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Sex differences in recovery pattern and migratory direction of Goldcrests *Regulus regulus* ringed in northern Europe during autumn migration

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Abstract

Among Goldcrests ringed in Denmark, Sweden and Finland, and recovered later the same autumn in the British Isles, a remarkably high proportion (30:5) of males are found, compared with the assumption of equal sex ratio or a surplus (55%) of males in the migrating population during autumn. Sex ratio bias was not found in birds ringed in Norway. Provided that males and females can be assumed to have on average the same relative fat deposits and that the sexes are morphologically similar, both sexes should have the same flight range. Differences in flight capacity can thus not be a main explanation to the sexual bias in the short time recoveries in the British Isles. An alternative explanation may be a difference in migratory strategy between the sexes when facing long sea passages. If there is a choice, e.g. an alternative migratory route along the coast, the females, although for unknown reasons, fly out over the sea to a lesser extent than the males. Different geografical situations, compared to the rest of southern Scandinavia, is assumed to explain why Goldcrests ringed in southern Norway and later recovered in the British Isles do not show the same sexual bias.

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Introduction

The Goldcrest *Regulus regulus* is one of the most numerous species trapped at bird observatories. In Sweden nearly 400,000 Goldcrests have been ringed (Stolt et al. 1995). In contrast to most other passerine species, the majority of Goldcrests can be sexed on plumage characters. This gives further valuable information in addition to other data collected in connection with ringing.

In autumn catches of Goldcrest, males usually predominate while the opposite seems to be true during spring migration (Table 1). The predominance of males during autumn migration seems to be a general phenomenon at north European ringing sites. The reason for this is howewer unclear (e.g. Karlsson 1980, Lifjeld 1982). High mortality among males during the migrations and wintering has been proposed as an explanation to the low proportion of males in spring catches (Busse & Machalska 1969).

Among Goldcrests ringed in Finland in autumn and recovered in the British Isles there was a remarkable sex bias as 7 recoveries were all males (Saurola 1978).

The purpose of this analysis of short time recoveries of Goldcrests during autumn migration ringed in Scandinavia is to elucidate the proportion of sexes among birds that presumably have crossed the North Sea or the Baltic Sea.

Methods

Data on recoveries of Goldcrests ringed in Sweden 1960–94 have been obtained from the data base at the Swedish museum of Natural History, Stockholm. Of these 221 were short time recoveries of birds ringed and recovered during the same autumn migration season (until 15 November), and displaced > 50 km. Mean overall speed of migration has by two different methods been estimated to 47 km/day (Hildén & Saurola 1982, Grenmyr & Olsen 1995).

A few recoveries with uncertain recovery circumstances have not been included in the analysis. In those cases (n = 8) where sex has not been noted at the time of ringing, or different sex at ringing and recovery, sexing in connection with the retrap has been used when made by a ringer.

Table 1. Sex ratio of Goldcrests trapped during autumn and spring migration at different localities in North Europe.
Könsfördelning i fångst av kungsfåglar under höst resp. vårflyttning vid olika lokaler i norra Europa.

Autumn *Höst*					
Locality *Lokal*	Sampling method *Fångstmetod*	Period *Period*	n *antal*	% males *% hannar*	References *Källa*
Netherlands, Schiermonnikoog	Mist-nets	1969, 72–73	1.949	63.2	Osieck (1976)
Poland, Mierzeja, Wislana	?	1963–67	21.303	61.4	Busse & Machalska (1969)
Poland, Hel	?	1963–67	4.933	58.7	Busse & Machalska (1969)
Germany, Augustusburg	Mist-nets (?)	1976–80	555	58.2	Saeman (1987)
Norway, Jomfruland	Mist-nets	1972, 74–80	6.733	57.4	Lifjeld (1982)
Finland	Mist-nets (?)	1913–77	72.000	ca 55–60	Saurola (1978)
Sweden, Hammarö	Mist-nets	1969–75	7.727	55.6	Ehrenroth & Lundin (1976)
Sweden, Falsterbo	Mist-nets	1970–78	12.300	55.6	Karlsson (1980)
Denmark, lighthauses	Found dead	1886–1939	1.037	55.2	Hansen (1954)
Sweden, Stora Fjäderägg	Mist-nets	1985–92	18.055	53.7	Grenmyr & Olsén (1995)
Latvia, Pape	"Rybachy-trap", Mist-nets	1967–86	60.811	53.1	Baumanis & Reinbergs (1990)
Sweden, Eggegrund	Mist-nets	1989–93	14.992	52.5	Grenmyr (not publ.)
Norway, Revtangen	?	1969	460	49.6	Holgersen (1970)
Britain, Calf of Man	Mist-nets	1989	3.309	46.7	Thorpe & Sapsford (1992)
Spring *Vår*					
Locality *Lokal*	Method *Fångstmetod*	Period *Period*	n *antal*	% males *% hannar*	References *Källa*
Britain, Calf of Man	Mist-nets	1989	1344	49.5	Thorpe & Sapsford (1992)
Sweden, Falsterbo	Mist-nets	1980–94	3011	42.9	Karlsson (in letter)
Poland, Hel	?	1963–67	5091	42.6	Busse & Machalska (1969)
Sweden, Eggegrund	Minst-nets	1993	524	41.3	Grenmyr (1994)
Poland, Mierzeja, Wislana	?	1963–67	2127	38.5	Busse & Machalska (1969)
Germany, Augustusburg	Mist-nets (?)	1976–80	93	35.5	Saeman (1987)

