nivå (92,5%). I K2 där beståndstätheten var stabil och lägre överlevde 91,2% respektive 92.0% av ungarna under motsvarande perioder. Detta kan vara ett ytterligare tecken på att tätheten i V2 och E, men inte i K2, under den tidiga perioden överskred en kritisk nivå för utarmning av habitatet. Genomsnittligt häckningsresultat för perioden1965–2010, uttryckt som medelantal flygga ungar per häckande par, var 2,26 ungar (från 0,34 till 4,71 ungar) (Figur 14). Detta antal är långt under de 4,4 ungar/häckande par som behövts för att populationen skulle vara självreproducerande. Det antalet producerades bara under två av åren. Figur 15 illustrerar att de årliga häckningsresultaten genomsnittligt minskade fram till 1990-talet och ökade därefter.

### *Äggskalsdefekter*

Varje år förekom att flugsnapparhonor som häckade invid Stor-Tjulträsket värpte ägg med defekta skal. Skalen var tunnare än normalt och porösa, och kalkskal kunde också saknas helt. Defekterna medförde att äggen torkade in under ruvningen. Även flera andra arter som häckade vid sjön värpte ägg med samma defekter. Andelen flugsnapparhonor som värpte defekta ägg ökade under de första ca tjugofem åren, men minskade igen från slutet av 1990-talet (Figur 16). Uppkomsten av skaldefekterna har sannolikt samband med ökad exponering, via födan, för aluminium som frisatts från marken i högre grad på grund av miljöförsurning.

Variationsmönstret för andelen defekta ägg stämmer tidsmässigt överens med nedfallet av försurande ämnen över Sverige. Detta har minskat kraftigt sedan mitten av 1980-talet. Nedfallet i Ammarnäsområdet och angränsande delar av fjällkedjan är nu så lågt att det medger återhämtning från försurning. Den minskande andelen defekta ägg under de senaste 15–20 åren indikerar den pågående återhämtningen.

### *Bopredation*

Andelen flugsnapparbon som rövades, framför allt av vesslor, varierade från 0% till 56% under 1965–2010. Variationen mellan åren var korrelerad med smågnagarnas populationcykler (Figur 17). Då smågnagarpopulationerna kraschat utgjorde fåglarna alternativ föda för vesslepopulationerna som byggts upp under de rika smågnagaråren. Under perioden 1965–1986 förekom bopredation sällan, förutom i samband med kollapsen av smågnagarpopulationen 1979. Andelen rövade bon ökade sedan avsevärt, men minskade igen under 2000-talet (Figur 18). De mycket låga andelarna rövade bon under 2007 och 2010, toppår för smågnagarpopulationen, antyder att predationen åter normaliseras till nivåerna före 1986. Predationens variationsmönster överensstämmer tidsmässigt med utbrottet av rävskabb i regionen. Minskade rävpopulationer ledde sannolikt till större vesslepopulationer under flera år.

### *Slutsatser*

Studien visar att häckningsresultatet påverkades av de ofta kärva väderförhållanden som är normala för fjällbjörkskogen i Ammarnäsområdet. Onormalt omfattande bopredation av vesslor och förekomst av defekta ägg var faktorer av tillfällig (men långvarig) art, som starkt bidrog till låga häckningsresultat.

Min hypotes är att hög populationstäthet i en del nyetablerade holkgrupper utarmade habitatets födoresurser. Följden blev minskande populationstäthet, till stabil nivå efter 10–15 år. Flugsnapparpopulationen var inte självreproducerande, och kommer sannolikt inte heller att vara det när bopredationen återgått till det normala och defekta ägg inte längre förekommer (Figur 23).

Appendix 1. Clutch size distribution and mean clutch size 1965–2010. Clutches which contained defective eggshells are excluded. N is number of clutches.

*Fördelning av kullstorlekar och medelkullstorlek 1965–2010. Kullar som innehöll ägg med defekt skal undantagna. N är antal kullar.*

| | Clutch size *Kullstorlek* | | | | | | | | | | N | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | | *Medel* |
| 1965 | | 2 | 1 | 6 | 15 | 52 | 17 | 2 | | | 95 | 5.82 |
| 1966 | | 1 | 1 | 8 | 35 | 22 | 2 | | | | 69 | 5.19 |
| 1967 | 1 | | 3 | 12 | 34 | 30 | 3 | 2 | | | 85 | 5.24 |
| 1968 | | 2 | 1 | 10 | 27 | 59 | 8 | | | | 107 | 5.53 |
| 1969 | 2 | 2 | 9 | 27 | 64 | 39 | 2 | | | | 145 | 4.89 |
| 1970 | | 3 | 4 | 23 | 71 | 72 | 2 | | | | 175 | 5.21 |
| 1971 | | 1 | 2 | 11 | 43 | 88 | 15 | 1 | | | 161 | 5.64 |
| 1972 | | 2 | | 8 | 36 | 70 | 24 | 2 | | | 142 | 5.77 |
| 1973 | | 1 | 1 | 14 | 46 | 72 | 18 | 2 | | | 154 | 5.62 |
| 1974 | 1 | 1 | 9 | 4 | 40 | 88 | 48 | 4 | | 1 | 196 | 5.88 |
| 1975 | | 3 | 4 | 14 | 61 | 64 | 6 | 3 | | | 155 | 5.35 |
| 1976 | | | 8 | 8 | 28 | 45 | 20 | 1 | | | 110 | 5.58 |
| 1977 | | 1 | 6 | 21 | 72 | 13 | 1 | | | | 114 | 4.82 |
| 1978 | | | 4 | 23 | 49 | 39 | 7 | | | | 122 | 5.18 |
| 1979 | | | 1 | 10 | 44 | 70 | 17 | 1 | | | 143 | 5.66 |
| 1980 | 1 | 1 | 1 | 1 | 23 | 55 | 16 | | | | 98 | 5.79 |
| 1981 | 1 | 1 | 2 | | 38 | 79 | 17 | | | | 138 | 5.74 |
| 1982 | 1 | 1 | 11 | 15 | 36 | 43 | 5 | 2 | | | 114 | 5.13 |
| 1983 | | | 3 | 4 | 39 | 79 | 17 | | | | 142 | 5.73 |
| 1984 | | | | 1 | 14 | 44 | 47 | 7 | | | 113 | 6.40 |
| 1985 | | | 3 | 14 | 31 | 44 | 5 | | | | 97 | 5.35 |
| 1986 | | 1 | 3 | 7 | 43 | 85 | 27 | 2 | | | 168 | 5.77 |
| 1987 | 1 | 1 | 3 | 25 | 69 | 38 | 3 | | | | 140 | 5.04 |
| 1988 | | 4 | 4 | 16 | 43 | 30 | 2 | | | | 99 | 4.98 |
| 1989 | | 3 | 4 | 17 | 55 | 19 | 1 | 1 | | | 100 | 4.90 |
| 1990 | | | 3 | 5 | 64 | 38 | 3 | | | | 113 | 5.29 |
| 1991 | | 2 | 4 | 4 | 38 | 29 | 3 | | | | 80 | 5.21 |
| 1992 | | | 1 | 2 | 29 | 51 | 12 | | | | 95 | 5.75 |
| 1993 | | | 3 | 9 | 12 | 24 | 3 | | | | 51 | 5.29 |
| 1994 | | 1 | 1 | 6 | 25 | 22 | 4 | | | | 59 | 5.32 |
| 1995 | | | 4 | 12 | 33 | 10 | 1 | | | | 60 | 4.87 |
| 1996 | | | 1 | 4 | 31 | 30 | 3 | | | | 69 | 5.43 |
| 1997 | | 3 | 3 | 19 | 48 | 30 | 1 | | | | 104 | 4.98 |
| 1998 | 1 | 3 | 2 | 13 | 23 | 20 | 3 | | | | 65 | 4.94 |
| 1999 | | 1 | 2 | 8 | 27 | 26 | 8 | | | | 72 | 5.38 |
| 2000 | 1 | 2 | 4 | 7 | 15 | 28 | 10 | 1 | | | 68 | 5.38 |
| 2001 | | 2 | | 3 | 31 | 24 | 5 | 1 | | | 66 | 5.42 |
| 2002 | | | 1 | 3 | 6 | 36 | 15 | 2 | | | 63 | 6.06 |
| 2003 | | | 1 | 4 | 22 | 37 | 22 | 3 | | | 89 | 5.94 |
| 2004 | | | 3 | 5 | 35 | 26 | 4 | | | | 73 | 5.32 |
| 2005 | | 1 | 2 | 10 | 34 | 27 | 1 | 2 | | | 77 | 5.23 |
| 2006 | 1 | 1 | 5 | 9 | 26 | 35 | 7 | | | | 84 | 5.27 |
| 2007 | | 1 | 4 | 6 | 24 | 43 | 11 | | | | 89 | 5.54 |
| 2008 | | | 3 | 12 | 23 | 52 | 8 | | | | 98 | 5.51 |
| 2009 | | 1 | 3 | 7 | 7 | 36 | 14 | 1 | | | 69 | 5.74 |
| 2010 | | | 1 | 8 | 23 | 39 | 5 | | | | 76 | 5.51 |

Appendix 2. Number of eggs, hatched eggs (Hatch), and fledged (Fledg) in all clutches, in clutches where at least one egg hatched, and in clutches where at least one nestling fledged. N is number of clutches. Depredated clutches and clutches with defective eggs are excluded.

*Antal ägg, kläckta ägg (Kläck) och flygga ungar (Flygg) i alla kullar, i kullar där minst ett ägg kläcktes och i kullar som gav minst en utflugen unge. N är antal kullar. Kullar som rövades eller innehöll defekta ägg är undantagna.*

| | All clutches *Alla kullar* | | | | At least one egg hatched *Minst ett ägg kläcktes* | | | | At least one nestling fledged *Minst en unge blev flygg* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Eggs *Ägg* | Hatch *Kläck* | Fledg *Flygg* | N | Eggs *Ägg* | Hatch *Kläck* | Fledg *Flygg* | N | Eggs *Ägg* | Hatch *Kläck* | Fledg *Flygg* | N |
| 1965 | 552 | 465 | 458 | 94 | 526 | 465 | 458 | 89 | 526 | 465 | 458 | 89 |
| 1966 | 358 | 314 | 304 | 69 | 348 | 314 | 304 | 66 | 348 | 314 | 304 | 66 |
| 1967 | 445 | 199 | 127 | 85 | 245 | 199 | 127 | 46 | 171 | 140 | 127 | 33 |
| 1968 | 549 | 401 | 317 | 99 | 464 | 401 | 317 | 82 | 411 | 354 | 317 | 72 |
| 1969 | 648 | 541 | 339 | 132 | 609 | 541 | 339 | 122 | 456 | 409 | 339 | 92 |
| 1970 | 891 | 726 | 462 | 171 | 834 | 726 | 462 | 158 | 665 | 571 | 462 | 125 |
| 1971 | 862 | 715 | 661 | 153 | 794 | 715 | 661 | 140 | 781 | 702 | 661 | 136 |
| 1972 | 796 | 676 | 590 | 138 | 741 | 676 | 590 | 127 | 713 | 649 | 590 | 122 |
| 1973 | 865 | 698 | 658 | 154 | 790 | 698 | 658 | 140 | 746 | 669 | 658 | 132 |
| 1974 | 1132 | 953 | 839 | 192 | 1062 | 953 | 839 | 176 | 1022 | 915 | 839 | 169 |
| 1975 | 720 | 459 | 414 | 137 | 553 | 459 | 414 | 96 | 516 | 431 | 414 | 96 |
| 1976 | 621 | 505 | 451 | 111 | 574 | 505 | 451 | 102 | 536 | 472 | 451 | 95 |
| 1977 | 537 | 381 | 154 | 111 | 445 | 381 | 154 | 92 | 228 | 192 | 154 | 48 |
| 1978 | 549 | 392 | 316 | 106 | 453 | 392 | 316 | 87 | 405 | 347 | 316 | 78 |
| 1979 | 363 | 254 | 209 | 64 | 289 | 254 | 209 | 51 | 263 | 233 | 209 | 46 |
| 1980 | 551 | 457 | 421 | 95 | 512 | 457 | 421 | 87 | 487 | 437 | 421 | 83 |
| 1981 | 750 | 492 | 138 | 131 | 536 | 492 | 138 | 93 | 240 | 195 | 138 | 41 |
| 1982 | 495 | 301 | 183 | 98 | 368 | 301 | 183 | 73 | 263 | 212 | 183 | 53 |
| 1983 | 724 | 521 | 408 | 126 | 584 | 521 | 408 | 101 | 478 | 431 | 408 | 83 |
| 1984 | 711 | 613 | 588 | 111 | 662 | 613 | 588 | 104 | 649 | 601 | 588 | 102 |
| 1985 | 480 | 400 | 353 | 90 | 449 | 400 | 353 | 84 | 408 | 364 | 353 | 76 |
| 1986 | 931 | 731 | 687 | 162 | 815 | 731 | 687 | 141 | 781 | 704 | 687 | 135 |
| 1987 | 326 | 171 | 93 | 64 | 211 | 171 | 93 | 41 | 124 | 108 | 93 | 25 |
| 1988 | 161 | 106 | 98 | 35 | 112 | 106 | 98 | 24 | 106 | 100 | 98 | 23 |
| 1989 | 397 | 265 | 208 | 82 | 299 | 265 | 208 | 59 | 267 | 238 | 208 | 53 |
| 1990 | 523 | 421 | 215 | 99 | 465 | 421 | 215 | 88 | 269 | 234 | 215 | 50 |
| 1991 | 277 | 162 | 122 | 54 | 183 | 162 | 122 | 35 | 134 | 125 | 122 | 26 |
| 1992 | 244 | 138 | 124 | 42 | 161 | 138 | 124 | 28 | 155 | 133 | 124 | 27 |
| 1993 | 102 | 38 | 28 | 20 | 46 | 38 | 28 | 10 | 30 | 28 | 28 | 6 |
| 1994 | 186 | 70 | 50 | 35 | 97 | 70 | 50 | 18 | 70 | 52 | 50 | 13 |
| 1995 | 260 | 149 | 106 | 53 | 180 | 149 | 106 | 37 | 125 | 108 | 106 | 25 |
| 1996 | 303 | 241 | 236 | 56 | 274 | 241 | 236 | 51 | 274 | 241 | 236 | 51 |
| 1997 | 359 | 215 | 202 | 73 | 243 | 215 | 202 | 49 | 232 | 208 | 202 | 47 |
| 1998 | 148 | 129 | 117 | 30 | 148 | 129 | 117 | 30 | 138 | 121 | 117 | 28 |
| 1999 | 348 | 250 | 245 | 65 | 279 | 250 | 245 | 52 | 279 | 250 | 245 | 52 |
| 2000 | 304 | 126 | 118 | 58 | 152 | 126 | 118 | 29 | 147 | 121 | 118 | 28 |
| 2001 | 215 | 169 | 157 | 40 | 187 | 169 | 157 | 35 | 171 | 158 | 157 | 32 |
| 2002 | 209 | 187 | 160 | 34 | 203 | 187 | 160 | 33 | 183 | 169 | 160 | 30 |
| 2003 | 353 | 273 | 267 | 60 | 288 | 273 | 267 | 48 | 283 | 268 | 267 | 47 |
| 2004 | 356 | 300 | 271 | 67 | 348 | 300 | 271 | 65 | 334 | 290 | 271 | 62 |
| 2005 | 283 | 195 | 178 | 55 | 239 | 195 | 178 | 46 | 222 | 180 | 178 | 43 |
| 2006 | 437 | 343 | 323 | 83 | 397 | 343 | 323 | 74 | 382 | 332 | 323 | 71 |
| 2007 | 493 | 401 | 380 | 89 | 433 | 401 | 380 | 77 | 418 | 388 | 380 | 74 |
| 2008 | 351 | 164 | 121 | 63 | 193 | 164 | 121 | 35 | 146 | 122 | 121 | 27 |
| 2009 | 302 | 231 | 214 | 54 | 260 | 231 | 214 | 45 | 243 | 218 | 214 | 42 |
| 2010 | 419 | 306 | 262 | 76 | 344 | 306 | 262 | 63 | 301 | 270 | 262 | 56 |

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# The migrations of Finnish Bean Geese *Anser fabalis* in 1978–2011

*Flyttning hos finska sädgäss* Anser fabalis *1978–2011*

LEIF NILSSON

## Abstract

Bean Geese *Anser fabalis* have been neck-banded extensively in the breeding areas in northern Finland during two periods: 1978–1994 and 2002–2009. The observations of these geese showed marked differences in timing of migration and location of wintering and staging areas between the two periods. The Bean Geese stayed further to the north in south Sweden during the autumn in the latter period and arrived later to wintering areas in southernmost Sweden. Moreover they did not go to the Netherlands and western Germany during cold winters in the second as they did in the first period. Spring migration started earlier in the second period. Most patterns revealed by the Finnish neck-banded geese were the same as those shown by the Bean Geese in general as observed by the national goose counts in southern Sweden.

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## Introduction

During the 1970s, there was much concern for the situation of the breeding Bean Goose populations of northernmost Fennoscandia, and the Nordic Collegium for Wildlife Research (NKV) established a special working group in 1975 with the task to run a Nordic Bean Goose Project (Nilsson & Fog 1984). The studies undertaken within this program included several different aspects of the ecology of Bean Geese such as breeding ecology (Pirkola & Kalinainen 1984), non-breeding ecology and censuses (Nilsson & Persson 1984), and migration studies (Lampio 1984, Nilsson 1984, Tveit 1984). The project also led to the start of regular goose monitoring in Sweden (Nilsson 2000).

The studies of Bean Goose migration was based on individual neck-banding of geese in different areas and searches for the marked geese on the staging and wintering areas. After the termination of the NKV project this neck-banding project continued as a joint Finnish-Swedish project (Nilsson & Pirkola 1986, 1991).

Whereas most other goose populations have shown positive development, this has not been the case for the Taiga Bean Goose *Anser f. fabalis* which is breeding in northern Fennoscandia and further to the east in Russia (Nilsson et. al. 1999, Fox et al. 2010). During the 2000s there was a renewed interest in the Bean Geese of northern Fennoscandia. In Sweden, discussions concerning Bean Goose management started with the debate related to a major railroad through one of the most important spring staging areas at Umeå in northern Sweden (*Botniabanan*). At the same time, a national Bean Goose Project was started in Finland. The studies in both countries included neck-banding programs.

