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The Swedish Reed Warbler *Acrocephalus scirpaceus* population estimated by a capture-recapture technique

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--- **Abstract** ---

The number of Reed Warblers *Acrocephalus scirpaceus* leaving Sweden on autumn migration was estimated by a capture-recapture technique. A large number of Reed Warblers are ringed annually, mainly in July–September. During the same period, shortly after ringing, these birds leave Sweden on autumn migration directed south-west. One sample is recaptured at the south-western corner of Sweden, at Falsterbo Bird Observatory, and the capture-recapture technique can be used to estimate the size of the total population. The result of the calculation for the total number of Reed Warblers leaving Sweden each autumn was 3.3 million (95 % confidence interval ±0.86 million). The corresponding number for the juvenile birds was 1.8 million (±0.63 million). Due to a low rate of recaptures of ringed adult birds at Falsterbo, the calculated total number may be too high, whereas the number achieved for juvenile birds was judged to be more correct. Detailed analyses of available data support that about 1.8 million juvenile birds leave Sweden on autumn migration. Among them, 5.7 % are assumed to be of Finnish origin and 1 % are assumed to come from other areas outside Sweden. On the basis of available data on survival, breeding success, pair density and reed areas, the mean annual breeding population of Reed Warblers in Sweden, 1988–1993, was estimated to be about 500,000 to 600,000 pairs, which is a larger population than previously assumed.

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Introduction

The size of an animal population can only exceptionally be assessed by direct counts of individuals. One indirect approach is the capture-recapture method, which has been frequently used in animal ecology (see Krebs 1978), but not much used in ornithology. The aim of this paper is to estimate the size of the Swedish Reed Warbler *Acrocephalus scirpaceus* population by applying a capture–recapture technique on data from bird ringing, and to discuss what errors might influence the result obtained.

The Reed Warbler has successively expanded its distribution towards the north and north-east from the end of the last century to the middle of the 1970s (SOF 1990, Glutz 1991). During the period 1975–1992, the Swedish Reed Warbler population continued to increase, more or less continuously, and during 1992–1997, it has remained on a high level according to the index of the Swedish breeding bird census (Svensson 1997, 1998). The species breeds mainly in reed beds standing in fresh water, preferably in eutrophic lakes, but also in reed beds bordering bays along the coast. The main distribution covers the southern parts of Sweden, to about 61° N, and parts of the coast of the Gulf of Bothnia. Suitable habitats for Reed Warblers seem to be lacking further north in Sweden, where the reed beds are less frequent.

More than a quarter of a million Reed Warblers were ringed in Sweden up to and including 1996 and 1,774 were recovered. An overwhelming majority of the birds ringed, as well as recovered, were captured in mist-nets. The ringing sites cover most of the breeding area in Sweden (Figure 1).