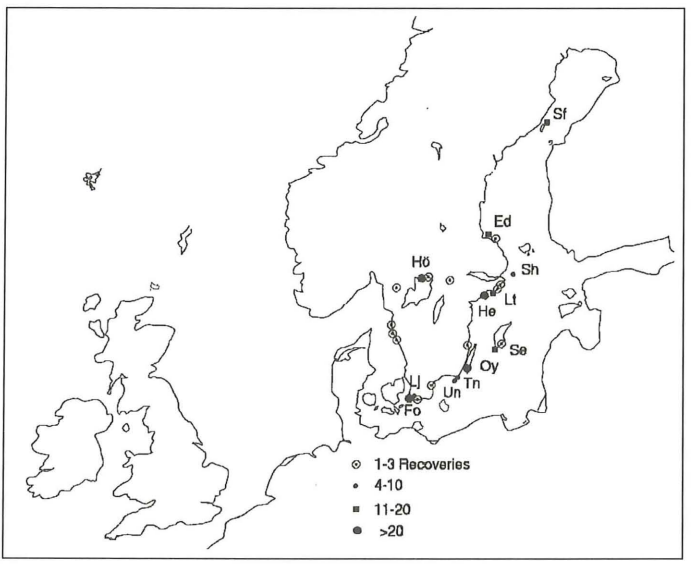

Figure 1. Ringing sites for Goldcrests ringed in Sweden and numbers of short time recoveries (> 50 km) during autumn migration until 15 November. (Designations of larger bird observatoriers are given in Table 2).

Ringmärkningslokaler i Sverige och antal korttidsfynd av kungsfåglar vilka tillryggalagt minst 50 km under höstflyttningen t.o.m. 15 november. (Beteckningar på större fågelstationer finns i Tabell 2).

Table 2. Distribution in four directional sectors of short time recoveries of Goldcrests during autumn migration until 15 November ringed in Sweden. M=males, F=females and N=not sexed.

Korttidsfynd t.o.m. 15 november av höstflyttande kungsfåglar ringmärkta i Sverige, fördelade på återfyndsriktning inom fyra sektorer. M=hannar, F=honor och N=obestämd kön.

		271–360°			181–270°			91–180°			1–90°			
Ringing locality, Landscape	Bird observatory	NW			SW			SE			NE			
Ringmärkningslokal, Landskap	*Fågelstation*	M	F	N	M	F	N	M	F	N	M	F	N	Total
Stora Fjäderägg, VB	Sf				10	7								17
Eggegrund, GÄ	Ed		1		4	4		3	1					13
Björns fyr, UP						1								1
Hammarö, VR	Hö	2			8	5	1	8	5		1			30
Arnön, VR					2				1					3
Bönkasen, DS							1							1
Ässön, NÄ						1								1
Svenska högarna, UP	Sh		1		3	1		3	2					10
Huvudskär, SÖ						1								1
Torö, SÖ					1	1			1					3
Landsort, SÖ	Lt	4	2		2	4		3						15
Hartsö-Enskär, SÖ	He				9	6		10	1					26
Faludden, GO									2					2
Sundre, GO	Se	1			5	4		4	1					15
Fredriksberg, SM						1								1
Ottenby, ÖL	Oy				7	6		6	7		1			27
Torhamn, BL	Tn				2	2		4	1	1				10
Utklippan, BL	Un		1		3	2		1	1			1		9
Falsterbo, SK	Fo	3	1	1	9	3	2	2	1	2	2			26
Ljunghusen, SK	Lj				2		1				1			4
Two localities, SK					1			1						2
Nidingen, HA						1		1	1					3
Mölndahl, VG									1					1
Total *Totalt*		10	6	1	68	50	5	46	26	3	5	1	0	221
Number of recoveries/sector *Antal återfynd/sektor*		17			123			75			6			221
Controlled by a ringer *Kontrollerad av ringmärkare*		53%			66%			95%			83%			75%

Data on short time recoveries during the autumn migration until 15 November in the British Isles, including two birds reported from the North Sea, of Goldcrests ringed in Norway, Finland and Denmark have been obtained from the British Trust for Ornithology (BTO, data base), Mead & Clark (1987), Runde (1987), Spencer & Hudson (1974, 1975, 1977, 1978), Saurola (1978) and Solvang, Cleve & Lifjeld (1991). Two birds ringed in Norway, recorded unsexed and as a female, respectively, were controlled by ringers on the British Isles as males.