The regular goose counts in Sweden have shown marked changes in the distribution of staging Bean Geese in southern Sweden during early autumn, from Scania to sites up to about 500 km to the north, such as Tåkern and Kvismaren (Nilsson 2000, 2008). In the present contribution I will analyze the observations of neck-banded Finnish Bean Geese and compare the migration patterns for the two different marking periods that are characterized by these different staging patterns. This paper does not analyze the migratory movements of Bean Geese within Finland with the exception that observations in April in Finland are included for comparison with movements along the Swedish coast of the Bothnian Sea.

Neck-band observations were to a large extent

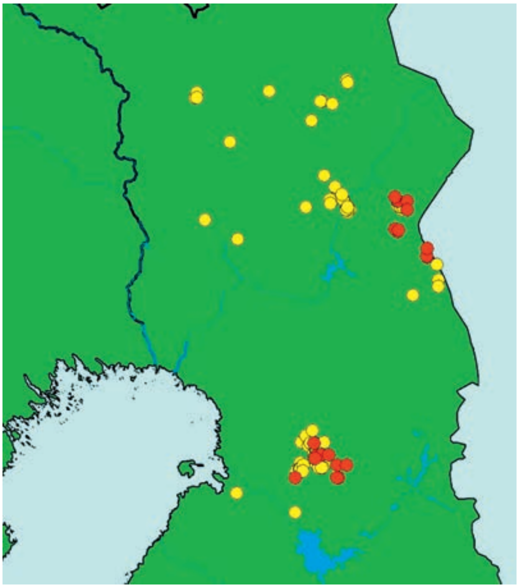

Figure 1. Marking places for Finnish neck-banded Bean Geese *Anser fabalis*. Yellow = marked before 2000, red = marked after 2000.
*Märkplatser för finska halsbandsmärkta sädgäss* Anser fabalis*. Gul = märkta före 2000, röd = märkta efter 2000.*

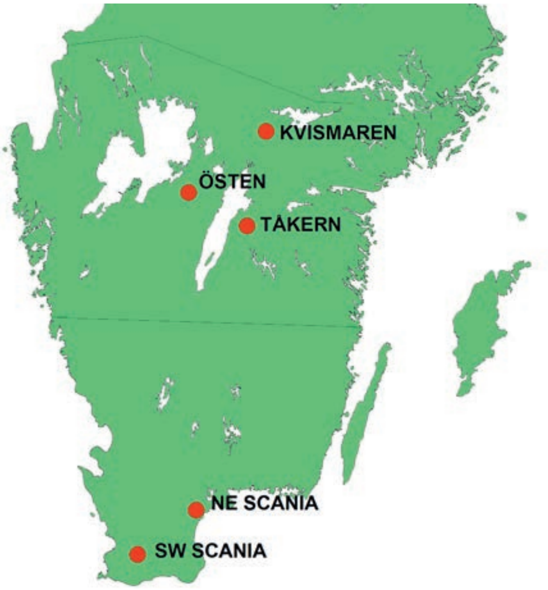

Figure 2. Important staging and wintering areas for Bean Geese *Anser fabalis* in south Sweden.
*Viktiga rast- och övervintringslokaler för sädgäss* Anser fabalis *i södra Sverige.*

obtained directly from the observers. In addition to this, the Finnish Bird Ringing Office has put all records of marked and observed neck-banded Bean Geese at my disposal.

## Material and methods

Neck-banding of Bean Geese in the Nordic countries started in south Sweden in 1976 and in Finland in 1978 as a part of the Nordic Bean Goose Project (Nilsson1984). Bean Geese were captured in Finland both on spring staging areas, moulting areas and breeding areas. On staging areas cannon nets were used, whereas moulting and flightless families were captured on the breeding grounds using different methods described in Pirkola & Kalinainen (1984).

During the Nordic Bean Goose Project, orange neckbands with a three digit code were used in Finland, Norway and Sweden. The same type of neckbands but of a more red colour was used in the second period of catching in Finland, the neckbands having either two-digit or three-digit codes.

During 1978–1994, 710 Bean Geese were neckbanded in Finland. The activity was resumed in 2002, and through 2009 another 173 Bean Geese were neck-banded. In the analysis below the number of individuals checked in the latter period is somewhat higher as some birds from the markings in the 1990s still survived. The geographical positions of the marking areas are shown in Figure 1.

The main staging areas in south Sweden mentioned in the text are shown in Figure 2. For further details of the distribution of staging and wintering Bean Geese in Sweden see Nilsson (2000).

## Results

During the first period, 1978–1994, a total of 5400 observations of Bean Geese that had been neckbanded in Finland were reported, whereas 2010 observations were reported in the second period 2002–2009. However, these totals include observations within Finland, which are not analyzed here. From outside Finland, 3038 neck-band readings were available from the first and 1108 from the second period.

Finnish Bean Geese arrive into Sweden in September–October, with the majority in October.

They arrive within a quite narrow zone at the coast of the province of Uppland after a passage over the Åland archipelago between Finland and Sweden. In general, the neck-banded Bean Geese from Finland were found in the eastern part of mainland Sweden from the arrival area in Uppland south to the province of Scania (Figure 3). A number of observations were also obtained from Denmark, Germany and the Netherlands, mainly from the winter (Figure 4). Only small numbers were found in the western part of south Sweden.

Some differences in distribution of neck-band readings from the two time periods were found, although the general picture was more or less the same. Within Sweden, one striking difference between the two periods is the much lower number of neck-bands reported from Tåkern in the latter period compared to the first period. There is also a tendency of fewer readings in southwestern Scania during the second period, but this difference is more apparent when each month is analyzed separately.

During the first period several reports of Finnish neckbands were obtained from the Netherlands with a few observations also from Schleswig-Holstein in Germany and Jutland in Denmark. Observations from these areas are totally lacking for the second period. Finnish Bean Geese were still found to a similar extent in the Danish Isles and also in the northern parts of eastern Germany.

In September, neck-band observations of Finnish Bean Geese were mostly from the province of Uppland and the Kvismaren area, but a few observations were also noted at Lake Tåkern. In the first period there were also three records from further south, including one from the German/Polish border.

October is the peak month for staging Bean Geese in Sweden (Nilsson 2000, 2008). The majority of the neck-band readings were reported from Kvismaren and Tåkern with smaller numbers from the other sites. During the first period, Kvismaren and Tåkern were both very important areas with more than 100 neck-band readings each, whereas Tåkern had lost much of its importance during the second period. In the first period, southwestern Scania was also much used by the Finnish Bean Geese with several neck-bands reported, but only

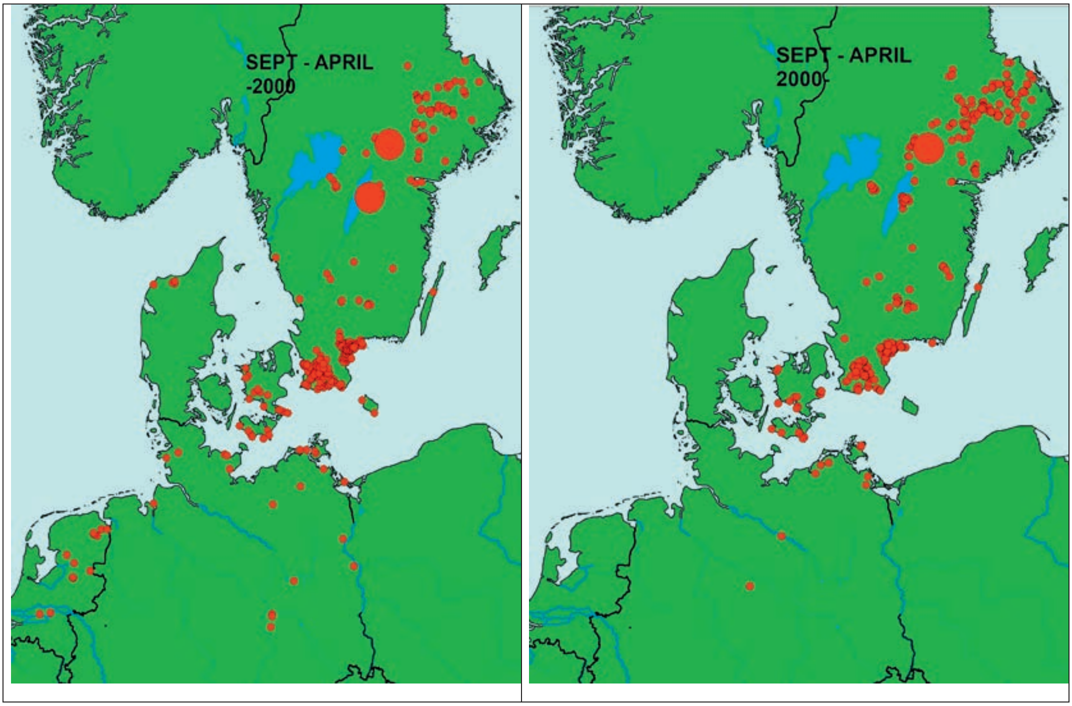

Figure 3. Observations of neck-banded Finnish Bean Geese *Anser fabalis* from September–April before 2000 (left) and after 2000 (right).
*Observationer av halsbandsmärkta finska sädgäss* Anser fabalis *från september–april före 2000 (vänster) och efter 2000 (höger).*

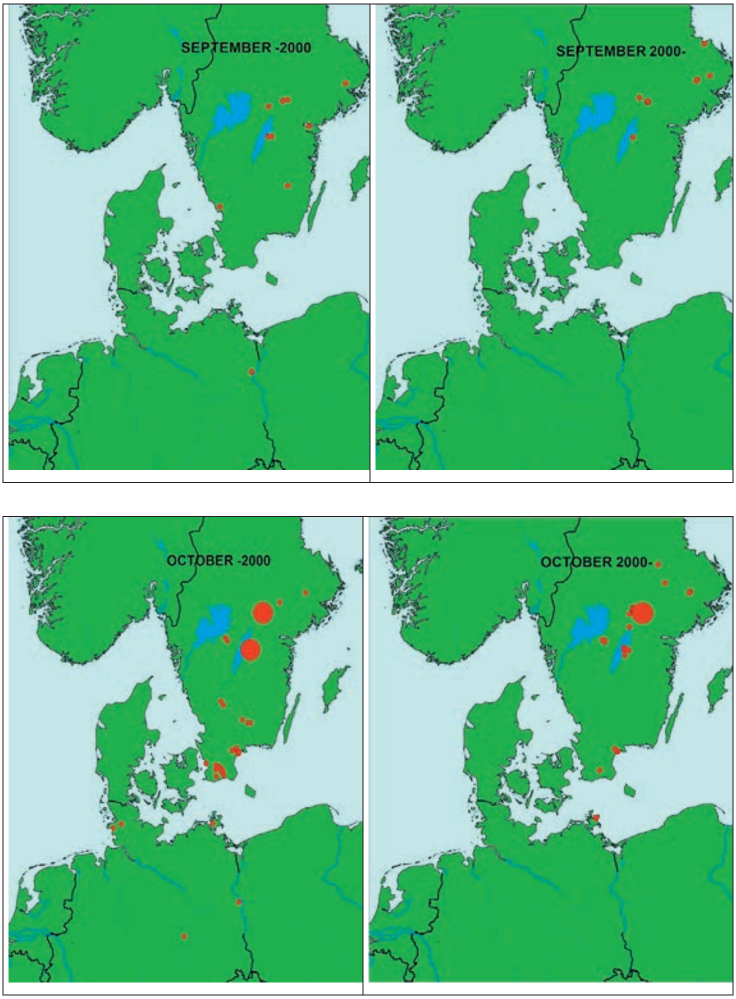

Figure 4. Observations of neck-banded Finnish Bean Geese *Anser fabalis* from different months during September–April before 2000 (left) and after 2000 (right). Note that observations from Finland are included for April to allow comparisons with the Swedish coast of the Bothnian Sea. *Observationer av halsbandsmärkta finska sädgäss* Anser fabalis *från olika månader under september–april före 2000 (vänster) och efter 2000 (höger). Notera att finska observationer visas på kartan för april för att möjliggöra jämförelser med den svenska sidan av Bottenhavet.*

one observation was reported here in October during the second period.

November and December are transition months between the autumn staging period and the winter period, and the distribution of the Bean Geese is much influenced by the weather. With early frost the geese leave the northern staging areas and more geese are found in Scania. Still there were some marked geese remaining at the northern sites in November, in mild winters also in December. These northern observations in November and December were relatively more frequent than in Scania during the second period.

January and February are more typical winter months. Most neckband readings were reported from Scania, both from the southwestern and the northeastern part. Comparing these two parts for the winter months do not reveal any marked differences in the total picture. Some neckband readings were also obtained from further north in Sweden, mostly from mild winters.

March is normally a spring migration period for the Bean Geese in south Sweden with observations all the way from Scania to the province of Uppland, where the majority of the Bean Geese from Finland leave Sweden. A comparison of the reported readings in the two time periods clearly shows that the migration north was earlier in the second period with relatively much fewer marked Bean Geese staying in Scania in March.

In April, spring migration was apparent even further north in the country and many neck-banded