During the autumn migration, between end of July and early October, Reed Warblers leave Sweden heading south-west, towards winter quarters in tropical West Africa. The south-west directed autumn migration is evident from ringing recoveries (Figures 2 and 3). From the results of the Swedish part of the ACRO-project, a project initiated by EURING
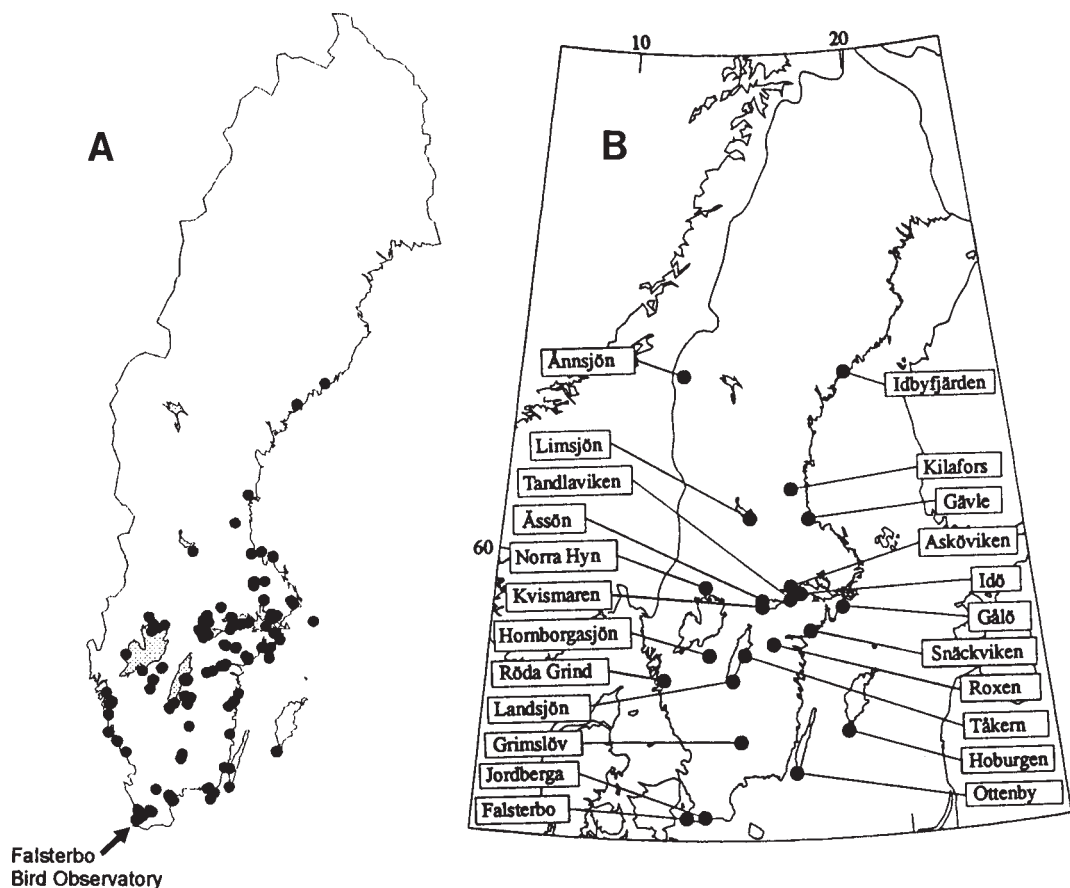
Figure 1. A. Locations of main ringing sites for Reed Warblers *Acrocephalus scirpaceus* in Sweden. Only ringing sites for birds that were later recovered are included. The map can be said to show the main ringing sites because the mean number of Reed Warblers ringed per recovery is 157.
B. The ringing sites participating in the ACRO-project in Sweden (From Stolt et al. 1993). Reed Warblers were ringed at all the sites with the exception of the most north-western one, Ånnsjön, where mainly Sedge Warblers *Acrocephalus schoenobaenus* were captured..

A. Geografisk fördelning av större märkplatser för rörsångare Acrocephalus scirpaceus *i Sverige. Endast märkplatser för återfunna rörsångare är medtagna. Kartan kan sägas visa märkplatser med ett stort antal ringmärkta rörsångare, eftersom medeltalet märkta per återfynd är 157.*
B. Märkplatser i det svenska ACRO-projektet (från Stolt et al. 1993). Rörsångare fångades vid samtliga märkplatser utom den längst i nordväst, Ånnsjön, där främst sävsångare fastnade i näten.

(the European Union for Bird Ringing), we know that adult Reed Warblers leave Sweden early in the season, shortly after completed breeding, in late July–August, and that juvenile birds follow from late July–early October (Stolt et al.1993).