Data on Goldcrests ringed in other countries and later recovered the same autumn in Sweden have been obtained from the Swedish Museum of Natural History, Stockholm.

Statistical analyses of sex ratios have been made from two different assumptions of the ratio among north European Goldcrests during autumn migration, i.e. equal sex ratio and a surplus (55 %) of males.

Results

Figure 1 shows the ringing sites in Sweden of short time recoveries (n=221). The distribution of the recoveries has been divided into four compass sectors from the respective ringing sites (Table 2). Of the recovered Goldcrests a majority (90 %) has moved within the SW and SE sectors (91–270°).

From the northernmost observatory, Stora Fjäderägg, all recoveries of ringed Goldcrests lie within the SW sector. The proportion of Goldcrests with migratory direction in the SE sector, compared with the SW sector, was at maximum in the southeastern part

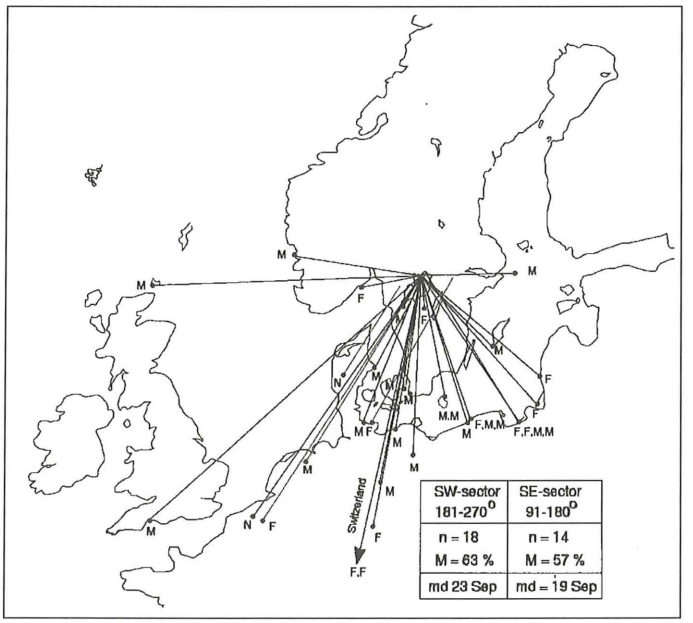

Figure 2. Short time recoveries of Goldcrests during autumn migration ringed at four sites in the interior of central Sweden. M=males, F=females, N=not sexed. Insert Table: Distributon of recoveries (n=number) and sex ratio in SW and SE sector and median date (md) of ringing.

Korttidsfynd av kungsfåglar under hösten från fyra inlandslokaler. M=hannar, F=honor och N=kön obestämt. Inflikad tabell: Antal fynd (n) samt könsfördelning inom SV respektive SO sektor samt mediandatum (md) för ringmärkning.

(Figure 4) of the Swedish Baltic coast (Chi^2=8.30, df=1, p<0.01).

The age distribution of the 221 recovered Goldcrests was 163 juveniles, 7 adults and 51 of which age was not determined. Of all autumn recoveries 75% has been controlled by other ringers. Along the southern and eastern shores of the Baltic this proportion was particularly high, 100% (n = 75). The distribution of recoveries over different countries is given in Table 3.

The temporal distribution of ringing dates in three areas of Sweden as well as the entire Sweden (excluded Stora Fjäderägg) is shown in Table 4. Recoveries from the northernmost ringing site, Stora Fjä-

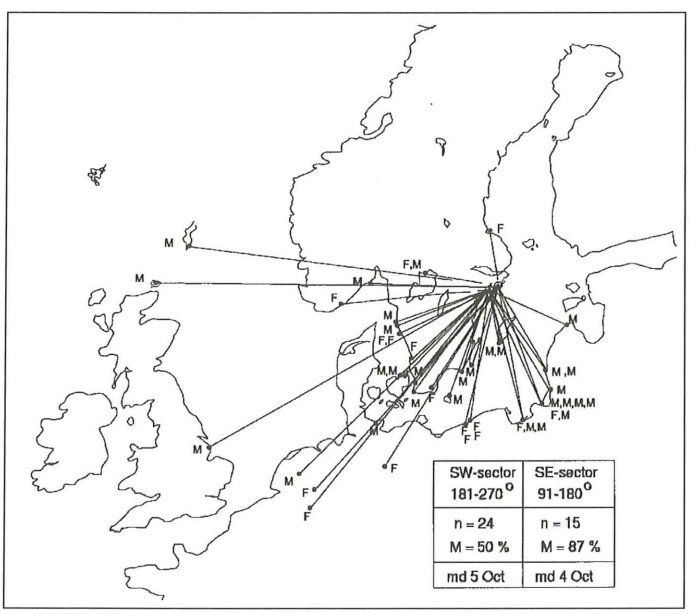

Figure 3. Short time recoveries of Goldcrests during autumn migration ringed at four sites along the Södermanland coast. M=males, F=females, N=not sexed. Insert Table: Distributon of recoveries (n=number) and sex ratio in SW and SE sector and median date (md) of ringing.