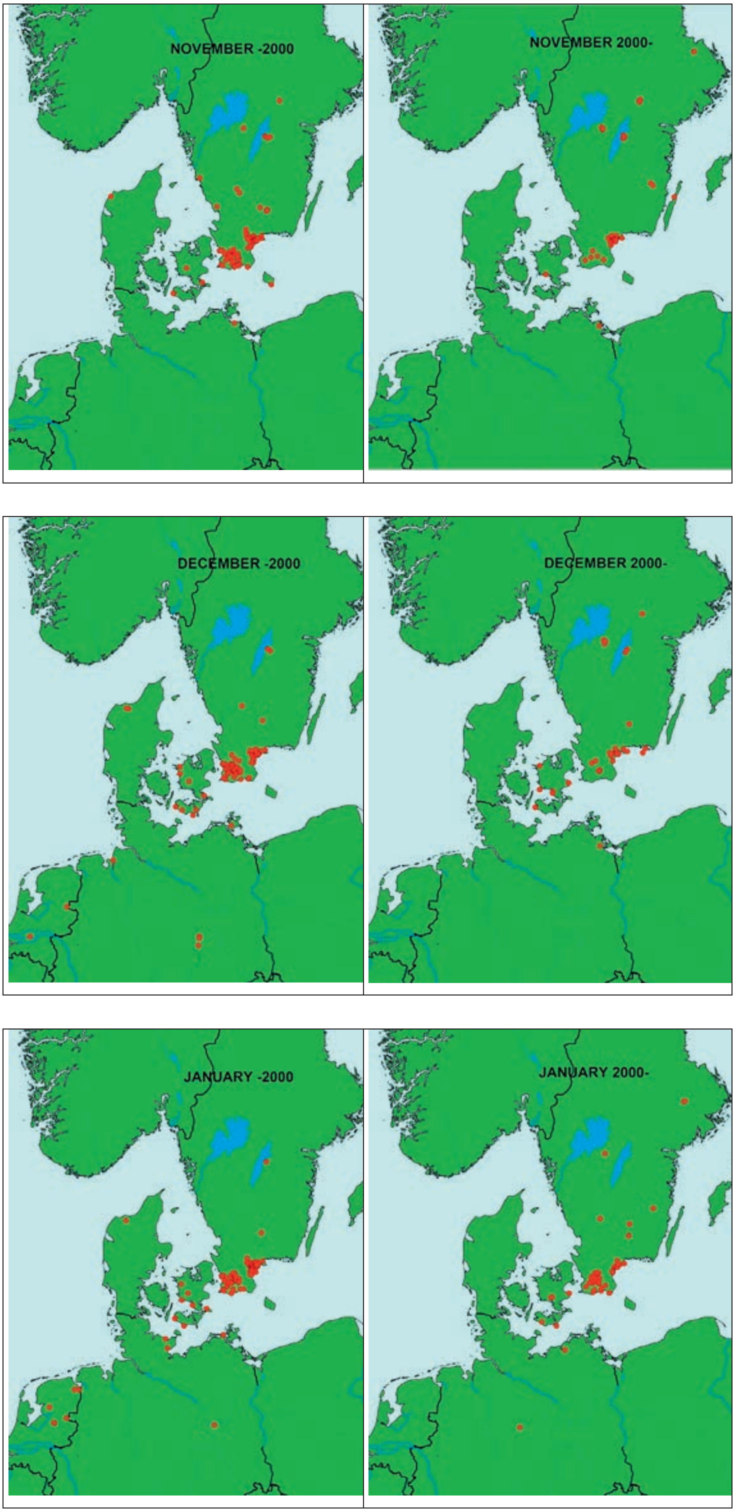

Figure 4. *continued* fortsättning

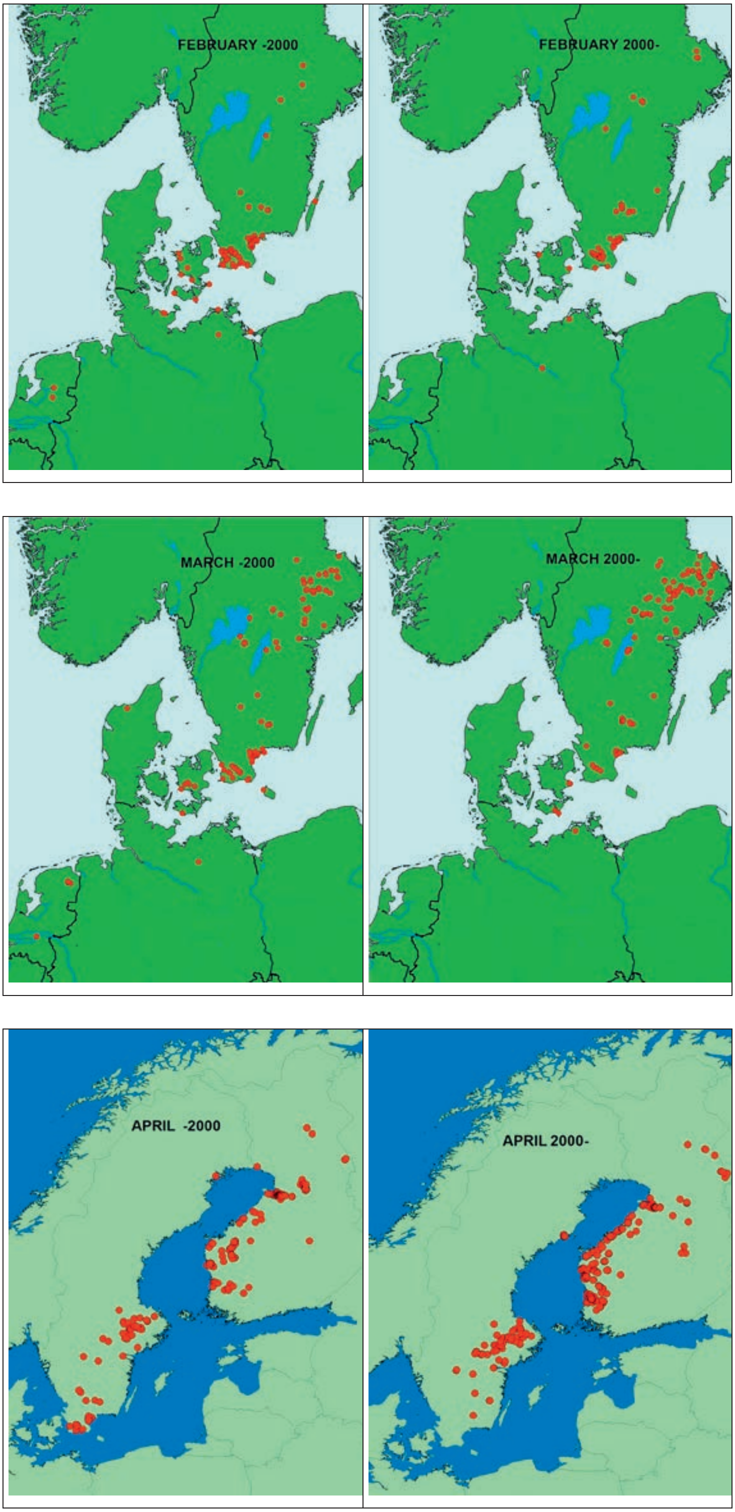

Figure 4. *continued* fortsättning

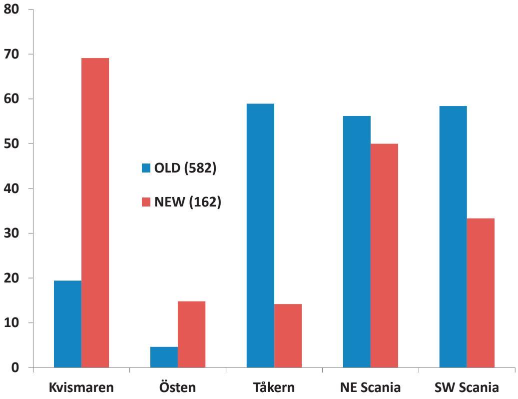

Figure 5. Percentage of all Finnish neck-banded Bean Geese *Anser fabalis* which have been recorded at the main staging and wintering areas in south Sweden. In all, 582 individuals are included in the sample marked before 2000 whereas the sample marked after 2000 include 162 individuals.
*Andelen av samtliga finska halsmärkta sädgäss* Anser fabalis *som har setts på de viktigaste rast/övervintringsområdena i södra Sverige. Sammanlagt ingår 582 individer som märkts före 2000 och setts i Sverige, medan motsvarande antal för de som märkts efter 2000 är 162.*

Bean Geese had reached Finland. During the first period several marked Bean Geese of Finnish origin were still left in Scania, whereas all of them had left the province during the second period. Observations from the province of Småland were also much fewer during the second compared to the first period. The maps for April show very clearly that the Finnish Bean Geese wintering in Sweden fly over the Baltic Sea via Åland to southwest Finland and then migrates north in the western part of Finland. Only six observations were obtained from the Swedish side of the Bothnian Bay, two at Luleå during the first period and four in the Ume River delta during the second period.

As already clear from the comparison of the two sets of maps from the first and second study period, there were marked changes in the distribution of the Bean Geese between the two periods and also between the neck-band readings during the two periods. In the first period, more than 50% of all marked Bean Geese seen in Sweden were also seen at least once at the three major staging/wintering sites Tåkern and the two parts of Scania (Figure 5). Relatively small proportions of the

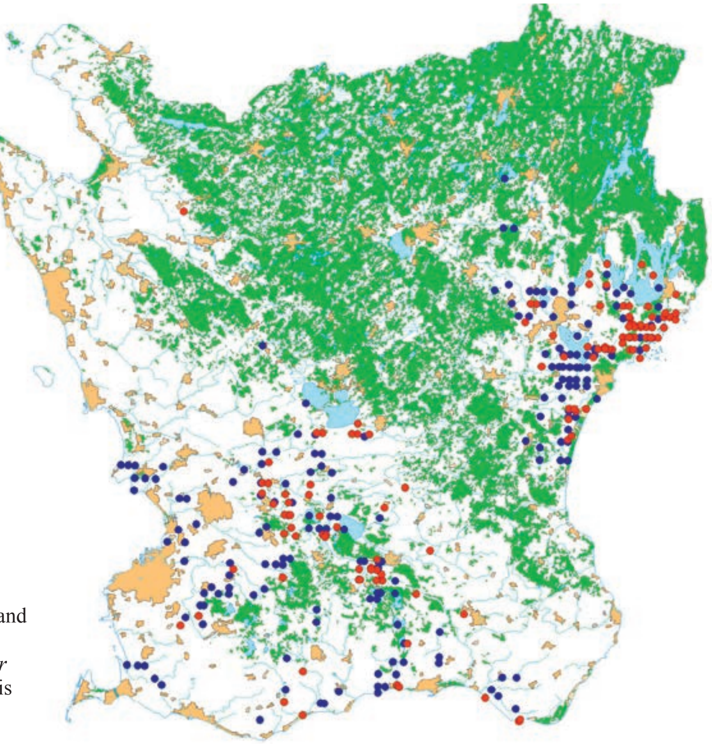

Figure 6. Detailed map of Scania, the southernmost province of Sweden, with observations of neck-banded Bean Geese *Anser fabalis* marked before 2000 (blue) and after 2000 (red).
*Detaljkarta over Skåne med observationer av halsmärkta finska sädgäss* Anser fabalis *märkta före 2000 (blå) resp. märkta efter 2000 (röda).*

marked geese were seen at Kvismaren and Östen in those years.

In the second period, the picture was totally different with close to 70% of all neck-banded Finnish Bean Geese seen in Sweden reported from Kvismaren at least once. Several of them were also seen at other sites. The proportion of marked geese seen in Scania was lower, but still about 50% were noted in northeast Scania, i. e. more or less the same percentage as in the first period, but the proportion reported from SW Scania was much lower in the second period. At Tåkern, only about 15% of the neck-bands from Finland were seen during the second period compared to nearly 60% in the first period. The shift in importance for staging geese in the autumn from Tåkern to Kvismaren was very apparent.

A detailed mapping of the neck-band readings from Scania show marked differences between the two time periods, especially in the southwestern part of the province (Figure 6). During the first period, important numbers of geese with many neckbands readings were found at the coastal sites especially during cold periods. In the second period most of the Bean Geese remained inland, and for the lake area in southwestern Scania there were no differences between the two periods. In the northeast there were more observations close to the coast during the second period, whereas most observations of neck-banded Bean Geese from the first period were reported from more inland areas.

## Discussion

In an earlier analysis of the migration pattern of Finnish neck-banded Bean Geese, Nilsson & Pirkola (1991) separated three main groups (see also Nilsson 1984, Nilsson & Pirkola 1986): (A) a group migrating to southern Sweden (and Denmark) from breeding areas in northern Sweden (and Norway), (B) an easterly group migrating into Sweden over Finland, probably coming from areas in Russia, and (C) a group coming from the Finnish breeding areas, maybe also parts of western Russia. The reason to separate the two groups B and C was mainly a marked influx of Taiga Bean Geese into Germany during autumn without producing any larger numbers of neck-band readings, indicating that they came from areas further to the east where no neck-banding was undertaken. If this early influx had come from Finland many more readings should have been reported.

Group A geese (mainly Swedish) seem to have very few connections with group C geese (mainly Finnish), with only six observations of the latter on the Swedish side. Group A probably consists of two subgroups, one migrating south to wintering areas in southernmost Sweden and another, probably from the southern part of Swedish Lapland, migrating to Britain via Denmark (Parslow-Otsu 1991). Group A and group C geese mix with each other in the winter-quarters as shown by neck-banding in Scania (Nilsson 1984).

The general picture of the migration of Bean Geese through Sweden from the Finnish marking areas is the same in the two time periods that are compared, with the exception that the geese did not reach western Germany and the Netherlands in the second period. During the first period they reached Scania and stayed there in normal winters, but moved further on and reached as far as the Netherland in winters with cold spells. In the latter period the Bean Geese from the Finnish marking areas still had Scania as a main winter area, but they did not reach further to the southwest than the Danish Isles.

The marked differences in neck-band reports between the two time periods were also reflected in the standard autumn counts of staging Bean Geese (Nilsson 2008). There was a shift in the migration schedule with the geese staying longer in more northerly parts of south Sweden and a much later arrival in Scania in the second period. This short-stopping was probably mostly related to changes in the agriculture with improved feeding conditions in the areas north of Scania, partly related to a shift to autumn-sown cereals. The standard autumn counts also showed a shift in the importance of different staging areas (Nilsson 2008). When the counts started in the late 1970s, very few geese were staging north of Scania in October, whereas hardly any geese had reached Scania in that month during the 2000s. Tåkern was taking over the dominance for a number of years, but then the picture changed again and Kvismaren grew to become the most important autumn area.

The shift of spring migration to earlier dates was about the same for the Swedish and Finnish populations. It is assumed (Drent et al. 2006, Nilsson 2006, Tombre et al. 2008) that this shift is associated with an ongoing amelioration of spring climate, making grazing habitats available at earlier dates along the whole migration route and also in the breeding areas.

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## Sammanfattning

Under 1970-talet genomfördes ett nordiskt sädgåsprojekt på uppdrag av Nordisk Kollegium för Viltforskning. Inom ramen för detta projekt studerades olika aspekter på sädgåsens ekologi, bl.a. dess flyttningsvanor. Flyttningsstudierna baserades på halsbandsmärkning av sädgäss på vinterområden i Skåne, häckningsplatser i Finland samt ruggningslokaler i Norge och Finland. Projektet fortsatte sedan som ett finskt – svenskt projekt som dock avslutades 1994.

Under 2000-talet uppkom ett förnyat intresse för sädgässen i Sverige och Finland och nya märkprojekt startades i båda länderna. I denna uppsats jämför jag flyttningsmönstret för de sädgäss som märktes i Finland under den första perioden (1978–1994) med dem som märktes under den andra perioden 2002–2009. Undersökningen omfattar inte rörelserna av sädgäss i Finland med undantag för vårflyttningen för att möjliggöra jämförelser med förhållandena på den svenska sidan.

Sädgäss har fångats på olika lokaler i Finland (Figur 1) med hjälp av kanonnät på rastplatser och genom att driva ruggande gäss och ungar in i nät.

Under 1978–1994 märktes totalt 710 sädgäss med halsringar i Finland, medan 173 sädgäss märktes under perioden 2002–2009.

### *Resultat*

Under den första perioden med halsbandsmärkning rapporterades totalt 5400 observationer av de halsmärkta gässen, medan motsvarande antal var 2010 för den senare perioden fram till våren 2011. Totalt har jag haft tillgång till 3038 rapporterade avläsningar utanför Finland från den första perioden och 1108 för den senare perioden.

De finska sädgässen anlände till Sverige under september–oktober, med majoriteten under den senare månaden. Huvudankomsten skedde över ett ganska begränsat område längs Upplandskusten. I huvudsak observerades de finska sädgässen i östra Sverige i ett bälte från ankomstområdet i Uppland ner till övervintringsområdena i Skåne (Figur 3). Ett antal observationer rapporterades också från Danmark, Tyskland och Nederländerna, huvudsakligen från vintern (Figur 4).

Om fördelningen av observationer från de båda tidsperioderna med halsbandsmärkning jämförs framträder huvudmönstret som det beskrivits ovan i båda tidsperioderna, men det föreligger en hel del skillnaderna, särskilt om man jämför observationernas fördelning på olika månader i de båda serierna. Skillnaderna är tydliga under vintern. Den första perioden erhölls flera rapporter från Nederländerna samt västra delen av Tyskland samt Jylland i Danmark. Sådana observationer saknas helt från den senare perioden. Däremot frekventerade sädgässen de östra delarna av Danmark under båda perioderna.

Inom Sverige förelåg också en hel del skillnader mellan perioderna. I samlingskartan framgår tydligt att Tåkern var av mindre betydelse som rastplats under den senare perioden jämfört med den första perioden. På motsvarande sätt är antalet observationer från sydvästra Skåne inte lika framträdande under den senare perioden.

Jämför man fördelningen mellan de båda tidsperioderna för de olika månaderna är skillnaderna mellan perioderna mer tydliga. I oktober, som är huvudmånad för sädgässen i Sverige, kan man tydligt se förskjutningen från Skåne och Tåkern som viktiga lokaler mot Kvismaren. Så finns endast en rapport från SV Skåne från den senare perioden i oktober jämfört med flera från första perioden. Under november–december kan man också se en tydlig skillnad mellan de båda skånska områdena, med fler sädgäss i nordöstra Skåne jämfört med sydvästra Skåne.

Vårflyttningen av sädgäss skedde tidigare under den andra perioden. I mars hade gässen under andra perioden nästan lämnat Skåne, medan fortfarande betydande antal sädgäss fanns kvar här under den första perioden. Bilden för april var ganska likartad mellan de båda perioderna, merparten av de finska gässen flyttade över Ålands hav mot sydvästra Finland, medan endast mycket få finskmärkta sädgäss observerades på den svenska sidan av Bottenhavet.

Som framgår av kartorna har det skett betydande omfördelningar av de finska sädgässens uppträdande i Sverige mellan de båda undersökningsperioderna. Detta framgår särskilt tydligt av Figur 5. Under den första perioden sågs över 50% av samtliga individer kontrollerade i Sverige åtminstone vid en av de tre områdena Tåkern, SV och NE Skåne, medan endast en mindre andel sågs vid Kvismaren. Under den senare perioden var Kvismaren den viktigaste lokalen i Sverige, där nära 70% av alla avlästa gäss från Finland observerats vid åtminstone ett tillfälle, medan Tåkern förlorat markant i betydelse.

I Skåne noterades också betydande skillnader i gässens uppträdande mellan de båda tidsperioderna, inte bara i skillnaderna mellan de båda delarna i stort utan också på det lokala planet (Figur 6). Speciellt påtagligt är avsaknaden av observationer av märkta gäss från kusterna under den senare perioden jämfört med den första.

### *Diskussion*

Tidigare analyser av de finska och svenska sädgässens flyttning visade att vi i Sverige kan räkna med tre olika huvudgrupper av sädgäss under flyttningsperioden : A) en grupp sädgäss som flyttar från norra Sverige till södra Sverige och Danmark, B) en östlig grupp sädgäss som flyttar genom Finland och Sverige till vinterområden söder om Östersjön samt en tredje grupp C) som flyttar från finska häckningsområden till övervintringsområden i södra Sverige och (under kallare perioder) till Danmark. Fynden av halsmärkta gäss visar att det inte under någon av perioderna förekommit mer än marginellt utbyte av gäss mellan populationerna A och C.

I denna undersökning har den tredje gruppens flyttningsvanor under två perioder jämförts och det har kunnat konstateras att gässen i betydande utsträckning ändrat rastvanor i södra Sverige under hösten, vilket också återspeglas i de nationella gåsinventeringarna. Samtidigt konstateras att gässen flyttar ner till sydligaste Sverige senare och inte flyttar lika långt åt sydväst under kallare perioder som tidigare. Sålunda saknades observationer från västar Tyskland och Nederländerna under den senare perioden.

Vårflyttningen konstaterades också vara tidigare under den senare perioden, vilket gäller gäss av både finskt och svenskt ursprung. Detta hänger samman med att vårens snögräns flyttats längre norrut så att betesmarkerna både längs flyttvägen och i häckningsområdet blivit tillgängliga tidigare.

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# Ortolan Bunting *Emberiza hortulana* at Kvismaren, central Sweden – breeding studies and suggested management

*Ortolansparven* Emberiza hortulana *vid Kvismaren, centrala Sverige – häckningsstudier och förslag till skötsel*

JAN SONDELL, CRAIG BROOKES & MAGNUS PERSSON

## Abstract

The only remaining Ortolan Buntings in the province of Närke are about 15 singing males in the Kvismaren valley. We studied this small population intensively during May–June, 2011. We found that the birds depend on bare soil of two kinds: potato fields turning green only in early July and open ground underneath birch and elder vegetation in an old bog. Thus spring sawing may be a "trap" as fields that look optimal when the Ortolans arrive in early May will in a few weeks turn green and become less suitable for breeding. In 2011, 6 pairs likely raised young and this result seems normal. Possibly this very small population persists due to recruitment from the much larger population in northern Sweden, that passes through Kvismaren during spring and autumn migration. The central Swedish population is only about 100 pairs and will probably disappear if a management plan is not implemented rapidly. New potentially suitable areas must be identified, and optimal breeding conditions must be provided at sites where Ortolan Buntings still occur.

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## Background

### *Population change in Europe, Sweden and at Kvismaren*

In the beginning of the 20th century the Ortolan Bunting *Emberiza hortulana* was breeding in most of central Europe; at the end of the century, however, breeding areas had significantly declined (Bernady 2009). The population in Norway (Naevia 2002) and southern Finland (Vepsäläinen et al. 2005) had almost disappeared and reductions were recorded in most European countries. In Spain, however, the population increased in areas with young forests after wildfires (Brotons et al. 2008).

The Ortolan Bunting was also present all over Sweden in the middle of the 20th century; the population gradually decreased in southern and central Sweden (Runesson 1996) and also on farmland in northern Sweden. Today Ortolan Buntings mainly breed on opened forest land (clear cuttings) in northern Sweden (The Swedish Bird Survey, Svalan). Furthermore a little residue of around 100 pairs still exists in Närke, Västmanland and Uppland. The known Närke population is today restricted to the Kvismare area.

At Kvismaren approximately 15 singing males have been counted annually during the last decade (Sondell & Runesson 2010). According to several censuses we know that in earlier decades the population was much larger (Runesson & Jönsson 1987). The pairs of Ortolan Buntings present at Kvismaren today breed in open agricultural landscape northeast of the Kvismaren lakes. Males sing from small moraine islets covered by trees and these groves are surrounded by farmland fields of organic soil.