Capture-recapture method

The Petersen method is the first and simplest form of capture-recapture technique used to study animal populations (Pollock et al. 1990). Briefly, when we capture, ring and release a known number of birds, the total population will consist of some individuals with a ring and some without a ring. In order to estimate the total population size we have to know the proportion of ringed birds in the population. This proportion can be estimated by recapture of a random sample and assuming that the sample will
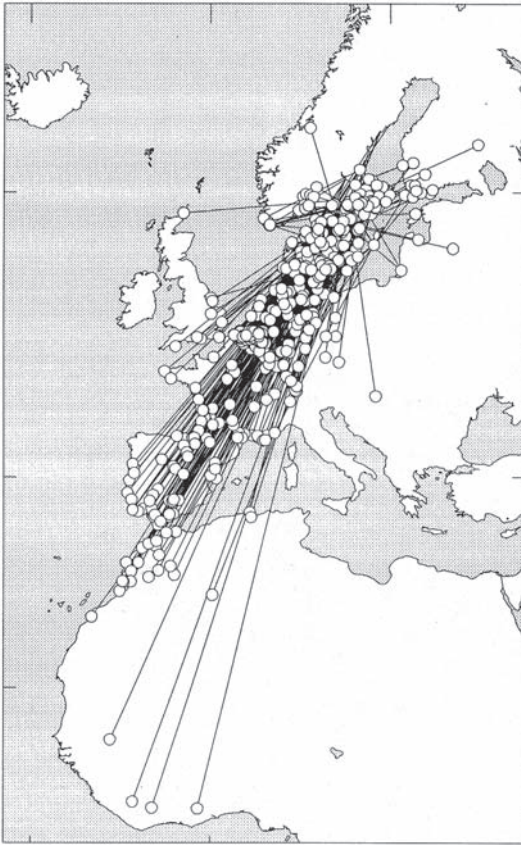
Figure 2. Geographical distribution of ringing recoveries, (n=1393), up to and including 1996, of Reed Warblers *Acrocephalus scirpaceus* ringed in Sweden, except those ringed at Falsterbo Bird Observatory. Each circle represents one or more recovered birds.

Geografisk fördelning av återfynd (n=1393) till och med 1996 av rörsångare Acrocephalus scirpaceus *märkta i Sverige, utom de som märkts vid Falsterbo fågelstation. Varje cirkel visar ett eller flera fynd.*
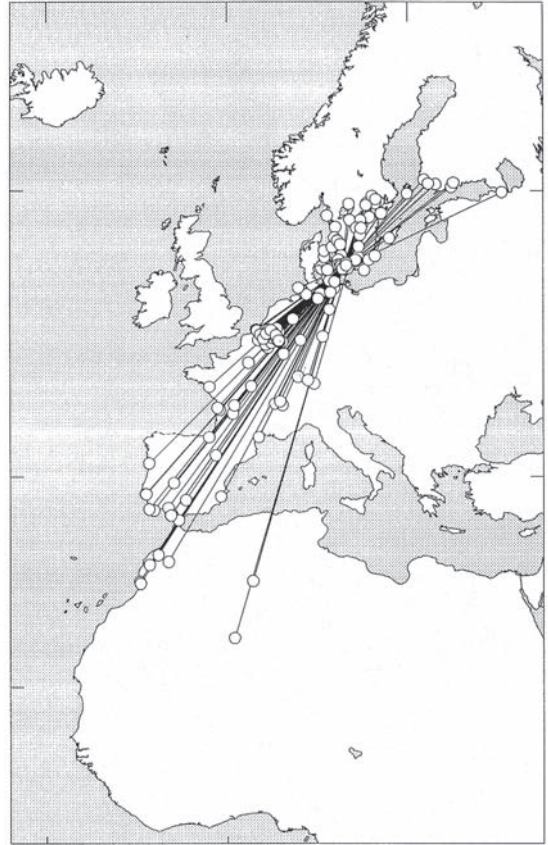
Figure 3. Geographical distribution of ringing recoveries, up to and including 1996, of Reed Warblers *Acrocephalus scirpaceus* ringed at Falsterbo Bird Observatory (n=265). Each circle represents one or more recovered birds.

Geografisk fördelning av återfynd till och med 1996 av rörsångare Acrocephalus scirpaceus *märkta vid Falsterbo fågelstation (n=265). Varje cirkel visar ett eller flera fynd.*

contain the same proportion of ringed birds as in the total population. The method is based on the following assumptions. First, that between capture and recapture the population is closed, which means that the proportion of ringed birds is not changed by for example births or immigration, which then would all be individuals without a ring. Second, birds with and without a ring should be equally likely to be captured. Third, rings are not lost. In the present study I have used this first simple form of the capture-recapture method. A modified version, compensating for bias in the above assumptions, and more

sophisticated models are described for instance in Pollock et al. (1990).

To estimate the size of the total population the following relation is used:

Total population size=

$$\frac{\text{Number of birds ringed in the population} \times \text{Number of birds in "recapture" sample}}{\text{Number of birds with ring in "recapture" sample}}$$

For the Reed Warbler, a large number of individuals were ringed in Sweden, in autumn, annually in 1988–1993. When these birds, during the same time period, July–September, left Sweden on their south-west directed migration a sample was recaptured at Falsterbo Bird Observatory situated at the south-western corner of the country. The proportion of birds which already carried a ring when captured at Falsterbo was determined and used to estimate the size of the population.