Återfynd av kungsfåglar ringmärkta vid fyra lokaler längs kusten av Södermanland. M=hannar, F=honor och N=kön obestämt. Inflikad tabell: Antal fynd (n) samt könsfördelning inom SV respektive SO sektor samt mediandatum (md) för ringmärkning.

derägg were excluded because all lie in the SW sector. The median dates (md) of ringing in the three areas were 4 days, 1 day and 1.5 days, respectively, earlier for Goldcrests found in the SE sector compared to birds found in the SW sector (P> 0.05, Mann-Withney U-test). The median date of ringing of the 182 recoveries from ringing sites in southern Sweden, i.e. from Eggegrund and southwards, with migratory directions within the SW sector was 4 October and for those with directions within the SE sector 1 October (P> 0.05, Mann-Withney U-test).

Recoveries of Goldcrests are shown from three areas in southern Sweden (Figure 2–4). Recoveries from the interior of central Sweden are shown in Figure 2, and recoveries from two coastal areas are shown in Figure 3 and 4. Among recoveries (n=35) of Goldcrests from the interior of central Sweden the majority has been ringed at Hammarön and Arnön, on the northern coast of lake Vänern.

Recoveries (n = 45) of Goldcrests ringed on the Södermanland coast, Hartsö-Enskär, Torö, Landsort and Huvudskär are shown in Figure 3. Two recoveries in the SE sector have been reported from Gotland, the others from the southern coast of the Baltic Sea. The sex ratio of the recoveries within the SE sector, i. e. birds heading out over the Baltic Sea, was 13 males against 2 females, compared to a presumed ratio of 55% males (P=0.0107, Binominal test) or alternatively an equal sex ratio (P=0.0074, Binomial test 2-Tailed). For birds moving in the SW sector, i.e. birds heading towards land, the sex ratio is equal, 12 females and 12 males.

Recoveries (n = 46) of Goldcrests from the southeastern part of the Swedish Baltic coast, ringed at Ottenby, Utklippan and Torhamn are shown in Figure 4. Here sex ratio was nearly the same for birds

Table 3. Distribution of short time recoveries of Goldcrests during autumn migration ringed i Sweden.

Korttidsfynd av kungsfåglar ringmärkta under höstflyttningen i Sverige fördelade på fyndländer.

Country *Land*	Males *Hannar*	Females *Honor*	Not sexed *obest. kön*
Sweden	24	14	1
Norway	6	6	
Denmark	20	9	2
Finland		3	
Estonia	1		
Latvia	2	1	
Litauania	2	3	
Russia (Rybachy)	19	8	
Poland	19	17	3
Germany	9	7	1
Netherlands	5	4	1
Belgium	8	6	
Britain	11	1	
Switzerland	1	2	
France	1	2	1
Spain	1		
Total	129	83	9

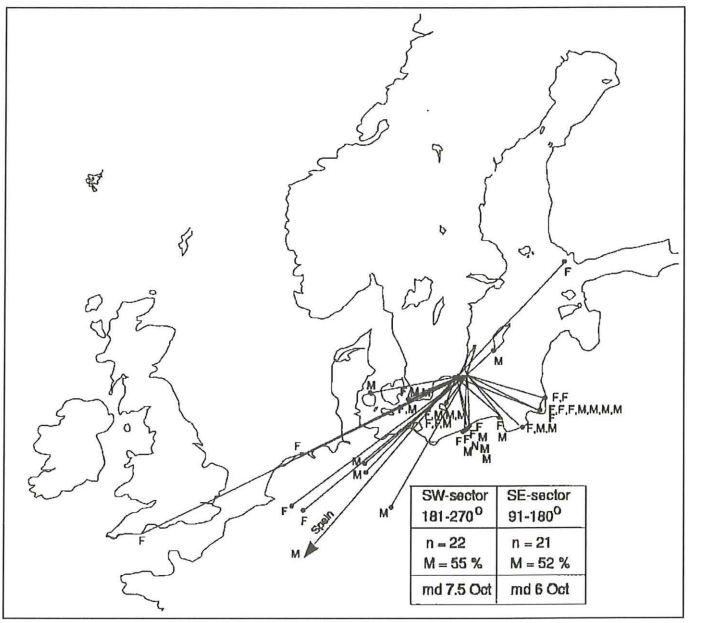

Figure 4. Short time recoveries of Goldcrests during autumn migration ringed at three sites of the southeastern part of the Swedish Baltic coast. M=males, F=females, N=not sexed. Insert Table: Distributon of recoveries (n=number) and sex ratio in SW and SE sector and median date (md) of ringing.