### *Thinning of forest groves at Kvismaren in 2009–2010*

Föreningen Kvismare Fågelstation, FKF (Society of Kvismaren Bird Observatory) managing the Kvismare Bird station since 1961, has for many years been concerned about the Ortolan Bunting decline (Runesson 1996). In 2009, FKF started to try to improve the situation. The first step in these efforts was to boost the nesting habitat. Many of the tree groves possible to use for nesting were engulfed by closed vegetation. In 2009, five islets were cleared (Sondell & Runesson 2010). Most of the undergrowth was removed and the taller trees were left as song posts with a distance of some 10 metres between. The thinning was repeated for five more islets in 2010.

### *SOF project*

In 2011, the Swedish Ornithological Society (SOF) became aware of the severe decline of the Ortolan Bunting population in central Sweden and started a project with the aim to understand the species' breeding biology and to find means to improve its population size. The Kvismaren "Ortolan Bunting project" is now co-ordinated with the SOF project.

### *Unsown fields in 2011*

A hypothesis proposing that the lack of bare soil is the main reason for the successively decreasing Ortolan Bunting population in central Sweden (Sondell 2009) inspired FKF to start a program where parts of the fields were left unsown in the spring of 2011 (Sondell 2010). This was done at three different farms in co-operation with the SOF´s farm project.

A study area was chosen in the area where the Ortolan Buntings were expected to settle. Three farmers were contacted and they were committed to leave in total some 1.5 hectares of arable land unsown in the spring of 2011. These areas were directly connected to the groves where the males had been singing in the previous years. To maintain the open soil it was necessary to harrow weed on the unsown areas one time during the breeding period.

Within and close to the study area, there is a large farm named Bärsta. Production on this farm is focused on potatoes; ca. 25% of its 350 hectares is used for potatoes every year. Other crops are less important. As the potatoes are planted around mid May the open soil is not fully covered by the potato plants until the beginning of July.

### *Aims*

The aims of the Ortolan Bunting project at Kvismaren 2011 was to monitor the arriving population to find out in detail how many birds were present, if males were stationary, if females showed up in reasonable numbers and if breeding took place.

Furthermore, we were interested in describing the vegetation at nesting and foraging sites. Based on our findings, we also aimed at proposing a management plan with the intention to improve the Ortolan Bunting population in central Sweden.

Figure 1. Unsown strip on field of spring seeds near Husön. A nest (A1) was situated in the vegetation in front of the grove at the left. 20 June 2011, the young are newly fledged. Photo Jan Sondell.
*Osått körstråk i fält med vårsäd nära Husön. Ett bo (A1) låg i vegetationen framför dungen till vänster. 20 juni 2011, ungarna har just lämnat boet.*

## Methods

Beginning at the arrival of the Ortolan Buntings in early May, singing, breeding and foraging activities were monitored and all observed activities were registered on maps. Every observation period resulted in a map where all relevant data were gathered. At the end of the observation period, the results were evaluated and the conclusions summarized on maps and in tables.

As a complement to the field studies, data from independent ornithologists accessible at the website Svalan was evaluated. In the Kvismaren area, approximately 70 additional Ortolan Bunting observations were registered at Svalan (SOF bird report site) in the spring and summer of 2011, a frequency of the same magnitude as in earlier years. Most observations were of course parallel to the project observations but still they represent a confirmation of the status of the Ortolan Buntings in Kvismaren and the whole county of Närke. For the "classic" locality in the grove near the Bird Observatory (Ängfallet), we present data on the number of Ortolan Buntings in the years 2005–2011.

Based on the detailed studies in 2011, knowledge of the Ortolan Bunting distribution in Kvismaren

Figure 2. Potato field at Husön, Bärsta, 20 June 2011. Potato containers are stored in the background. Most part of the soil is still uncovered in the potato field. Photo Jan Sondell.
*Potatisåker vid Husön, Bärsta, 20 juni 2011. Potatislårar är travade i bakgrunden. Den största delen av marken i potatisfältet är ännu inte täckt av vegetation.*

Figure 3. Forest ground at southwestern part of Restamossen (males B4-B6 singing places). The peat soil is partly open underneath the birches and elder bushes. 27 August 2011. Photo Jan Sondell.
*Skogsmarken i sydvästra Restamossen 27 augusti 201 (där hannarna B4-B6 sjöng). Mossjorden är delvis bar under björkar och druvfläderbuskar.*

in earlier years, as well as in other parts of central and northern Sweden, a preliminary management plan to improve the Ortolan Bunting population in Sweden has been launched.

## Results

### *Study area in 2011*

The actual study area, ca 150 ha in size, was defined in April 2011 before the Ortolan Buntings arrived. Most of the groves in the area were thinned in 2009/2010 and three of the landowners were asked to leave 1.5 ha unsown around these groves (Figure 1). When the Ortolan Buntings arrived in late April–early May most of the ground within the survey area was devoid of vegetation. Sawing was under way and in the middle of May most fields within the area started to turn green. This was however not the case for the fields intended for potatoes or carrots, covering some 20% of the area. The potato plants did not fully cover the soil until the beginning of July (Figure 2). Furthermore along the southern part of Restamossen (NE part of the study area) the vegetation is rather unique. The forest roof is exploited by high birches growing fairly sparsely. The undergrowth is however rather thick and consists mainly of red-berried elder *Sambucus racemosa*. The bushes are fairly dense and under the bushes the ground is partly bare and consists of organic soil (Figure 3).

### *Monitoring of the main study area*

The study area was monitored by Craig Brookes and Magnus Persson, on average every third day during the period 26 April–7 June. All Ortolan Bunting activities were registered on maps, and approximately 70 man-hours were used for the field work. The study area and all places with Ortolan Bunting activity are presented in Figure 4. The first male arrived on 26 April and until the end of the observation period (7 June), 8–14 males and 6–8 females were registered.

Two concentrations of Ortolan Buntings were identified (Table 1, Figure 4). Group A was present in the north-western part and group B in the north-eastern part of the main study area. In the southern part no Ortolan Buntings were observed. The Ortolan Buntings used six territories/places in each of the two core areas (A and B). In the A area, A6 was used only once and a male from A1–A5 may have been visiting this place. In area B, possibly B1 and B2 were used by the same pair. Place B3 is a single tree and might be used by some of the other B pairs.

Strong indication of breeding was registered at three places each in the two areas. No attempts to find nests were made because the nests are placed on the ground and are very difficult to find without risking nest damage. Instead, we used observations of birds carrying food into a limited area as a strong

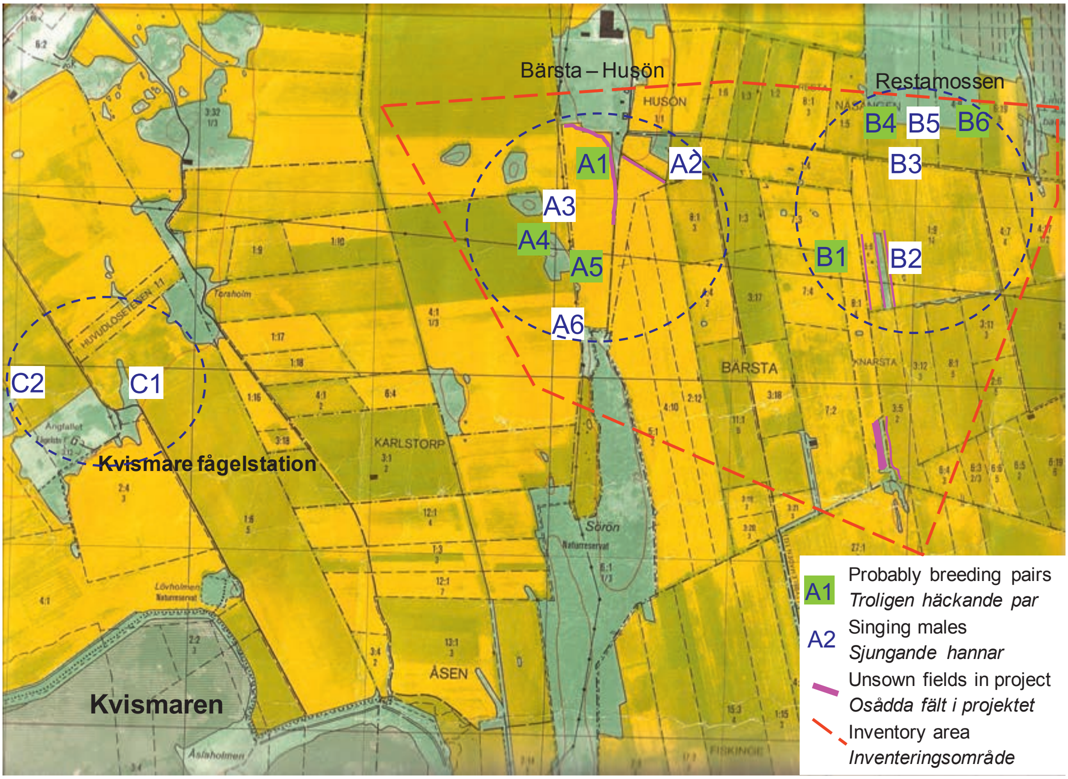

Figure 4. Study area at Kvismaren 2011 for Ortolan Buntings. Areas left unsown are indicated with red and the different Ortolan groves are numbered. Three groups of birds, A–C, was identified.
*Studieområde i Kvismaren 2011 för ortolansparv. Osådda stråk är markerade med rött och de olika dungarna med sjungande ortolansparvar är numrerade. Tre grupper fåglar, A–C, identifierades.*

Table 1 Areas with singing Ortolan Buntings, singing period of males, observations of females, breeding criteria and probable nesting in Kvismaren 2011.
*Områden med sjungande ortolansparvar, sångperiod, observationer av honor, häckningskriterier och trolig förekomst av bo i Kvismaren 2011.*

| Observation area<br>*Observationsområde* | Dates singing<br>*Sångperiod* | Female present?<br>*Hona närvarande?* | Breeding criteria<br>*Häckningskriterier* | Probable nest<br>*Troligt bo* |
|---|---|---|---|---|
| A1 Husön, southern part | 3 May–12 June | Yes, several times | Mating, food in bill | Yes |
| A2 Husön SE, small grove | 13 May–3 June | No, male lacking tail | No | No |
| A3 Husön SW, small grove | 13 May–7 June | No | Singing male | No |
| A4 Husön SW, small grove, western part | 3–7 June | Yes | Food to nest | Yes |
| A5 Husön SW, small grove, eastern part | 26 April–7 June | Yes, several times | Food to nest | Yes |
| A6 Sörön, northern tip | 13 May | No | No | No |
| B1 Sörön NE, small grove | 3–7 June | Yes | Pair present | Yes |
| B2 Sörön NE, tree row | 13 May–7 June | No | Singing male | No |
| B3 Husön E, tree at roadside | 9 May–7 June | No | Male present | No |
| B4 Restamossen SW, western part | 9 May–3 June | Yes, several times | Pair present | Yes |
| B5 Restamossen SW, middle part | 20–27 May | Yes | No | No |
| B6 Restamossen SW, eastern part | 9 May–3 June | Yes, several times | Pair present | Yes |
| C1 Ängfallet NE | 30 April–4 July | Yes | Pair seen once | No |
| C2 Ängfallet NW | 10–20 May | No | No | No |

Figure 5. Male Ortolan Bunting (A1) with food for youngsters on the road from Husön to Sörön. Observations such as this have been used as confirmation of a successful breeding nearby. 12 June 2011. Photo Hasse Molin.
*Hanne av ortolansparv (A1) med föda till ungarna på vägen mellan Husön och Sörön. Denna observation är en bekräftelse på att fågeln häckar i närheten.*

indication that a nest was present in the neighbourhood.

One male had lost his tail (A2). He was observed four times at the same place between 13 May and 3 June; this means he stayed at least three weeks in the same grove. However, there was no indication that this male became paired.

Only a few observations of Ortolan Buntings searching for food were made. One bird was however found on the ground in each of two of the fields where sowing did not take place. In the third southern area with unsown fields no Ortolan Bunting at all were observed in 2011.

At Ängfallet, some 2 km west of the main study area, two males (C1, C2) were noted (Table 1, Figure 4). Also a female was reported here on one occasion in the middle of May (by local ornithologists). We did, however, not record any further nesting indications in this area. There were only two additional Ortolan Bunting observations, both on 11 May, reported via Svalan from other parts of the Kvismaren valley (Öby kulle and Löten). Furthermore, in the whole county of Närke, only two more Ortolan Buntings were observed in the spring of 2011.

### *Ortolan Bunting observations at Ängfallet in 2005–2011*

In 2005–2009 the most convenient locality to spot Ortolan Buntings in central Sweden was probably close to the Kvismare Bird Observatory building (Ängfallet), situated 1 km south of Norrbyås in Närke. In Table 2, the period of Ortolan bunting records listed at Svalan are shown for the years 2005–2011.

In all years, the Ortolan Buntings have arrived to Ängfallet in the period 30 April–5 May. Most years singing has taken place until the beginning of July. Females have been recorded five out of seven seasons. No clear evidence for breeding has been recorded, but breeding has probably taken place in some years.

Table 2 Time period when Ortolan Buntings were present at Ängfallet, Kvismaren 2005–2011, as well as the maximum number of males and number of females (according to observations reported at Svalan). Types of crops in the surroundings (next to the Ängfallet forest groves) are also presented.
*Period då ortolansparvar observerats vid Ängfallet, Kvismaren 2005–2011, samt maximalt antal hannar och antal honor, enligt rapporter till Svalan. Typ av gröda som har omgärdat träddungarna vid Ängfallet är också redovisade.*

| Year<br>*År* | Period birds seen<br>*Period med obsar* | Max. ♂, date<br>*Max. ♂, datum* | Number of ♀ present<br>*Antal närvarande ♀* | Type of crops<br>*Typ av gröda* |
|---|---|---|---|---|
| 2005 | 5 May–19 June | 4 ex: 21 May | 1 ex: 9 June | Hay and spring seeds |
| 2006 | 3 May–3 July | 2 ex: 5 June | 1 ex: 7, 13 May | Hay and spring seeds |
| 2007 | 3 May–27 June | 3 ex: 5 May | 1 ex: 2 June | Hay and spring seeds |
| 2008 | 1 May–23 June | 2 ex: 21 May | - | Hay and spring seeds |
| 2009 | 2 May–14 June | 3 ex: 22 May | 1 ex: 22 May | Hay and spring seeds |
| 2010 | 3 May–12 May | 1 ex: 3 May | - | Hay and autumn seeds |
| 2011 | 30 April–4 July | 2 ex: 14 May | 1 ex: 15 May | Hay and autumn seeds[1] |

[1] Autumn seeds included several bare areas

In 2010 the situation was unusual as all fields had been sawn in autumn and a dry spring resulted in no bare soils. The only singing male abandoned the area already 12 May. In 2011 there were no spring sown fields either, but the autumn crops were damaged by hard winter weather and several partly bare soil areas were present, particularly close to Ängfallet.

## Discussion

### *Kvismaren 2011*

The situation for the Ortolan Bunting in the county of Närke is presently very vulnerable. According to Svalan, Kvismaren is the only area in Närke where Ortolan Buntings are present during the breeding season. However, the Ortolan Bunting is known to suddenly appear or disappear in an area, and it is therefore possible that there can be unknown groups in other parts of the county.

The study area and the number of pairs studied were admittedly small, so even if the 2011 studies were fairly intense, the conclusions made in the present study are based on a small data set. Despite this drawback, there is an urgent need to increase our knowledge about this vulnerable bird species, and all new information is therefore of importance.

The Ortolan Bunting is rather difficult to study. Singing males are fairly easy to find within some 100 m. Females, however, are normally only observed in connection with males. To spot a single female is difficult and nests even more difficult to find. As the nest is built on the ground there is an obvious risk to damage it during nest search. Therefore the best way of obtaining indications of nesting is by observing birds with food in their bill (Figure 5).

In spring 2011, we collected data implying nesting at six sites and between 10–16 territorial males and 6–8 females were counted. All birds except two males and one female were found in the main study area (Table 1, group A and B).

The Ortolan Buntings were very stationary as no males were observed outside the 14 singing posts (12 in the main study area). One male was possible to identify individually as it lacked its tail; this male was only observed within his one singing grove.

The first singing male was heard on 26 April (in A5) and he later bred close to his singing site. Only 37–40% of the observed individuals were females. As females are more difficult to spot than males, the true proportion of females may be somewhat higher and thus not far off from an even sex ratio.

The 2011 survey result has some positive implications. We have no indications of individuals moving long distances from one song post to another to seek for females. Most males have been present the whole monitoring period at their original song posts. Furthermore, females have showed up in rather good numbers. In south-eastern Norway, where studies were carried out just before the population was extinguished, males moved up to 30 km in the same season, as almost no females were present (Steifetten & Dale 2006). Obviously the population at Kvismaren is in a better situation presently. Breeding occurred to an extent that would be expected in a healthy population.

Potentially this positive result could be due to contacts with the population from northern Sweden, which migrates straight over the Kvismaren area. Or alternatively, breeding conditions for Ortolan Buntings may have been unusually favourable in 2011.

### *Fields sawn is spring – a “breeding trap”?*

The Ortolan Bunting favours groves in open areas with bare soil on its arrival from Africa in the beginning of May. The males take up song posts in the small groves scattered like small “habitat islands” over the large open fields. However, the open bare soil is completely transformed within a few weeks as the seeds germinate and vegetation emerges. Therefore the whole open field landscape changes to become green and areas with bare soil may be very rare. Thus, the spring habitat that appeared perfect for Ortolan Buntings has changed completely into unfavourable “grassland”.

In the green surroundings, the ground-feeding Ortolan Bunting may have difficulty finding food to their young. Hence, this situation may constitute a “breeding trap” and lead to low breeding success and an insufficient number of recruits.

It has been suggested that a reason for the declining Ortolan Bunting populations in Scandinavia might be found at migration and/or wintering sites. This is however very unlikely – a Spanish report based on two atlas censuses in Catalonia (1975–1983 and 1999–2002) strongly contradict this (Brotons et al. 2008). In the Spanish study, the Ortolan Bunting has in general increased and in particular in areas where wildfires have increased in later years. The species has also at the same period been extinct in some areas without fires. Thus, the increase of Ortolan Buntings in Catalonia seems closely connected to a positive development of the breeding habitat, rather than caused by changes in winter mortality.

### *The present situation for the Ortolan Bunting in central Sweden*

The Ortolan Bunting is on the verge of extinction in central Sweden and it will soon disappear if the habitat is not managed in favour of bare soil in spring and early summer. In addition, more research has to be conducted to understand why it cannot produce enough offspring to maintain a stable population size.