Thus, by applying the capture-recapture technique we have a method to estimate the size of the Reed Warbler population leaving Sweden on migration. If we can identify the number of birds originating from areas outside Sweden, we can estimate the breeding Reed Warbler population in Sweden. The accuracy of the population estimate would be improved if the number of juvenile and adult birds in the autumn population could be separated.

Material

The data included in this paper on birds ringed and recovered are stored at the Bird Ringing Centre, Swedish Museum of Natural History.

For the present estimate of the population size the numbers of Reed Warblers ringed and recovered during the years 1988–1993 were used. Many of the birds were ringed during the period July–September at permanent ringing sites participating in the Swedish part of the ACRO-project (Figure 1). During these six years the total number of Reed Warblers ringed in Sweden was 88,488 and of them 52,589 were ringed within the ACRO-project. For those ringed within the ACRO-project adult and juvenile birds are summed up separately. For those ringed at other sites only the total number of specimens ringed is available, not separated on adults and juveniles.

One important ringing site was situated at Falsterbo, at the south-western point of Sweden (Figure 1). In autumn, during the six years 1988–1993, more than 13,000 Reed Warblers were captured and ringed. The sample at Falsterbo was achieved through daily capturing during the period 21 July to 30 September.

Two different sets of data were used for the calculations. The first data set, included all individuals captured and ringed during the years 1988–1993. I used the annual totals published in the annual reports of the Swedish Bird Ringing Centre (Stolt et al. 1991, 1992a, 1992b, 1993, 1994, 1995). In these reports adults and juveniles are not separated. The numbers include, in addition to birds ringed during

July–October, also the adult birds ringed at spring arrival and during early summer (May–June).

Within the ACRO-project, separate ringing totals were available for adult birds as well. There were 6,894 adults ringed at other sites than Falsterbo, but none of them was recaptured at Falsterbo in the same year as it was ringed. Therefore, no separate calculation could be made for adult birds. Hence, the second data set included only juvenile birds captured and ringed within the ACRO-project during July–September 1988–1993.

The total number of birds recovered as dead, in the records at the Bird Ringing Centre, includes 126 Reed Warblers ringed as nestlings or first year birds. Out of these 126 birds 33 (26%) survived the first year, with limit 1 July, and 16 (48%) out of the 33 survived a second year and 9 (58%) survived a third year. After the third year the numbers are too small to allow for accurate survival estimates. However, longevity is relatively large. The three oldest birds from Swedish bird ringing were all controlled alive and between 10 and 12 years old.

Sweden is the main area of recruitment for Reed Warblers captured at Falsterbo in autumn. This is shown by the geographical distribution of recoveries (Figures 2 and 3). However, from recoveries of birds ringed in Finland as well as in Sweden, it is evident that the recruitment area for the Reed Warblers ringed in Sweden in autumn also includes part of south-western Finland. This part is approximately the Helsinki area and areas west of Helsinki, including the islands of Åland.

Seven Reed Warblers ringed at Falsterbo were recovered in Finland and 115 in Sweden. This indicates that 5.7% of the birds at Falsterbo originate from the Finnish population. This is a reasonable estimate if we assume that the chance of being recovered in Finland, e. g. get trapped in a Finnish ringer's mist-net, is about the same as being recovered in Sweden. The value of 5.7% might be a minimum, because also some of the birds ringed at Falsterbo and recovered in Sweden may originate in Finland, but caught while on migration through Sweden. On the other hand, 5.7% would be a too high estimate, if Finnish ringers are more efficient in capturing birds.

From recoveries of birds ringed in Sweden (Figure 2), and from recoveries of foreign ringed birds passing through Sweden in autumn, it is clear that some of the Reed Warblers originate in Norway and Estonia. However, they make up only a very small proportion of the total population. The Norwegian and Estonian birds probably represent less than 1%.

Results

Considering the whole period of six years, 51 Reed Warblers were recaptured at Falsterbo of those ringed in the same year at other sites in Sweden. Of those ringed within the ACRO project 28 juvenile birds were recaptured at Falsterbo (Tables 1 and 2).