Återfynd av kungsfåglar ringmärkta vid tre lokaler vid sydöstra delen av svenska ostkusten. Inflikad tabell: Antal fynd (n) samt könsfördelning inom SV respektive SO sektor samt mediandatum (md) för ringmärkning.

Table 4. Ringing dates of Goldcrests ringed in three regions of Sweden and entire Sweden, with the northernmost ringing site, Stora Fjäderägg Bird Observatory, excluded.

Ringmärkningsdatum för fynd av kungsfåglar fångade i tre områden i södra Sverige, samt totalt hela Sverige exklusive Stora Fjäderäggs fågelstation.

Region *Område*	Interior *Inland* Fig. 2		Södermanland *Södermanland* Fig. 3		Southeast *Sydöstra* Fig. 4		Sweden excl. S. Fjäderägg *Sverige exkl. S. Fjäderägg*	
Sector	SW	SE	SW	SE	SW	SE	SW	SE
n	16	14	24	15	22	21	106	75
first date	30 Aug	22 Aug	12 Sep	28 Aug	18 Sep	19 Sep	24 Aug	22 Aug
2 quartile	15 Sep	11 Sep	27 Sep	20 Sep	29 Sep	28 Sep	27 Sep	25 Sep
median	23 Sep	19 Sep	5 Oct	4 Oct	7.5 Oct	6 Oct	4 Oct	1 Oct
3 quartile	29 Sep	29 Sep	11 Oct	9.5 Oct	12 Oct	18 Oct	11 Oct	11.5 Oct
last date	9 Oct	12 Oct	21 Oct	18 Oct	26 Oct	24 Oct	27 Oct	24 Oct

heading in the SE and SW sectors, respectively.

Goldcrests ringed in Norway, Finland, Sweden and Denmark during autumn migration (until 15 November) and recovered in the same season in the British Isles are shown in Table 5. Excluding birds ringed in Norway there are only 5 females among the recoveries (Figure 5) and the biased sex ratio is significantly different from an expected ratio of 55 % males (P=0.0000, Binominal test) or alternatively from a presumed equal sex ratio (P=0.0002, Binomial test 2-Tailed).

Short time recoveries of Goldcrests ringed in Norway (n = 20) during autumn migration and later found in the British Isles are shown in Figure 6. The sex ratio, 9 males to 11 females, among the recoveries does not deviate from an assumed ratio of 50–55 % males (55% males, P=0.249, n.s. Binomial test).

Of short time recoveries (n = 155, Table 6) of Goldcrests found in Sweden during autumn migration and ringed in other countries up to the end of 1994 a high proportion (89 %) has been controlled by ringers. The median recovery date (controlled by ringers) in Sweden for Goldcrests ringed in Norway is 6.5 October and for those ringed in Finland it is 10 October (P>0.05, Mann-Whitney U-test).

Discussion

Goldcrests ringed in Sweden move in different directions towards wintering areas on the continent. A mean vector calculated collectively for all recoveries does not in a relevant way describe the migratory

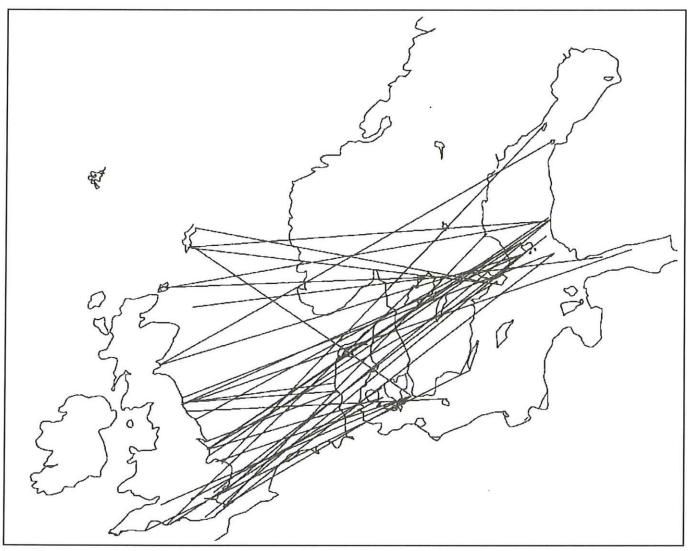

Figure 5. Short time recoveries in the British Isles of Goldcrests, 30 males and 5 females, ringed in Denmark, Sweden and Finland during autumn migration (P=0.0000, Binominal test, expected ratio of 55 % males respectively p=0.0002, Binominal test 2-Tailed, expected ratio of 50% males).

Korttidsåterfynd på Brittiska öarna av kungsfåglar, 30 hannar och 5 honor, ringmärkta under höstflyttningen i Danmark, Sverige och Finland (P=0,0000, Binominal test, förväntad andel 55 % hannar respektive p=0,0002, Binominal test tvåsidig, förväntad andel 50% hannar).