In size and shape the Ortolan Bunting resembles its close relative the Yellowhammer, but the two species have totally different strategies of living. The Yellowhammer breeds in the same area of Kvismaren as the Ortolan Bunting but find its summer food amongst trees, bushes and on meadow ground. It stays the winter in Sweden (Fransson & Hall-Karlsson 2008).

In contrast, the Ortolan Bunting initiates migration as fast as possible after breeding and primary moult, and it spends the winter in Africa south of the Sahara. An early onset of autumn migration seems essential, because most adult individuals suspend the moult of their secondaries allowing them to leave the breeding area earlier (Svensson 1984, Kvismare Bird Observatory, unpublished). In Egypt, on passage, it is found on sandy fields on the edge of the desert (Witherby et al. 1952), where it obviously favours bare soil for feeding.

In earlier decades, when we had small scale farming in Sweden with fallow fields without vegetation, the Ortolan Bunting found bare soil on the unused set-aside fields (probably main feeding habitat), cow tracks, field horse roads, in the vicinity to open dunghills etc. Successively when the farming got more efficient and the farmers stopped leaving bare set-aside fields, the farmland gradually became greener and then followed a gradual decline of the Ortolan Bunting population.

Today the Ortolan Buntings in central Sweden are reported from gravel quarries, energy woods and other forest types with bare soil underneath the trees, industry grounds and on forest clear cuttings (Svalan 2001–2011). The latter habitat is the main habitat in northern Sweden (Sondell 2009) where we still have a fairly stable population of several thousand pairs (The Swedish Bird Survey). Before man started to use the forests in northern Sweden, the main habitat for Ortolan Bunting was probably areas newly burnt by natural forest fires.

### *Conclusions*

1. The Kvismaren Ortolan Bunting population is very small and vulnerable. It is primarily dependent on areas with open soil in the agricultural landscape. The distribution is presently restricted to the north-eastern Kvismaren valley.
2. An explanation for why this is the only area in the county of Närke where Ortolan Buntings still show up is probably the large scale growing of potatoes on organic soil. Potato farming creates open soil during the breeding period of the species, because the potatoes are planted relatively late in the season. The crops do not cover the ground until the beginning of July when most Ortolan Bunting young have already fledged.
3. The small population at Kvismaren seems to have a stable population size. At least 50% of the singing males became mated in 2011 and most of the pairs seemed to produce young.
4. Even if the 2011 breeding seasons was good, the fact remains that the Kvismaren population is very small and isolated, and therefore vulnerable to chance effects that may lead to extinction.
5. A positive circumstance is that the relatively large population breeding on forest clearings in northern Sweden is migrating through the Kvismaren area and may possibly contribute with immigrants to the Kvismaren population.
6. If we want to keep a population of Ortolan Buntings in Närke and central Sweden, all means must be taken to enlarge the present population; to start building up a population in another area where no Ortolan Buntings are present today, is probably much more difficult.

## Substantial measures

Below, we suggest a number of measures that must be taken into account if authorities decide to protect the Swedish Ortolan Bunting population. To be able to carry out the actual managements, organisers are needed to be assigned by all county administrative boards concerned, primarily from central Sweden (the counties of Örebro, Västmanland and Uppsala) and northwards.

### *Core areas of Ortolan Buntings in central Sweden*

In central Sweden, at least some 25 core areas should be identified and actual measures be implemented in these areas. Core areas are defined as areas where at least two males were singing for some weeks and were in contact with each other. In these areas, prime open soil must be secured during the period May–June. Observe that the harrowing of weeds may be necessary during the actual period.

By offering the Ortolan Buntings generous areas of open soil, the number of pairs in the core areas may rise and within a couple of years potentially enable expansion.

Inevitably all aforementioned core areas are not yet known. A search for such areas must be conducted as soon as possible and actions quickly undertaken to secure such core areas.

### *Other potential Ortolan Bunting areas*

Other suitable areas need to be found not too far from the core areas. To establish a totally new population far from areas used by Ortolan Buntings seems very difficult at present. This means that individuals on migration should find an area so attractive that they terminate their migration and start to sing and breed at the actual site. To achieve this, some kind of extra arrangements probably must be undertaken. Unfortunately, we do not yet have the knowledge to create such conditions.

### *The situation in northern Sweden*

The situation for the Ortolan Buntings in northern Sweden is probably not critical. The main habitat is newly made mechanical clear cuttings. Such measures will result in open areas with scattered trees, and on the ground there will be tracks from the machines, leaving bare soil on 5–10% of the area.

To know more about the favourite habitats some analysis of data from the Swedish Bird Survey ought to be carried out and the best sites revisited and described in detail.

Maybe it would be possible for the big enterprises in northern Sweden to adapt their cutting methods to the demand of the Ortolan Bunting.

### *Measures by priority*

1. Open soils during the breeding season is crucial, and to set aside unsown parts of fields (preferably with high humus content) is therefore of absolute top priority. Potatoes growing in the neighbourhoods are an extra advantage. The open soil should be left at the borders of the fields, close to trees/groves that contain potential singing posts and breeding sites. To really improve the habitat, a minimum of 0.5 ha per potential pair should be left unsown. It is better to leave long strings of open soil at the border of the fields and surrounding the groves rather than smaller square areas. Small areas in the middle of the fields are probably of no use for the Ortolan Buntings.
2. Breeding groves or wood edges bordering the actual fields must be present. Undergrowth at the edge should be cleared until approx. 25 metres from the edge and bigger trees should be left fairly sparse in this area.
3. Field roads with gravel are a positive factor (Figure 5). Avoid grass in the centre by preparing the road surface both in spring and autumn. Song posts on wires or big stones are also favoured.
4. Studies with similar aims as in Kvismaren 2011 need to be carried out in the next-coming years to further understand and verify the breeding ecology. The question: how to create a new core area is important to answer.
5. Studies of feeding habits and the species' breeding ecology also need be carried out at forest clear cuttings in northern Sweden to find out how the Ortolan Buntings make use of this habitat and if cutting methods could be adapted to the need of the species.

## Acknowledgements

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This is contribution No. 163 from Kvismare Bird Observatory.

## Sammanfattning

Ortolansparven häckade i hela Västeuropa i början på 1900-talet. Idag har häckningsområdet krympt betydligt (Bernady 2009). Förekomsten i Norge (Naevia 2002) och södra Finland (Vepsäläinen et al. 2005) har nästan upphört liksom i Götaland. I Svealand finns kanske ett hundratal sjungande hannar kvar. I norra Sverige och Finland finns fortfarande tusentals par där de håller till på skogshyggen. Från Spanien har det dock rapporterats att populationen ökat under senare år i skogsområden som varit påverkade av markeld (Brotons et al. 2008).

Den enda kända ortolansparvpopulationen i Närke återfinns i Kvismaren. Tidigare decennier var arten tämligen allmän (Runesson & Jönsson 1987). Dagens ortolansparvar finns nordost om Kvismarsjöarna där hannarna sjunger från små trädtäckta moränholmar omgivna av åkrar med organogen jord.

Föreningen Kvismare Fågelstation, FKF som driver Kvismare fågelstation har i många år varit oroad av ortolansparvens tillbakagång (Runesson 1996) och år 2009 startade föreningen att praktiskt försök att göra något åt situationen. Ett första steg var att gallra de åkerholmar som tenderade att växa igen. År 2009 gallrades fem holmar (Sondell & Runesson 2010) och året därpå ytterligare fem. Den mesta undervegetationen togs bort och större träd lämnades med ca 10 m avstånd.

En hypotes att ”brist på bar jord var den huvudsakliga orsaken till ortolansparvens tillbakagång” har framförts (Sondell 2009) och i ett åtgärdsprogram har det föreslagits att man skall lämna delar av fälten osådda på våren (Sondell 2010). År 2011 lämnade tre lantbrukare ca 1,5 hektar åkermark osådd. Detta skedde i samarbete med SOFs gårdsprojekt. Inom och i närheten av vårt studieområde i Kvismaren är den stora gården Bärsta belägen. Odlingen där är fokuserad på potatis och på ungefär en fjärdedel av den totala arealen (350 hektar) odlas potatis. Eftersom potatis sätts i mitten av maj täcks inte marken helt av potatisblast förrän i början av juli (Figur 2).

### *Syfte och metodik*

Målsättningen med studierna av ortolansparv i Kvismaren 2011 var att inventera populationen för att i detalj finna ut hur många fåglar som fanns närvarande samt att försöka konstatera i vilken utsträckning häckning ägde rum. Intressanta frågor att besvara var om hannarna var stationära och om tillgången på honor var tillräcklig. Vidare var det av intresse att se hur markvegetationen utvecklades med hänsyn till boplacering och födosök.

Baserat på kunskaperna från 2011 och tidigare år var syftet att också föreslå en skötselplan med avsikt att förbättra förutsättningarna för den svenska ortolansparvpopulationen.

Med början vid artens ankomst noterades aktiviteter som sång, häckning och matning på kartor. Efter fältarbetets slut utvärderades kartorna. Även uppgifter som noterades på Svalan ingick i grunddata. Därifrån erhölls ca 70 ytterligare observationer, de flesta av naturliga skäl liknande de observationer som stationens fältpersonal gjorde.

### *Resultat*

Det aktuella studieområdet avgränsades i april före ortolansparvarns ankomst. De flesta träddungar i området hade blivit gallrade 2009–2010 och tre markägare lämnade 1,5 hektar mark osådd (Figur 3). När ortolansparven anlände i början av maj pågick vårsådden. I mitten av maj började de flesta fälten att bli gröna. Detta gällde dock inte de ca 20% av arealen som skulle användas för potatis. På dessa bara ytor täckte inte potatisblasten marken förrän i början av juli (Figur 2).

Vidare fanns i sydvästra hörnet av Restamossen (NO-delen av studieområdet) en unik vegetation av glest stående stora björkar och under dem ett buskskikt av i huvudsak druvfläder *Sambucus racemosa*. Torvjorden under buskarna var till stor del bar och här fanns två till tre ortolansparvrevir (Figur 3).

Studieområdet inventerades av Craig Brooks och Magnus Persson, i medeltal var tredje dag under perioden 26 april till 7 juni och alla ortolansparvarnas aktiviteter registrerades på kartor. De platser där ortolansparvar sågs redovisas i figur 3. Den första hannen anlände 26 april. Maximalt 14 och minst 8 hannar respektive 6–8 honor registrerades.

Två grupper ortolansparvar kunde identifieras (Tabell 1); grupp A i nordvästra delen av inventeringsområdet och grupp B i den nordöstra delen. I söder fanns inga ortolansparvar detta år. Fåglarna använde sex sångplatser i varje grupp. Goda häckningsindikationer kunde insamlas på tre platser i vardera gruppen. Eftersom bona är placerade på marken gjordes inget sökande efter bon, då risken att skada dem bedömdes som för stor. Ett par som sågs bära föda i näbben i ett begränsat område utgjorde därför det bästa häckningskriteriet (Figur 5).

En hanne hade förlorat stjärten (A2). Han sågs fyra gånger under perioden 13 maj–3 juni, alltså under tre veckor i samma träddunge. Bara få observationer av födosökande fåglar gjordes. Fåglar sågs dock på marken på vart och ett av de fält som lämnades osådda.

Vid Ängfallet 2 km väster om studieområdet noterades ytterligare två hannar (C1 & C2, Tabell 1), och en hona rapporterades därifrån vid ett tillfälle på Svalan. Inga indikationer på bon erhölls dock. Förutom dessa fåglar finns bara två observationer av ortolansparv på andra håll i Kvismaren, och i hela landskapet Närke noterades bara ytterligare två ortolansparvar på Svalan våren 2011.

Under femårsperioden 2005–2009 var Ängfallet kanske den säkraste lokalen att kryssa ortolansparv i mellersta Sverige. I Tabell 2 listas ortolansparvens förekomst vid Ängfallet 2005–2011. Ortolansparvarna anlände varje år under sexdagarsperioden 30 april–5 maj. Honor har noterats 5 av 7 säsonger. Inga häckningar har konstaterats men har säkerligen ägt rum. År 2010 är något avvikande eftersom den enda ortolansparvhannen i dungarna vid Ängfallet slutade sjunga redan 12 maj. Detta år fanns ingen vårsäd omkring Ängfallet (Tabell 2). Vårsäd saknades även 2011 men höstsäden var skadad av den kalla vintern och flera områden med bar jord fanns, särskilt i närheten av Ängfallet.

### *Diskussion*

Ortolansparvens situation i Närke är verkligen utsatt. Enligt Svalan är Kvismaren det enda område där det finns ortolansparvar under häckningstid i Närke. Möjligen kan det finnas någon oupptäckt grupp av ortolansparvar på andra håll.

Studieområdet och antalet studerade par är litet men tyvärr de enda tillgängliga fåglarna. Även om studien 2011 var relativt intensiv är slutsatserna som dras här alltså baserade på ett litet material. Det är emellertid bråttom att öka kunskapen om denna tillbakadragna arts häckningsbiologi. All tillgänglig kunskap är av betydelse.

Ortolansparven är relativt svår att studera. Sjungande hannar hörs bara några hundra meter medan honor är lättast att finna i närheten av hannar. Eftersom boet läggs på marken är det svårt att finna utan att riskera att det skadas. Bästa indikationen på bo är gamla fåglar med mat i näbben (Figur 5).

Studien identifierade ca 6 häckningar och antalet sjungande hannar var minst 10 och maximalt 16. Totalt fanns 6–8 honor i området. Alla fåglar utom två hannar och en hona fanns i det huvudsakliga studieområdet (Tabell 1, grupp A och B).

Ortolansparvarna var mycket stationära eftersom ingen fågel observerades utanför de 14 sångplatserna (12 i huvudområdet). En hanne kunde dessutom identifieras individuellt eftersom han saknade stjärt. Han observerades under tre veckor och då alltid i sin ordinarie träddunge.

Proportionen honor var ca. 40%. Eftersom honor är svårare att hitta är troligen den riktiga siffran något högre, dvs nära 50-50% könskvot, vilket är relativt normalt för monogama tättingar.

Inventeringens resultat 2011 har några positiva inslag. Vi har inga indikationer på att vissa hannar flyger långa sträckor mellan sångplatser för att söka efter honor, vilket var fallet i södra Norge innan population dog ut där (Steifetten & Dale 2006). Dessutom uppträdde honor i ett som man kan anta normalt antal. Detta positiva resultat kan bero på att populationen i Kvismaren står i kontakt med de ortolansparvar som flyttar över området från de större populationer i norra Sverige och kanske Finland.

Vårsådda fält – är dessa en ”häckningsfälla”? Ortolansparven föredrar öppen jord när den anländer från Afrika efter flyttningen. Hannarna sjunger från små träddungar ute på fälten. Den öppna bara jorden förändras dock ett par veckor efter ankomsten när vårsäden gror. Landskapet blir grönt och öppen jord blir sällsynt. Det habitat som tidigare på våren sett ut att vara perfekt för häckning förvandlas nu helt. I vegetationen har ortolansparven troligen svårt att finna föda. Situationen kan bli till en ”häckningsfälla” som kan leda till lågt reproduktionsresultat och över tiden en minskande populationsstorlek.

Som nämnts är ortolansparven på gränsen till utrotning i mellersta Sverige och kommer utan tvivel att försvinna om ingen biotopförbättring äger rum. Det viktigaste är att fullt ut förstå varför den inte kan föda upp tillräckligt många ungar för att bibehålla en stabil population.

I storlek och utseende liknar ortolansparven den närbesläktade gulsparven, men dessa två arter har helt olika livsstrategier. Gulsparven häckar i samma område vid Kvismaren men finner födan bland träd, buskar och på ängsmark. Den övervintrar inom landet (Fransson & Hall-Karlsson 2008).

Ortolansparven däremot flyttar nästan direkt efter häckningen till tropiska Afrika. Den avbryter ruggningen av vingpennorna för att kunna starta tidigare (Svensson 1984, Kvismare fågelstation, opublicerat). I Egypten återfinns den under flyttning på sandiga åkrar intill ökenkanten (Witherby et al. 1952).

När vi fortfarande hade ett småskaligt jordbruk i Sverige där åkrarna låg i träda ungefär vart fjärde år och det fanns många små fållor, kostigar, hästtrampade körvägar och öppna gödselstackar, upprätthöll ortolansparven sin numerär. Idag är åkrarna större, antalet djur färre och det finns nästan inga fält utan vegetation. Denna omställning har skett gradvis och parallellt med detta har ortolansparven också minskat i antal.

Idag rapporteras ortolansparv från grustag, industriområden, avverkningsytor, energiskog och annan skog med bar jord under ett trädskikt (Svalan 2001–2011). Skogsavverkningsytor är det klart vanligaste habitatet för arten i norra Sverige (Sondell 2009) och där finns en population på flera tusen par (Svensk Fågeltaxering).

### *Slutsatser*

I Närke finns idag ortolansparven bara i ett litet område i Kvismardalen. Förklaringen till att ortolansparven håller sig kvar där är troligen att den storskaliga potatisodlingen i området erbjuder öppen jord och att de häckande paren därför har normal häckningsframgång. Även markskiktet vid Restamossen ger liknande förutsättningar.

Studien 2011 visade att häckningen gick bra och uppenbarligen producerade de häckande paren ungar. Risken är dock stor att denna lilla kvarvarande population inom några år försvinner, kanske på grund av slumpartade faktorer. Ett positivt förhållande är dock att den större populationen på Nordkalotten sträcker förbi Kvismaren och att ett tillskott av individer då sannolikt möjliggörs.

Om vi önskar behålla ortolansparven i Närke och övriga Mellansverige måste konkreta åtgärder vidtas för att förbättra förutsättningarna där. Att försöka bygga upp en population i andra delar av Mälardalen är troligen avsevärt mycket svårare.

### *Konkreta åtgärder*

Naturvårdsverket har under 2011 gett länsstyrelsen i Örebro i uppdrag att utarbeta en åtgärdsplan för ortolansparven i Sverige. Nedan föreslås ett antal åtgärder för att förbättra förhållandena. För att genomföra åtgärderna är det ytterst viktigt att man länsvis utser personer som kan samordna åtgärderna. De län som berörs är T, U och C län samt länen norr därom.

I mellersta Sverige bör åtminstone 25 kärnområden identifieras och konkreta åtgärder måste vidtas i alla dessa områden. Kärnområden kan definieras som områden där åtminstone två ortolansparvar sjöng inom hörhåll för varandra våren 2011. Troligen är bara 10–15 kärnområden kända idag. Övriga måste upptäckas våren 2012 genom att systematiska inventeringar genomförs. I kärnområdena måste god tillgång på öppen jord erbjudas under perioden maj–juni. Harvning kan bli nödvändig för att hålla jorden fri från ogräs. Genom att erbjuda ortolansparvarna god tillgång på öppen jord och därmed goda reproduktionsmöjligheter bör antalet par inom några år kunna öka.

Andra lämpliga områden bör utväljas inte långt från kärnområdena. Att idag etablera en helt ny population långt från nuvarande områden med ortolansparvar verkar mycket svårt. Någon form av extra åtgärder måste då vidtas, men vad dessa skulle bestå i har vi ännu ingen kunskap om.

Ortolanens situation i norra Sverige är troligen inte kritisk. Det vanligaste habitatet, nyupptagna hyggen, skapas varje år av skogsbrukets föryngringshuggningar. Maskinerna som går på hygget gör spår på 5–10 % av arealen, vilket troligen gynnar ortolansparven. Exakt hur de utnyttjar hyggena bör studeras för att skogsbolagen möjligen ska kunna anpassa arbetsmetodiken till artens behov.

Åtgärder i prioritetsordning: (1) Identifiera ett kärnområde, lämna minst 0,5 hektar osått per beräknat par i form av stråk längs kanten av fälten i närheten av troliga sångplatser (Figur 1). (2) Skogsholmar lämpliga för häckning röjs, särskilt i brynen mot åkrarna huggs undervegetationen bort. Större träd lämnas med ett avstånd på ca 10 m. (3) Körvägar i åkerlandskapet är positivt. Ytan bör utgöras av grus. Gräsväxt i vägarna bör tas bort genom sladdning ett par gånger per år. Stora stenar och ledningar är positivt som sångplatser. (4) Studier med liknade målsättning som i Kvismaren 2011 bör genomföras även kommande år för att verifiera 2011 års kunskapsläge och ytterligare utöka kunskapen om ortolansparvens häckningsbiologi. (5) Studier bör även genomföras på norrländska hyggen för att se hur ortolansparven utnyttjar dem och för att undersöka om avverkningsmetoderna kan anpassas till artens behov.

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# Dynamics of garden birds at a feeding station in a suburban area near Oslo, Norway, 2000–2008

## *Variationer i fåglarnas antal vid en matningsplats i en trädgård i ett förortsområde nära Oslo, Norge, 2000–2008*

KÅRE ELGMORK †

### Abstract

The presence of birds visiting a feeding site near a villa in a suburban area to the west of Oslo was observed daily at close range during 2000–2008. The bird assemblage consisted of 17 species. Some species were present throughout the year, whereas others occurred during different seasons. Most species showed a stable occurrence from year to year and was little influenced by climatic factors. When comparing with the bird community in a spruce forest about three kilometres away, only 36% of the forest species occurred regularly at the suburban site, showing a considerable loss of diversity when a forest is changed into a suburban habitat. Abundance was recorded by the time it took the birds to consume one kilo of sunflower seeds. Maximum consumption occurred during summer and minimum during late winter. A general decrease in consumption in all years of study started during autumn followed by another marked decrease at the time of the first snowfall, which obviously acted as a signal for emigration out of the area.

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## Introduction

Few long term and detailed bird studies are conducted in gardens all year round. The present paper presents results from nine years of study by approximately daily observations at close range of a bird assemblage in a suburban area near Oslo. This study together with a previous study 1997–1999 (Elgmork 2002) provides continuous data for a period of 12 years. In the 2002-study only the number of weeks the birds were present throughout the year was recorded. After an idea by Cowie & Hinsley (1988) a study of the consumption rate was made for the years 2002–2008 by recording the time spent to consume one kilo of sunflower seeds.

Comparisons with variation in bird assemblages in national surveys in Norway and Sweden were performed, as well as with the bird assemblage in a nearby climax spruce forest.

Knowledge of garden birds is wanted as a great part of the terrestrial bird fauna belongs to garden birds, and many households provide bird feeders.

### *Location, surroundings, and climate*

A detailed description of the locality and surroundings is given in Elgmork (2002) and only a short recapitulation will be presented here. The site was situated at Jar in Bærum municipality about midway between contiguous spruce forests to the north-west and the downtown areas of Oslo city to the south-east (Figure 1). The Garden with the feeding site was situated in a contiguous residential area with parks and gardens with many large trees. The feeding site was located only 2.5 meters from a big kitchen window from where the observations were made. A young spruce tree was situated about four meters from the feeding site.

Attacks by predators were negligible. There were only three attacks by Sparrowhawks *Accipiter nisus*, all of which were unsuccessful.

As stated in Elgmork (2002), data from the Meteorological Institute in Oslo are very representative for the observation site, situated only 6.4 km away and at about the same altitude. Mean monthly normal temperature and precipitation for the 30-year period 1993–1999 was presented in Elgmork (2002). During this period maximum temperature

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† Kåre Elgmork died on 19 November 2011; see p. 189.

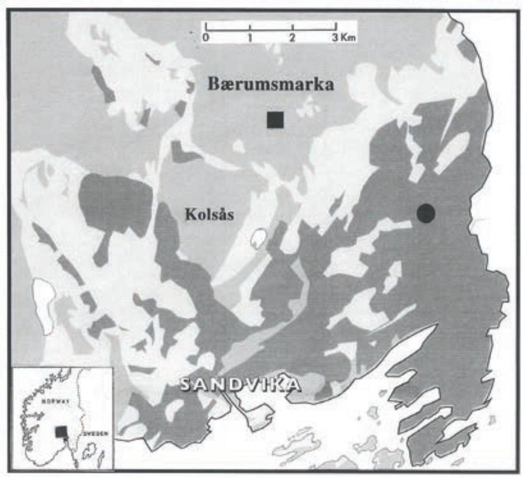


Figure 1. Parts of Bærum municipality with location of the study site (filled circle), and area of the forest bird study of Hogstad (1967) (filled square). *Darkest shading*: suburban areas to the west of Oslo city. *Medium shading*: continuous, mostly spruce forests. *Lightest shading*: agricultural areas. (Redrawn from Aschehoug og Gyldendals Store Norske Leksikon 1996, third volume; permission granted.)
*Delar av Bærum kommun. Studieområdet markerat med fylld cirkel och Hogstads skogsinventering med fylld kvadrat. Mörk skuggning: bebyggelse. Halvmörk skuggning: sammanhängande skog. Ljusaste: Jordbruksmark.*

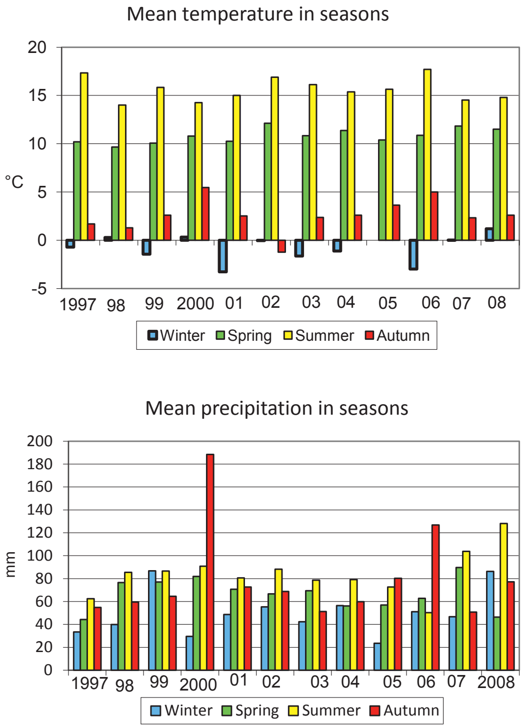


Figure 2. Temperature (upper diagram) and precipitation (lower diagram) during different seasons 1997–2008. Each column represents the mean for three months, here defined as the four seasons.
*Temperaturen (övre) och nederbörden (nedre) under de olika årstiderna 1997–2008. Staplarnas höjd anger medelvärdet för tre månader.*

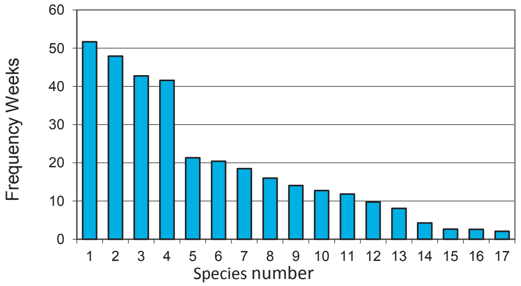


Figure 3. Assemblage of garden birds at the study site and average occurrence (average number of weeks) during the period 2000–2008. 1 Great Tit, 2 Blue Tit, 3 Greenfinch, 4 Tree Sparrow, 5 Nuthatch, 6 Blackbird, 7 Chaffinch, 8 Wood Pigeon, 9 Robin 10 House Sparrow, 11 Collared Dove, 12 Bullfinch, 13 Siskin, 14 Brambling, 15 Redpoll, 16 Yellowhammer, 17 Hawfinch
*Fåglarnas genomsnittliga förekomstfrekvens (genomsnittligt antal veckor) 2000–2008 i den studerade trädgården.*

had in July an average of 16.4° C. Minimum temperature occurred in January with an average of –4.3° C. Precipitation was at a maximum in September with 90 mm as average. Minimum precipitation occurred in February with an average of 36 mm. Total precipitation for the whole year was 763 mm, in the winter months from December to March mostly as snow.

For comparison with the bird occurrence the mean temperature and precipitation for periods of three months, representing the four seasons, are given in Figure 2. The temperatures were fluctuating among years in autumn and winter, whereas temperatures were more constant during spring and summer. Precipitation was more erratic with exceptionally high values in autumn 2000 and 2006 and in summer 2008.

## Methods

For details on methods I refer to my earlier paper (Elgmork 2002), and only a short recapitulation will be given here. The food presented at the feeding site consisted exclusively of sunflower seeds

Table 1. Rare species. Number of weeks the species occurred on average per year, 2000–2008.
*Sällsynta arter. Frekvens är medelvärdet för antal veckor med förekomst per år 2000–2008.*

| Species | Frequency | Season |
|---|---|---|
| Coal Tit *Periparus ater* | 0,6 | Nov. Dec. |
| Fieldfare *Turdus pilaris* | 0,6 | Mar. May Jun. Jul. |
| Sparrowhawk *Accipiter nisus* | 0,3 | Jul. Oct. Nov. |
| Wren *Troglodytes troglodytes* | 0,3 | Oct. Nov. |
| Crested Tit *Lophophanes cristatus* | 0,1 | Nov. |
| Goldfinch *Carduelis carduelis* | 0,1 | Apr. |
| Hooded Crow *Corvus cornix* | 0,1 | Nov. |
| Waxwing *Bombycilla garrulous* | 0,1 | Dec. |

(*Helianthus* spp.) and commercial "tit balls", as in the previous study. The balls were given as a supplementary food and were not counted. The tit balls were consumed at a lower rate than the seeds in the food box. Approximately daily observations are available for nine years (2000–2008). The number of visits and rate of consumption at the feeding site rests on the assumption that these parameters are proportional with the density of birds in the surrounding area.

The daily observations were interrupted by a few weeks absence every year, mainly in the autumn. To see if this would give some distorted results, some control observations were made. After the author had been away for 10 to 14 days during three instances, some of the four most common bird species reappeared after a few hours. After a day or two, the assemblage of birds was identical with that before the break. These results indicate that some postponement in feeding has not significantly influenced the results.

## Results

### *Bird assemblages during 12 years*

Frequency of a species is defined as number of weeks that a species was observed during one year.

The bird assemblage studied is presented in Figure 3 arranged after falling frequency during 2000–2008. Frequencies for this period follow approximately the same trend as in the first period 1997–1999 (Elgmork 2002). The four predominant species were the Great Tit *Parus major*, Blue Tit *Cyanister caeruleus*, Greenfinch *Carduelis chloris*, and Tree Sparrow *Passer montanus*. In addition the Magpie *Pica pica* was permanently present and the Great Spotted Woodpecker *Dendrocopos major* sporadically present, but neither was recorded on a weekly basis. The most remarkable difference between the two periods of study is the absence of the Collared Dove *Streptopelia decaocto* during the years 2005–2008 (Figure 7).

Rare species are defined as species with an average occurrence of less than one week per year for the period 2000–2008 (Table 1). Of the species recorded as rare in 1997–1999, only three were so rare in 2000–2008 (Fieldfare *Turdus pilaris*, Wren *Troglodytes troglodytes*, Coal Tit *Periparus ater*). On the other hand, there were some new species occurring in 2000–2008. An increase in the frequency of the Yellowhammer *Emberiza citrinella* and Hawfinch *Coccothraustes coccothraustes* led to these species being removed from the rare species category. The Yellowhammer increased from 0.3 to 3.4, and the Hawfinch from 0.3 to 2.9 weeks presence per year on average between the two study periods. The rare species occurred most frequently from October to December.

### *Seasonal variation*

The weekly frequencies of birds can be grouped into five categories (Figures 4–8) according to different patterns of occurrence. The four most common species (Figure 4) occurred throughout the year with the Great Tit being present during all weeks except three. The Blue Tit, Greenfinch, and Tree Sparrow were abundant throughout the year. The number of Greenfinches and Tree Sparrows increased from week 26 and 27, and numbers remained high throughout most of the following autumn. This sudden increase was due to the appearance of a new generation of young. The time of first occurrence of young was very stable from year to year, being about a week earlier in the Greenfinch than in the Tree Sparrow.

A group of bird species with irregular occurrence consists of the Robin *Erithacus rubecula*, Siskin

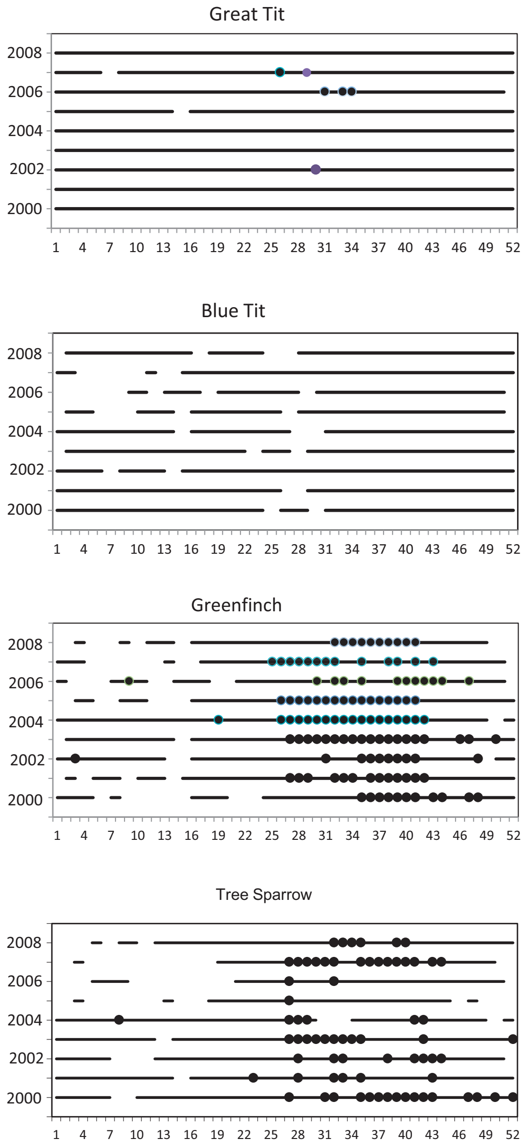


Figure 4. Yearly frequencies of the four most common species. Shortest lines indicate at least one observation in that week. Lines: <= 10 individuals. Filled circle: >10 individuals observed simultaneously that week. Horisontal axis: week number.

*Årlig frekvens för de fyra vanligaste arterna. Upplösningen (kortaste linje) motsvarar en vecka. Linje markera 10 eller färre individer. Fylld cirkel anger fler än 10 individer den veckan. Horisontella axeln anger veckonummer.*

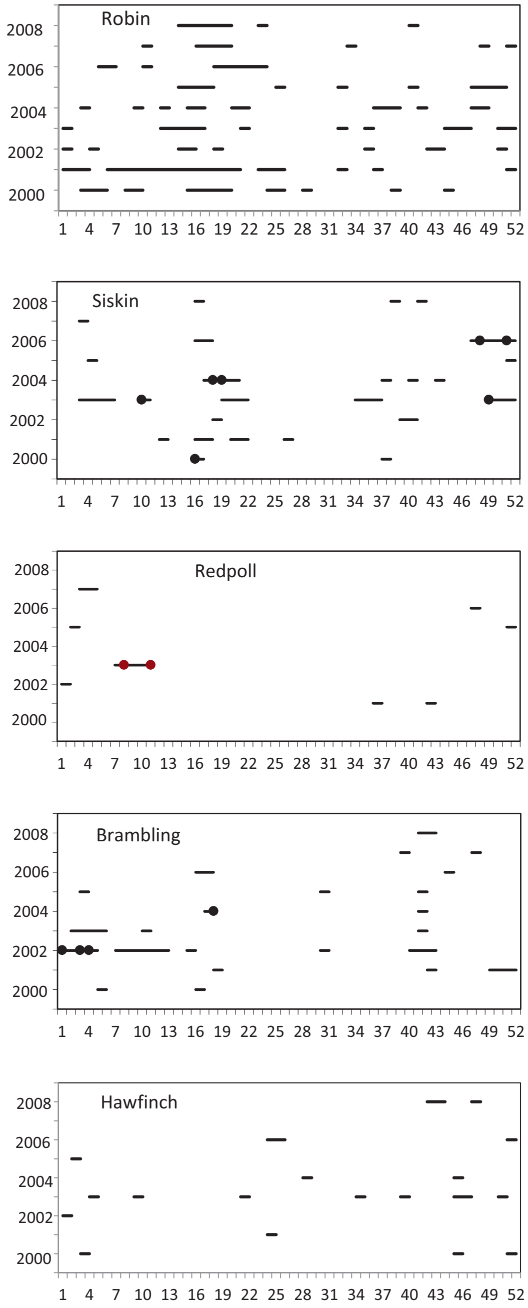


Figure 5. Yearly frequencies of species with scattered incidence. Legend as in Figure 4.