Table 5. Short time recoveries of Goldcrests during autumn migration ringed in Scandinavia and later found in the British Isles until 15 November .

Korttidsfynd på Brittiska öarna t.o.m. 15 november av kungsfåglar ringmärkta under höstflyttningen i Skandinavien.

Country (ringed) *Land (ringmärkning)*	Males *Hannar*	Females *Honor*	Total *Totalt*
Norway	9	11	20
Finland	13	3	16
Sweden	11	1	12
Denmark	6	1	7
Total	39	16	55

movements over southern Sweden. The proportion of Goldcrests with a migratory direction in the SE sector is at its largest in the southeastern part of the country, while Goldcrests ringed in northern Sweden exhibit a closely collected orientation towards SW. A minor part of the migratory Scandinavian Goldcrest population crosses the Baltic during autumn migration, and the proportion reported from the SE sector is, however, biased by the extremely high ringing activity on the southeast Baltic coast, compared to western Europe (Hanssen 1982).

There are most likely several reasons for the dispersion in different migratory directions among the Goldcrests passing through Sweden on autumn migration. The most likely main explanation is that southern Sweden is passed by Goldcrests from populations of widely different origins. Recoveries in Sweden stem from Norway in the west to Karelia, Russia in the east (Table 6). Goldcrests of eastern origin probably pass southern Sweden later than those of western origin.

Wind drift may certainly also contribute to an increase in dispersion, particularly in movements over open sea. Generally speaking it is difficult to determine the degree of influence of this factor on the movements of the recovered birds, since the time for sea passage is known with certainty only for very few individuals.

Stationary anticyclone weather and associated easterly winds in autumn affect migrating Goldcrests on northerly and southerly routes respectively (Saurola 1978). A connection between easterly winds and larger catches of Goldcrests has been found at Ottenby Bird Observatory (Gezelius & Hedenström 1988).

The small size and thereby the limited migratory capacity of the Goldcrest makes it particularly sensitive to adverse winds. Migration over large bodies of water like the Baltic Sea involves great risks. It can thus be assumed that to accomplish a successful migration a favourable weather situation should be used to reach the target area together with a predetermined migratory direction. One hypothesis is that different individuals (or populations) with different migratory directions, participate in the migratory movements in different winds. A certain wind direction favours birds to a varying degree depending on the direction of their target area; the ones that in a

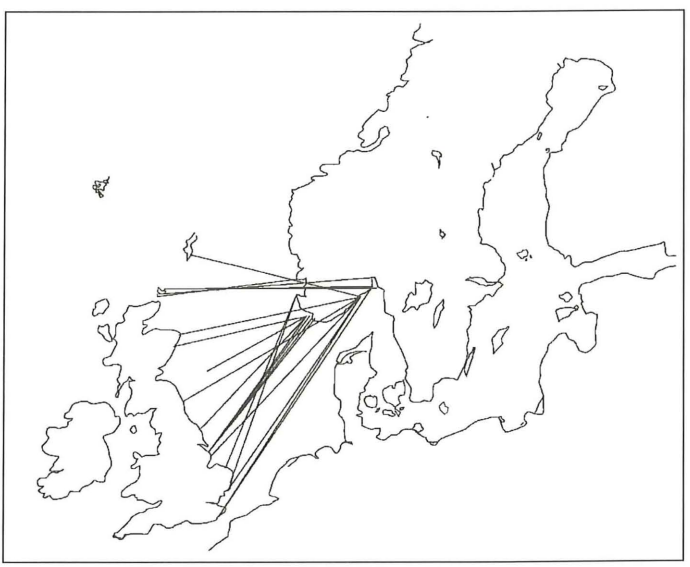

Figure 6. Short time recoveries (n = 20) in the British Isles of Goldcrests, 9 males and 11 females, ringed in Norway during autumn migration. (P=0.249, Binomial test n.s., expected ratio of 55% males).

Korttidsfynd, av kungsfåglar på Brittiska öarna, 9 hannar och 11 honor, av kungsfåglar ringmärkta under höstflyttningen i Norge. (P=0,249, Binomial test, ej signifikant skild mot förväntad andel 55% hannar)

Table 6. Short time recoveries of Goldcrests in Sweden during autumn migration until 15 November of birds ringed abroud.

Korttidsfynd t.o.m. 15 november av kungsfåglar påträffade i Sverige ringmärkta under höstflyttningen i andra länder.

Country (ringed) *Land (ringmärkning)*	n
Norway	23
Finland	58
Estonia	31
Latvia	3
Lithuania	5
Russia (Rybachy)	5
Russia	9
Poland	6
Denmark (Christianso)	15
Total	155

given situation have the most favourable winds will to the greatest extent be on migration, so called pseudodrift (Alerstam 1982).

A significantly large proportion of males was represented among recoveries of Goldcrests ringed in Northern Europe and found in the British Isles later the same autumn, with the exception of Norway. This confirms the trend Saurola (1978) noted for Goldcrests ringed in Finland.

The reason for the heavily biased sex ratio regarding movements to the British Isles and also over the Baltic Sea by Goldcrests ringed on the Södermanland coast is unclear. Morphologically the males are on average slightly larger (e.g. wing and tail length, Saemann 1987). Whether this small difference in size can be decisive on long nonstop migratory flights is uncertain. According to flight mechanical theory geometrically similar birds with the same relative fat load have equal maximum flight range (Pennycuick 1975). Fat measurements during stopover of Goldcrests on autumn migration at Ottenby, Sweden, indicate equal fat deposits for both sexes (Hansson & Pettersson 1989). For individuals staying less than 24 hours the fat index was 3.0 ± 1.4 for males as well as females (scale 0–6, males n = 2413, females n = 2209). Provided that the above measurements can be applied generally, and that males and females can be assumed to be approximately geometrically similar, both sexes should on average have the same maximum flight range. Differences in flight capacity can therefore probably not be a major explanation to the predominance of males among short time recoveries in the British Isles during autumn migration.

The Goldcrest can be assumed to follow leading lines such as the coast lines as far as possible (Hansen 1981). An explanation to the difference between the sexes in the number of recoveries in the British Isles may be a differences in migratory strategy, between males and females, when facing open sea. One possible hypothesis could be that, provided there is a choice, females avoid flying out over the sea to a greater extent than males. For the majority of Goldcrests ringed in Finland, southern Sweden and Denmark and on SW migration the Swedish and Danish west coast would provide a leading line. Corresponding conditions would apply to birds on SE migration along the Swedish east coast (Fig 7).

The British Isles are not a major wintering area for Scandinavian Goldcrests (Hanssen 1982). Norwegian Goldcrests probably follow the coastline in preference to crossing open sea, reaching the southern tip of Norway before crossing the Skagerak SSE to Denmark (Cramp et al. 1992). I think birds ringed in Norway and later recovered on the British Isles are both birds from the south crossing of the Skagerrak in adverse weather conditions, and birds of eastern origin on SW migration. Goldcrests on SW migration ringed in southern Norway lack an alternative route towards the SW when facing the Atlantic ocean in the west. Individuals on SE migration in the southeastern part of the Swedish east coast face a similar geographical situation. Provided that both sexes on average have the same fat deposits, males and females probably have the same maximum flight range, which may explain why Goldcrests

Figure 7. Principle flight patterns along leading lines, mainly coasts, in south Scandinavia.

Principskiss över ledlinjeflyttning längs södra Skandinaviens kuster.

ringed in Norway and shortly afterwards recovered in the British Isles do not exhibit a biased sex ratio compared to the expected c. 50–55 % males.

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Sammanfattning

Könsskillnader i återfyndsmönster och flyttningsriktning hos kungsfåglar Regulus regulus *ringmärkta i Nordeuropa under höstflyttningen*

Kungsfågeln är en av de mest ringmärkta fågelarterna på fågelstationerna. I Sverige har nära 400.000 individer ringmärkts (Stolt et al. 1995). I höstfångsterna av kungsfågel dominerar vanligen hannar medan det omvända förhållandet förefaller gälla under vårflyttningen (Tabell 1).

Fynd av kungsfåglar funna t.o.m. 1994 ingår som underlag. Tabell 2 visar 221 korttidsfynd (t.o.m. 15 november) av kungsfåglar ringmärkta i Sverige och återfunna > 50 km från fångstplatsen under samma höstflyttning. En sammantagen beräknad medelvektor beskriver sannolikt inte relevant flyttrörelserna över södra Sverige, där såväl östliga, som västliga populationer passerar. Betydande spridning av fyndriktningar gäller från såväl fyra lokaler i inlandet (Figur 2) som från två kustnära områden (Figur 3–4). Andelen kungsfåglar med flyttriktning mot SO-sektorn är som störst i sydöstra delen av

Sverige (Figur 4) medan kungsfåglar ringmärkta i norra Sverige (Stora Fjäderägg) visar en samlad flyttriktning i SV-sektorn (Chi^2=8,30, df=1, p<0,01). Sydostliga rörelser av Skandinaviska kungsfåglar under höstflyttningen är ett generellt inslag, men troligen passerar en mindre del av populationen mot sydost över Östersjön (Hanssen 1982). Bakomliggande orsaker till den betydande spridningen av flyttriktningar är sannolikt flera. Förutom risk för vindavdrift vid t.ex. havspassager är den troligen viktigaste förklaringen att över södra Sverige passerar kungsfåglar med vitt skilda populationsursprung (Tabell 6). En hög andel av fynden har gjorts av ringmärkare, 75% av fynden av ringmärkta kungsfåglar i Sverige (n=221) respektive 89% av fynden i Sverige av ringmärkta individer utomlands (n=155). Av fynden vid södra och östra delen av Östersjökusten har samtliga gjorts i samband med ringmärkningsverksamhet. Tidsmässigt passerar troligen östliga kungsfåglar södra Sverige senare än västliga. Mediandatum (Tabell 4) för kungsfåglar med flyttriktning mot SO-sektorn jämfört mot SV-sektorn är 1 till 4 dagar tidigare för de tre undersökta områdena (P> 0,05, Mann-Withney U-test). Mediandatum för fynd (kontrollerade av ringmärkare) i Sverige av kungsfåglar ringmärkta i Norge är 6,5 oktober jämfört med Finland 10 oktober (P> 0,05, Mann-Withney U-test).