*Årlig frekvens för arter med spridd förekomst. Förklaring som i Figur 4.*

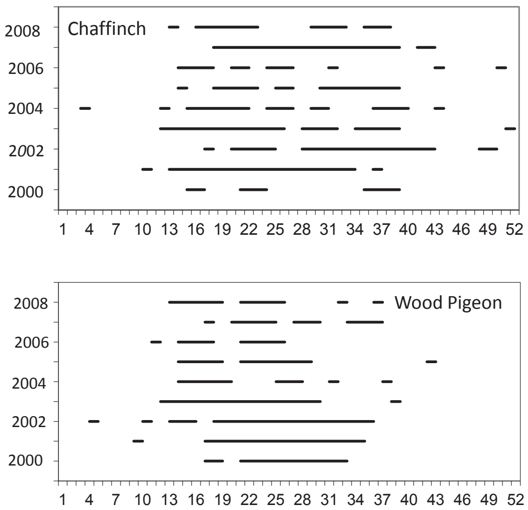


Figure 6. Yearly frequencies of the two truly migrating birds. Legend as in Figure 4.
*Årlig frekvens för två äkta flyttfåglar. Förklaring som i Figur 4.*

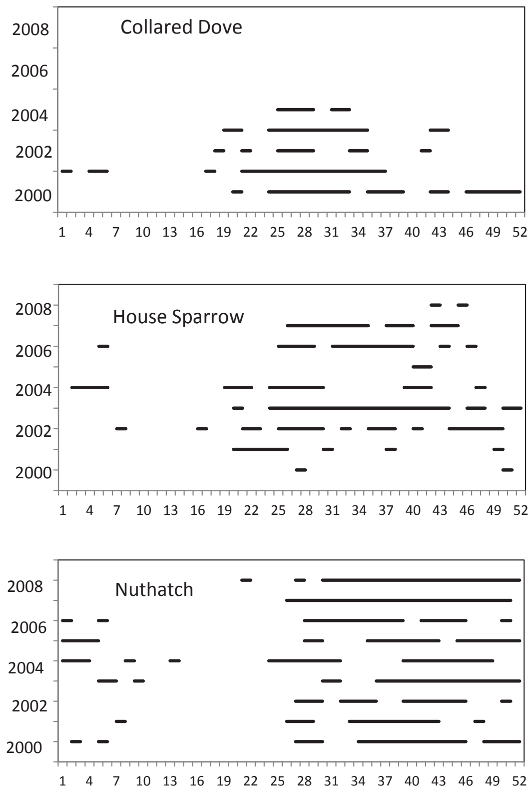


Figure 7. Yearly frequencies of species present primarily during summer and autumn. Legend as in Figure 4.
*Årlig frekvens för arter som registrerades främst sommar och höst. Förklaring som i Figur 4.*

*Carduelis spinus*, Redpoll *Carduelis flammea*, Brambling *Fringilla montifringilla*, and Hawfinch (Figure 5). All except the Robin and Hawfinch are invasion species occurring at large numbers at irregular times of the year. At the end of April 2004 both the Siskin and the Brambling occurred in large numbers simultaneously.

Species primarily present during spring and summer were the Chaffinch *Fringilla coelebs* and Woodpigeon *Columba palumbus* (Figure 6), whereas the Collared Dove, House Sparrow *Passer domesticus*, and Nuthatch *Sitta europaea* were found during summer and autumn, and sparsely also during the winter (Figure 7). Species occurring primarily during winter and spring were Blackbird *Turdus merula*, Bullfinch *Pyrrhula pyrrhula*, and the Yellowhammer (Figure 8). The Nuthatch and Blackbird were present in the general area all year but appeared on the feeding site particularly in autumn and winter (Nuthatch) and winter and spring (Blackbird). This variation throughout the year is most likely due to a shift in food preference since both species prefer food from the feeding site during winter and spring when other food is absent or extremely scarce.

Characteristic for the Bullfinch is a lower frequency in the last three years, and an interrupted occurrence indicating pulses of immigrants of both sexes even as late as at the end of May. This was also observed in 1998 and 1999 (Elgmork 2002) and reported by Nordby (1991) from a site about two km to the north.

Some preliminary bird observations from other parts of the municipality showed different assemblages, apparently influenced by local ecological conditions.

The average frequency of birds in each season was compared with average temperature and precipitation (Figure 2), and with duration of the snow cover for the same period. The analysis gave no statistically significant correlations.

The yearly frequency of individuals of each species throughout the twelve year study period 1997–2008 is presented in Figure 9. The Great and Blue

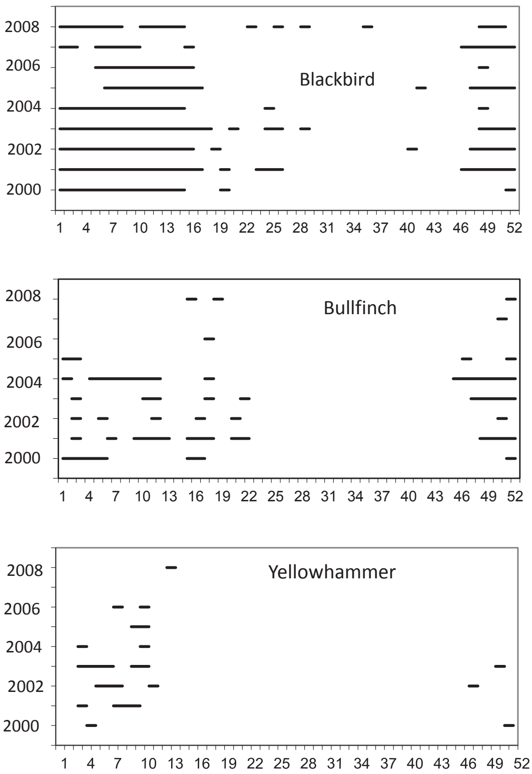


Figure 8. Yearly frequencies of species present primarily during winter. Legend as in Figure 4.
*Årlig frekvens för arter som registrerades främst under vintern. Förklaring som i Figur 4.*

Tit showed very similar occurrence with very high and stable frequencies each year, except for an intermediate falling trend in the Blue Tit. Greenfinch, Tree Sparrow, Collared dove, Blackbird, Robin, Woodpigeon, and Chaffinch showed maxima in the middle of the period from 2000–2002. The rest of the species showed a more erratic occurrence over the years. In Figure 9, I compare the results from my study site with those from the national survey of breeding birds in Norway 1997–2008 (Huseby & Stueflotten 2009). Generally, the yearly fluctuations are greater at the study site than in the national survey. This is especially so for the two invasion species Siskin and Redpoll which showed large maxima in 1999 and 2003 at the feeding site. This indicates that some species show great local variation in occurrence. The yearly variation of the Siskin and Redpoll at the feeding site was significantly correlated (0.66, P=0.02, N=12).

Some species showed a corresponding variation in occurrence at the study site and in the national survey. This is apparent for the Bullfinch, the Nuthatch, and the Greenfinch. If the sum of all the 13 shared species in the two data sets are compared, a close correlation was found between the study site and the national survey (r=0.59, P=0.04, N=12) (Figure 9). A similar comparison with the Swedish survey with 15 species (Lindström et al. 2009) exclusive of the Collared Dove and the Hawfinch, gave no significant correlation (0.43, P=0.16, N=12).

### *Habitat change and reduced bird diversity*

When comparing the bird assemblage at the study site with that in the continuous forests to the northwest about 4 km away (Figure 1), great differences are revealed. This comparison became possible due to a detailed study by Hogstad (1968) using a strip survey method during the period May 1966 to May 1967. The types of forest surveyed were spruce dominated forests and mixed forest edge. Altogether 132 surveys were made, an average of 11 per month. It seems legitimate to use so old results for comparison with the present situation as no major changes are expected to have taken place in overall assemblage composition in the forest. The comparison reveals profound differences both in number of species and in frequencies (Table 2).

Only three species were found only at the study site. The remaining fourteen species in Table 2 are regularly present both at the study site and in both types of forest. In the forest assemblage the Bullfinch, Willow Tit *Poecile montana*, Jay *Garrulus glandarius*, and the Goldcrest *Regulus regulus* were present throughout the year. The 21 species at the bottom of Table 2 were found only in the forest, some occasionally occurring at the study site as single individuals at extremely low frequencies (Table 1). This means that only 36% of the spruce forest assemblage occurred regularly at the study site in the suburban area. This is a dramatic reduction showing that when forest habitats are transformed into agricultural and suburban areas, a considerable loss of diversity ensues.

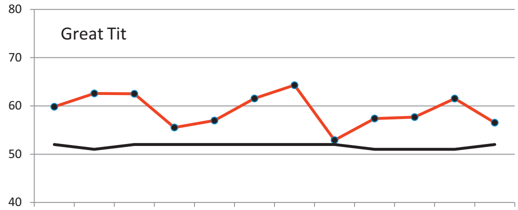
### *Rate of consumption*

The consumption of sunflower seeds as grams per day on average per week is shown in Figure 10. The tit balls were not used in this experiment. During periods of intense feeding, the food box, containing one kilo of seeds, was eaten empty during

Table 2. Comparison of the Jar garden community with a neighbouring forest community, according to Hogstad (1968). The values give the number of months during a year that the species have been observed. * accidental observations 1997–2008. Bold: Maximum record for that species.

*Jämförelse mellan fågelsamhället i trädgården i Jar och det i ett närliggande skogsområde enligt Hogstad (1968). Värdena anger antalet månader under året så arten observerats. * tillfällig observation 1997–2008. Fet stil: högsta noterat värde. Kolumnerna avser granskog, skogskan med blandskog respektive trädgården i Jar.*

| Species | Spruce forest | Mixed forest edge | Jar site |
|---|---:|---:|---:|
| House Sparrow *Passer domesticus* Gråspurv | 0 | 0 | 3,1 |
| Tree Sparrow *Passer montanus* Pilfink | 0 | 0 | 9,6 |
| Collored Dove *Streptopelia decaocto* Tyrkerdue | 0 | 0 | 3 |
| Wood Pigeon *Columba palumbus* Ringdue | **5** | 1 | 3,7 |
| Magpie *Pica pica* Skjære Skata | 8 | 10 | **12** |
| Great Tit *Parus major* Kjøttmeis Talgoxe | 11 | 10 | **12** |
| Blue Tit *Cyanistes caeruleus* Blåmeis | 7 | 10 | **11,2** |
| Nuthatch *Sitta europea* Spettmeis Nötväcka | 4 | **8** | 4,9 |
| Blackbird *Turdus merula* Svarttrost Koltrast | **8** | 7 | 4,7 |
| European Robin *Erithacus rubecula* Rødstrupe | **7** | 5 | 3,2 |
| Greenfinch *Carduelis chloris* Grønnfink | 10 | 9 | 10 |
| Siskin *Carduelis spinus* Grønnsisik | **9** | 5 | 1,9 |
| Redpoll *Carduelis flammea* Gråsisik | 0 | **6** | 0,6 |
| Bullfinch *Pyrrhula pyrrhula* Dompap | **12** | 9 | 2,4 |
| Chaffinch *Fringilla coelebs* Bokfink | **6** | 4 | 4,3 |
| Brambling *Fringilla montifringella* Bjørkefink | **6** | 5 | 1,1 |
| Yellowhammer *Emberiza citrinella* Gulspurv | 8 | **9** | 0,6 |
| Hooded Crow *Corvus corone cornix* Kråke | **11** | 10 | * |
| Treecreeper *Certia familiaris* Trekryper | **10** | 5 | * |
| Black Woodpecker *Dryocopus martius* Svartspett Spillkråka | **11** | 6 | 0 |
| Wren *Troglodytes troglodytes* Gjerdesmett Gärdsmyg | **7** | 5 | * |
| Fieldfare *Turdus pilarus* Gråtrost Björktrast | **8** | 7 | * |
| Songthrush *Turdus philomelos* Måltrost Taltrast | **7** | 4 | 0 |
| Redwing *Turdus iliacus* Rødvingetrost | **7** | 6 | * |
| Willow Tit *Poecile montana* Granmeis Talltita | **12** | 2 | 0 |
| Crested Tit *Lophophanes cristatus* Toppmeis Tofsmes | **11** | 1 | * |
| Garden Warbler *Sylvia borin* Hagesanger Trädgårdssångare | 2 | 2 | 0 |
| Chiffchaff *Phylloscopus collybita* Gransanger | **5** | 3 | 0 |
| Willow Warbler *Phylloscopus trochilus* Løvsanger | **4** | 2 | 0 |
| Jay *Garrulus glandarius* Nøtteskrike | **12** | 7 | 0 |
| Goldcrest *Regulus regulus* Fuglekonge | **12** | 5 | 0 |
| Hedge Accentor *Prunella modularis* Jernspurv | **5** | 2 | * |
| White Wagtail *Motocilla alba* Linerle Sädesärla | 2 | **4** | * |
| Long-tailed Tit *Aegithalos caudatus* Stjertmeis | 1 | 1 | 0 |
| Green Woodpecker *Picus viridis* Grønnspett | 1 | **3** | 0 |
| Tree Pipit *Anthus trivialis* Trepiplerke | **3** | 1 | 0 |
| Periparus ater *Parus ater* Svartmeis | **11** | 0 | 0 |
| Hazel Grouse *Tetrastes bonasia* Jerpe | **1** | 0 | 0 |
| Woodcock *Scolopax rusticola* Rugde Morkulla | **3** | 0 | 0 |
| Crossbill undet. *Loxia sp*. Korsnebb | **7** | 0 | 0 |
| Starling *Sturnus vulgaris* Stær | 0 | 5 | * |
| Marsh Tit *Poecile palustris* Løvmeis Entita | 0 | **9** | 0 |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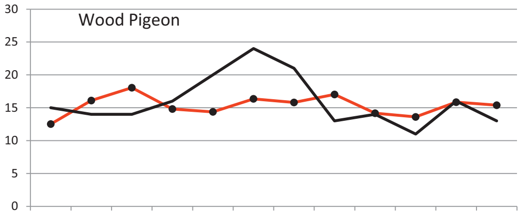
Great Tit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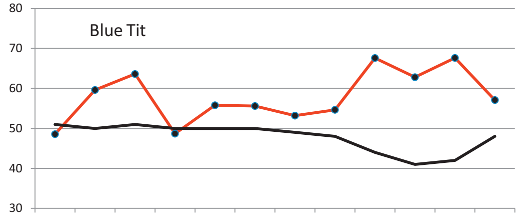
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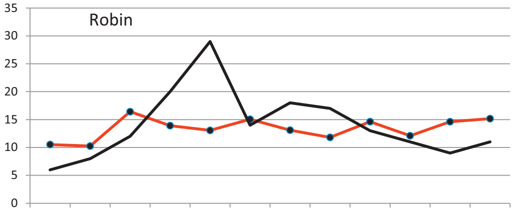
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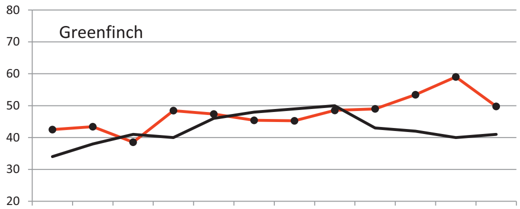
Robin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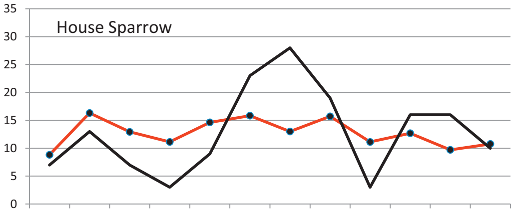
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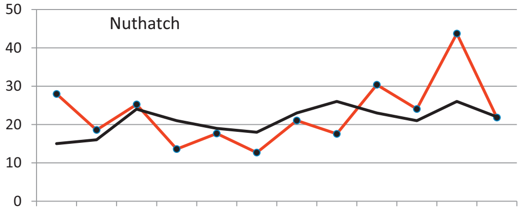
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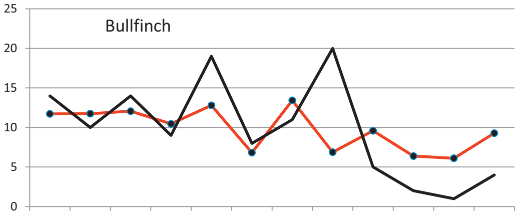
Nuthatch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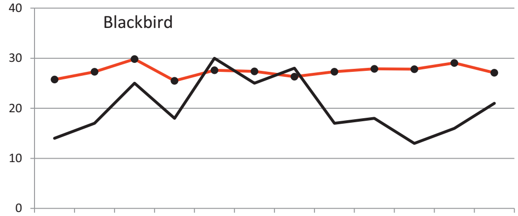
Bullfinch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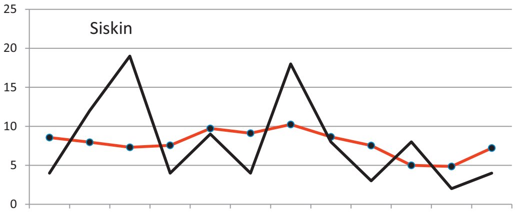
Blackbird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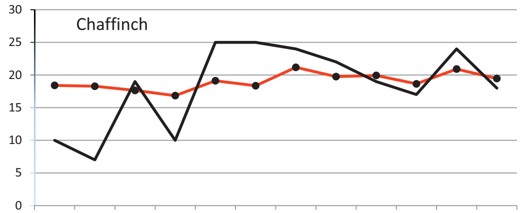
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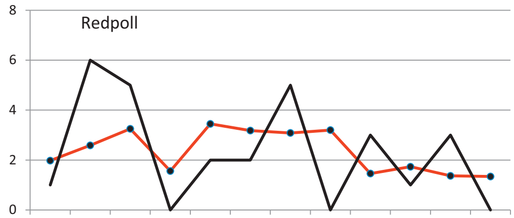
Chaffinch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Redpoll

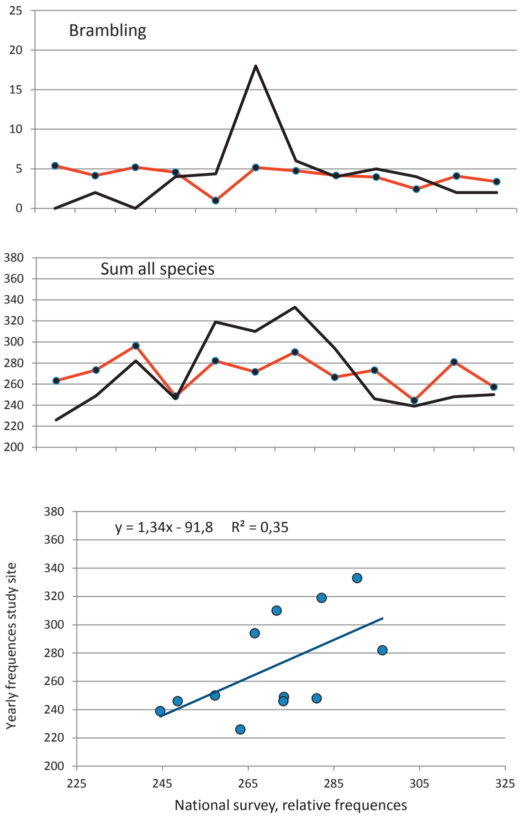

Figure 9. Variation of single bird species at the study site (black line) compared with results from the national survey of breeding birds in Norway (red line) in the period 1997–2008. The vertical axis represents relative values to make the curves fit in the diagrams. The last two diagrams compare the whole assemblage of birds at the study site and in the national survey.

*Variationen hos enskilda arter i den studerade trädgården (svart linje) och enligt den norska häckfågeltaxeringen (röd linje) perioden 1997–2008. Vertikala axeln representerar relativa värden. De sista två diagrammen avser summan av alla arter.*

one day. As seeds fallen to the ground was eaten during the following day, a minimum consumption time was set to two days, giving 500 g eaten maximally per day.

The highest rate of consumption occurred in summer and autumn with lower values during the other seasons. Minimum consumption was observed in late winter and spring when it could take up to 88 days to eat down one kilo of seeds. Record in consumption rate was set in July 2003 when the feeding cylinder was empted in the course of 4 hours, mainly by Greenfinch and Tree Sparrow and their young.

To avoid statistical noise the year was divided into three months intervals and average consumption for each interval was correlated with average temperature and precipitation (Figure 2). Precipitation during January–March was represented by the duration of the snow cover. No significant correlation could be traced between seasonal consumption and climatic factors.

The period April–June was characterized by very rapidly increasing consumption, especially in May. In the years 2002, 2003, and 2004 there was an early maximum followed by a period of lower consumption. This maximum may indicate a wave of immigrants. This was not recorded, however, in the four last years of study.

Consumption during July–September was relatively stable with long periods of maximum consumption, except in 2004, when a reduction started already in July under medium temperature and precipitation. Also the summer of 2005 showed low values. High consumption values occurred in 2003, 2007, and 2008, but there was no significant correlation to temperature or precipitation. If the week numbers of the first summer maximum are correlated with average temperature of the foregoing spring, no correlation was found (r=0.13, P=0.77, N=7). The correlation with precipitation was negative, but not quite significant (–0.69, P=0.09, N=7), indicating that a high precipitation in spring may lead to an earlier summer maximum.

A marked decrease in consumption during all seven years of study took place in October–December, starting usually in October or November. A cold period followed by the first snow in autumn trigger two reactions. Firstly, a sharp rise in consumption in the years 2002–2005 indicates extraordinary high intake of food by the birds present. An increase in the number of birds is unlikely as the maxima are very short and it is unreasonable that new flocks of birds should occur exactly in the same setting every year. The increase in consumption was followed by an abrupt fall in consumption in all years synchronous with the first snowfall, marked with an asterisk in Figure 10. The fall took place from none to two weeks after the first snowfall in six of seven years. In 2007, however, the decline occurred shortly before the snowfall. The decrease continued even if temperature was increasing later in the autumn. This indicates a regular emigration out of the area in autumn.

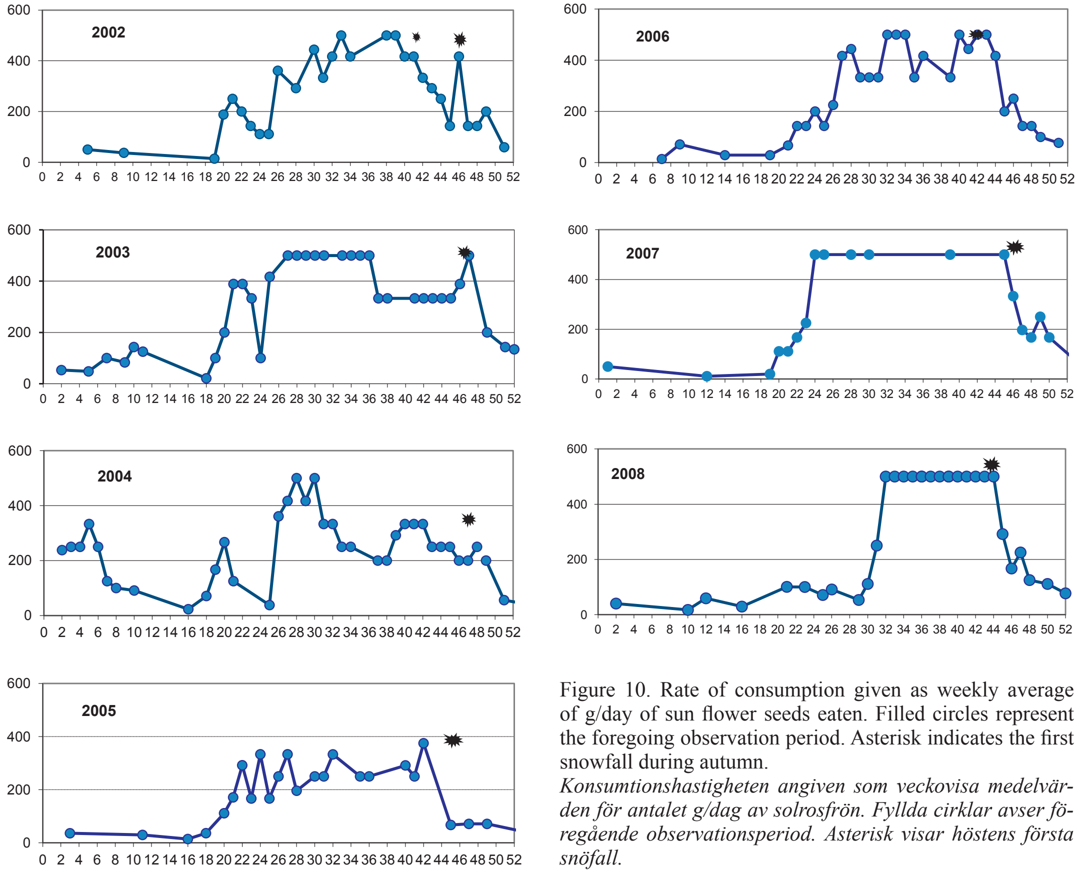

Figure 10. Rate of consumption given as weekly average of g/day of sun flower seeds eaten. Filled circles represent the foregoing observation period. Asterisk indicates the first snowfall during autumn.
*Konsumtionshastigheten angiven som veckovisa medelvärden för antalet g/dag av solrosfrön. Fyllda cirklar avser föregående observationsperiod. Asterisk visar höstens första snöfall.*

## Discussion

The large frequency of the Great Tit and Blue Tit is in accordance with the presence of these species in the Nordic countries. According to breeding bird surveys in Norway, Sweden, Denmark, and Finland (Heldbjerg & Eskildsen 2009), the Great Tit is the garden bird number one in these countries, seen in 90% of the gardens. Number two is the Blue Tit, seen in 80% of the gardens.

The species observed at the feeding site do not represent the true assemblage of birds in the area. The restricted feeding with only seeds and fat reduces or excludes species with other food preferences as insect eaters. This is borne out by the presence in the same garden of other species never seen on the feeding site. Such species were the Pied Flycatcher *Ficedula hypoleuca*, White Wagtail *Motacilla alba*, and Lesser Whitethroat *Sylvia curruca*. Maximum consumption during summer in the present study is inconsistent with the results of Cowie & Hinsley (1988) who found maximum consumption during the winter in England. The most common species in both studies were the Great Tit, Blue Tit, and Greenfinch. In the English study, also the House Sparrow was common.

The close relation between the sum of species in the study area and in the national survey indicates that the birds at the study site vary in concert with birds in a much wider area. Some overriding, universal factor or factors must regulate the number of birds synchronously over vast areas of Norway. Testing climatic factors is problematic as the climate varies considerably over the country. Lack of correlations with climatic factors in the study area seems to disqualify the climate as a regulatory factor.

## Acknowlegements

I am grateful to Magne Husby, Trondheim, and Åke Lindström, Lund, for help in obtaining data from the respective national breeding bird surveys in Norway and Sweden.

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## Sammanfattning

Under nio år (2000–2008) har antal fåglar som besökte en matplats med solrosfrön och talgbollar räknats dagligen året om med bara några få korta avbrott. Dessförinnan hade fåglarna räknats mindre frekvent än dagligen under tre år, räkningsperioden är alltså tolv år lång. Platsen är en villaträdgård i Bærum, ett villaområde beläget mellan Oslo city och sammanhängande skogar (Figur 1). Matningsplatsen låg 2,5 m från ett stort köksfönster från vilket alla observationer gjordes. Klimatet framgår av Figur 2, som visar temperatur och nederbörd i form av årstidsmedelvärden. En äldre kvantitativ och detaljerad inventering året runt av fågelfaunan i skogsområdet gjorde det möjligt att jämföra skogen fågelfauna med den i villaområdet. Vanliga namn på fågelarterna tillsammans med engelska och latinska finns i Tabell 2.

De fyra mest frekventa besökarna var talgoxe, blåmes, grönfink och pilfink (Figur 3). En del sällsynta arter registrerades (Tabell 1) men en av de arter som förekom åren 1997–1999, turkduvan, saknades helt under den efterföljande nioårsperioden. Fåglarnas säsongsmässiga variation presenteras i Figurerna 4–8. De har grupperats med hänsyn till sina förekomstmönster under året. De nyssnämnda fyra arterna som förekom mest frekvent visas i Figur 4. Antalet grönfinkar och pilfinkar ökade från vecka 26 och 27 beroende på att årets ungfåglar dök upp. Figur 5 redovisar arter med mera oregelbundet uppträdande, och dessa arter är invasionsarter, förutom rödhake och stenknäck. Rena sommarfåglar (Figur 6) var bofink och ringduva. Några arter (Figur 7), exempelvis gråsparv, iakttogs främst under sommar och höst men bara sällan under vintern. Vinter- och vårarter (Figur 8) var koltrast och domherre. Den senare arten har varit fåtalig de senaste åren men uppträtt stötvis på våren ända in i slutet av maj. En analys av väderdata och fågelförekomst visade inget samband med temperatur, nederbörd eller snöperiodens längd.

I Figur 9 visas de olika arternas och hela fågelsamhällets årliga förekomst vid matningen i förhållande till det nationella beståndet som det registreras av den nationella häckfågeltaxeringen. Flera arter visade tydlig samvariation och för summorna för tretton arter som var med i båda räkningarna var korrelationen signifikant. Motsvarande korrelation med den svenska häckfågeltaxeringen visade däremot inte någon signifikans.

I Tabell 2 redovisas frekvensen för fåglarna i trädgården och i det inventerade skogsområdet bara fyra kilometer därifrån. Det var stora skillnader. Bara tre arter enbart i trädgården. Fjorton arter registrerades både i trädgården och i skogen, medan majoriteten av arterna bara fanns i skogen. När en skog omvandlas till villaområde förloras alltså en mycket stor del av den biologiska mångfalden.

**Kåre Elgmork 1924–2011**
This article is published posthumously. Kåre Elgmork died on 19 November 2011, only a few weeks before his 87th birthday. He had just prepared the letter to offer the paper for publication in *Ornis Svecica*. Kåre Elgmork was professor of zoology, studied first copepods, and then the brown bear. He was deeply engaged in conservation, and for his achievements in this field he was the second person in Norway on whom the Order of St. Olav was conferred. He was also an ornithologist. In his later years he could no longer walk in the fjelds and woods. Instead he counted the birds at his feeder every day for years. The editor thanks Viggo Ree, who saw to that the manuscript was transferred to *Ornis Svecica*.

# Korta rapporter – *Short communications*

## Vattenrall *Rallus aquaticus* som häckfågel på torrmark och möjlig predator på småfågel

### *The Water Rail* Rallus aquaticus *breeding in dry habitat and possible predator on songbirds*

DAN LUNDBERG

Vattenrallen *Rallus aquaticus* är känd för att häcka i vegetationsrika våtmarker, företrädelsevis i områden med tät vass eller säv. Den kan dock uppträda även i mindre typiska miljöer, såsom i starrmarker kring sänkta sjöar (Svensson m.fl. 1999). Arten är också känd som predator på ägg och fågelungar (Cramp 1980, Hansson m.fl. 2000). I samband med häckningsstudier av hämpling *Carduelis cannabina* sommaren 2009 i Torsviken, Göteborg, gjordes flera observationer av vattenrall, relevanta för kunskapen om artens biotopval och potentiella effekt som predator på småfågel.

Undersökningsområdet (57°41,7’ N, 11°47,7’ E) består av invallade vattenområden, utfyllnader och en deponi för muddermassor. Det finns stora bestånd av vass i de våtare delarna, områden till synes lämpliga för vattenrall. Sedan många år finns det även områden med torrare mark. I ett sådant delområde, 30×90 m stort och avgränsat av grusvägar på tre sidor och en bred stenvall på den fjärde sidan, påträffades vattenrall. Marken är ganska stenig och har knä- och lårhög örtvegetation, blandat med buskar (varav de flesta är trädgårdsrymmare). Den lägre växtligheten domineras av brännässlor, åkertistel, renfana och diverse gräs. Några enstaka strån vass fanns också, men ingen säv eller starr alls. I delområdet fanns ungefär åtta par törnsångare *Sylvia communis* och tre par hämpling.

Jag besökte Torsviken ungefär varannan dag från april till september, oftast 4–6 timmar per dag. Den första kontakten med vattenrall i delområdet hade jag den 2 juni. Vid i stort sett varje besök därefter hördes en eller två vattenrallshonor med det läte som arten använder när den vallar ungar (Cramp 1988, Svensson m.fl. 1999). Från till synes samma platser hördes ofta ilsket varnande törnsångare och vid andra tillfällen gav dessa varningsläten indikationer på var rallarna höll till i området. Två kullar av vattenrall sågs. Den 3 juli sågs några svarta dunungar som kom ut ur vegetationen och vände 2 dm ut på en grusväg. Ungarna var ca 1/5 av en vuxen fågels storlek. Tre dagar senare såg jag tre fjäderklädda ungar, vars storklek var ca 3/5 av adult storlek. Ungarna klättrade ungefär 1 meter upp i en buske, där de möjligen letade fågelbon.

Jag undersökte även ett annat delområde beläget 15 m nordost om den torra ytan. Det är en 500×350 m stor yta omgiven av en 15 m bred stenvall, i princip helt avgränsat från det andra delområdet. Vegetationen domineras av strandaster, vass, säv, tussilago och åkertistel. Där häckade ungefär tio par vardera av sånglärka *Alauda arvensis*, sydlig gulärla *Motacilla flava flava* och sävsparv *Emberiza schoeniclus*, samt några arter till. Där häckade också minst åtta par vattenrall. Detta är dock troligen en låg skattning, eftersom man när man gick ut i området oftast kunde höra två eller tre vattenrallshonor valla sina ungar, där de olika honorna avlösta varandra i området.

Jag letade bon i båda delområdena och täckte ca 60% av den mindre ytan och 40% av den större. I öppnare områden sökte jag efter bobyggande och matande fåglar och i buskmark letade jag igenom buske för buske. I vassytor gick jag linjer med några meters mellanrum. Nilsson m.fl. (1982) visade på en metod att inventera vattenrall och rörsångare *Acrocephalus scirpaceus* i vass genom att leta bon efter häckningstid. Jag prövad detta men fann inga bon. Ett problem var att jag inte hade sett vattenrallsbo förut, ett annat att ca 1/3 av vassen var liggvass och därmed inte kunde undersökas ordentligt. Jag hittade dock resterna av tre rörsångarbon som till synes prederats (bodelar som hängde i vassstrån).

Häckningsutfallet för tättingarna i området blev synnerligen magert. Vid trettio besök med boletning återfanns inga bon med ungar (dock flera med ägg) och sågs sammanlagt bara en kull flygga gulärlor och en flygg sävsparvsunge. Inga flygga sånglärkor sågs. Den dåliga häckningsframgången skulle kunna bero på de många vattenrallarna. Av andra potentiella predatorer på ägg och ungar sågs spår av räv vid ett enda tillfälle, inga spår av mink alls, och inga vildsvinsspår på sommaren. Kråkfåglar sågs födosöka bara enstaka gånger i området men inte där vegetationen var hög. Brun kärrhök *Circus aeruginosus* häckar inte i området. Detta gör vattenrallen till den mest sannolika predatorn på fågelungar i området.

Jag har inte påträffat någon tidigare beskrivning av vattenrall som häckfågel på torrmark. När man påträffar en art i nya biotoper så undrar man om arten har blivit förbisedd eller om den möjligen har breddat sitt habitatval. Sedan några år häckar till exempel vattenrall med minst tio par på Nidingen, en 500×50 m stor och 3–4 meter hög ö av sten och sand i Kattegatt med vindpinad låg buskvegetation och endast lite havssäv att häcka i (Tommy Järås, muntligen). Arten lär också ha häckat vid Hoburgsklippan på södra Gotland (Thord Fransson, muntligen). Håller arten på att sprida sig till nya habitat och vad beror då detta på? Om så är fallet kan det också vara värt att notera den potentiella effekten på häckningsframgång hos tättingar som vattenrallens intåg kan tänkas få.

Figur 1. Undersökningsområdet där vattenrallar förmodades utöva stark predation på småfåglarna.
*The study area where Water Rails were assumed to strongly influence breeding success of songbirds by predation.*

## Tack

Denna artikel grundas på observationer gjorda i samband med en studie av hämpling som stöttats av Alvins fond. Tack till Tommy Järås, Stig Fredriksson, Lars Carlsson och Tord Fransson för uppmuntran och information, samt till Åsa Wilske och Susann Dutt för tillstånd att fältarbeta i områden som tillhör Göteborgs hamn.

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## Summary

Two pairs of Water Rail were found with young in a dry and stony area with up to one metre tall herb vegetation. The area was about 30×90 m, and apart from the rails, eight pairs of Common Whitethroat and three pairs of Linnet were breeding there. The former were alarmed and often called intensively when the rails moved about with their young. In another area not far away, at least eight pairs of Water Rails were breeding. This area was about 500×350 m, and several pairs of Reed Warblers and ten pairs each of Skylark, Yellow Wagtail and Reed Bunting were also breeding there. I searched both areas carefully for nests and young of the passerines. I saw only one fledged brood of Yellow Wagtail and one young of Reed Bunting, indicating a very low breeding success in both areas. I suggest that the cause was predation by the Water Rails. A photo of the study areas is given in Figure 1.

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