Figur 5 visar korttidsåterfynd (n=35) på Brittiska öarna av höstflyttande kungsfåglar vilka ringmärkts i Sverige, Danmark och Finland. Av återfynden är endast 5 honor. Snedfördelningen könsmässigt är signifikant skild ifrån ett antaget förhållande av 55% hannar bland höstflyttande nordeuropeiska kungsfåglar (P=0.0000, Binominal test) eller alternativt lika (50% hannar) könsfördelning (P=0.0002, Binomial test 2-sidig). Detta bekräftar den trend Saurola (1978) noterade för kungsfåglar ringmärkta i Finland. Däremot är den könsmässiga fördelningen, 9 hannar resp 11 honor, av kungsfåglar ringmärkta i södra Norge (Figur 6) och senare påträffade på Brittiska öarna inte snedfördelad (Binominial test ej signifikant, jämfört med fördelning 55% hannar).

Figur 3 och 4 visar motsvarande jämförelse för flyttningar över Östersjön av ringmärkta kungsfåglar i Sverige. Återfynden visar en betydande könsmässig snedfördelning för fåglar ringmärkta vid Södermanlandskusten (Binominal test p=0,0107 jämfört med 55% övervikt av hannar) vilka återfunnits med riktning mot SO medan mot SV-sektorn är könsfördelning jämn. För kungsfåglar ringmärkta i sydöstligaste området är könsfördelningen i SO- resp. SV-sektor väsentligen jämn. Orsaken till den kraftiga snedfördelningen könsmässigt, beträffande flyttningarna dels till Brittiska öarna och dels även över Östersjön av kungsfåglar ringmärkta vid Sörmlandskusten (Figur 3) är oklar. Morfologiskt är hannarna genomsnittligt något större (t ex stjärt- och vinglängd; Saemann 1987). Huruvida den knappa storleksskillnaden kan vara utslagsgivande vid längre flyttsträckor non-stop är osäkert. Enligt flygmekanisk teori har geometriskt lika fåglar med relativt lika fettdepåer samma räckvidd (Pennycuick 1975). Fettmätningar av höstflyttande kungsfåglar vid Ottenby, Sverige, visar för båda könen likvärdiga fettdepåer (Hansson & Pettersson 1989). Om förhållandet gäller generellt, d.v.s. att honor och hannar har relativt lika fettdepåer, samt att könen aproximativt sett är geometriskt likformiga, bör honor resp. hannar av kungsfåglar ha genomsnittligt samma räckvidd. Kapacitetsskillnader mellan könen kan troligen därför inte vara en huvudsaklig förklaring till den observerade könsskillnaden.

En förklaring, om än med oklar orsak, till könsskillnader i återfynden på t.ex. Brittiska öarna kan vara skilda flyttningsstrategier mellan könen vid mötet med havet. En hypotes är att om valmöjlighet gives undviker honorna att flyga ut över havet i mindre grad än hannarna. För huvuddelen av SV-flyttande ringmärkta kungsfåglar i Finland och södra Sverige samt Danmark, torde svenska och danska västkusten utgöra en ledlinje. Motsvarande gäller mot öster för SO-flyttande individer längs svenska ostkusten (Figur 7).

Ringmärkta kungsfåglar i södra Norge och senare påträffade på Brittiska öarna utgörs troligen av dels västliga fåglar flyttande över Skagerack och vinddrivna, dels SV-flyttande östliga individer. SV-flyttande kungsfåglar ringmärkta i södra Norge (Figur 6) saknar i väster mot Atlanten en alternativ flyttväg mot sydväst under höstflyttningen. Motsvarande situation föreligger geografiskt för SO-flyttande individer vid sydöstra delen av svenska ostkusten (Figur 4). Med utgångspunkt ifrån relativt lika fettdepåer hos båda könen, har troligen hannar och honor samma flygkapacitet, vilket kan vara en förklaring till varför dels kungsfåglar ringmärkta i Norge och påträffade på Brittiska öarna, dels kungsfåglar ringmärkta vid sydöstra delen av svenska ostkusten och som flyttat över Östersjön, inte uppvisar någon könsmässig snedfördelning jämfört med förväntad könsproportion (ca 50–55% hannar).