The number of recaptured already ringed birds varied considerably between the years, and was small, especially in 1988, 1991 and 1993. This variation is probably partly random. Therefore, the calculations for separate years contain a large degree of uncertainty. Calculations for the separate years, give total autumn population estimates of Reed Warblers leaving Sweden between 2.4 million and 6.6 million. The mean value for the six years is 3.26 million with 95% confidence limits of ±0.86 million (Petersen estimate, according to Coughley 1977).

The annual estimated number of juvenile Reed Warblers leaving Sweden varies between 1.4 million and 5.3 million birds. The mean value is 1.82 million with 95% confidence limits of ±0.63 million (Petersen estimate, according to Coughley 1977). A total number of 3.26 million birds of which 1.82 million were calculated to be juveniles suggests an adult population of 1.4 million birds.

In order to estimate the size of the Swedish breeding population we have to identify the number of birds, of those leaving Sweden in autumn, that originate from areas outside Sweden. These numbers were estimated to be 5.7% from Finland and 1% from other areas outside Sweden. After these reductions, we obtain (Table 3) an estimated number of 1.34 million adult birds leaving Sweden in autumn and an estimated number of 82 thousand adults passing Sweden on migration from Finland. This corresponds to an estimated number of about 670,000 pairs from Sweden and about 40,000 pairs from Finland, e. g. from the south-western part of Finland.

Discussion

What sources of error may influence the results? How reliable is the estimate of 670,000 breeding pairs of Reed Warblers in Sweden? How does this estimate correspond to the calculated number of juveniles when related to available data on breeding success per pair and to survival of adults and juveniles?

Sources of error

A crucial assumption is that the recaptured sample at Falsterbo contains the same proportion of ringed birds as in the total population. If the ringed birds in

Table 1. Capture-recapture figures and estimates made from the total number (adults + juveniles) of Reed Warblers *Acrocephalus scirpaceus* ringed in Sweden during the years 1988–1993. Recaptures at Falsterbo include only birds ringed the same year at other sites in Sweden.

Fångst-återfångst siffror med uppskattningar beräknade från totala antalet (gamla + ungfåglar) rörsångare märkta i Sverige åren 1988–1993. I återfångsterna i Falsterbo ingår endast fåglar märkta samma år på någon annan plats i Sverige.

Year	Ringed in Sweden excluding Falsterbo	Ringed at Falsterbo	Recaptures at Falsterbo	Estimated number leaving Sweden in autumn
År	*Märkta i Sverige utom Falsterbo*	*Märkta i Falsterbo*	*Återfångster i Falsterbo*	*Uppskattat antal som lämnar Sverige under hösten*
1988	11,481	2,883	5	6,619,945
1989	10,986	1,993	9	2,432,789
1990	14,963	1,775	11	2,414,484
1991	9,238	1,744	3	5,370,357
1992	15,605	3,307	19	2,716,091
1993	12,936	1,577	4	5,100,018
1988–1993	75,209	13,279	51	3,263,727 (per year)

Table 2. Capture-recapture figures and estimates made from the number of juvenile Reed Warblers *Acrocephalus scirpace*us ringed within the Swedish ACRO-project during July–September 1988–1993. Recaptures at Falsterbo include only juveniles ringed the same year at other sites within the Swedish ACRO-project.

Fångst-återfångst siffror med uppskattningar beräknade utifrån antal ungfåglar märkta i svenska delen av ACRO-projektet under juli–september 1988–1993. Återfångster vid Falsterbo innefattar endast ungfåglar märkta samma år vid andra svenska märkplatser inom ACRO-projektet.

Year *År*	Ringed excluding Falsterbo *Märkta utom Falsterbo*	Ringed at Falsterbo *Märkta vid Falsterbo*	Recaptures at Falsterbo l *Återfångade vid Falsterbo*	Estimated number of juvenile Reed Warblers eaving Sweden in autumn *Uppskattat antal ungfåglar av rörsångare som lämnar Sverige under hösten*
1988	5,168	1,872	3	3,224,832
1989	4,518	1,278	4	1,443,501
1990	6,709	1,309	6	1,463,680
1991	4,368	1,211	1	5,289,648
1992	8,075	2,426	11	1,780,905
1993	4,255	1,166	3	1,653,777
1988–1993	33,093	9,262	28	1,824,449 (per year)

the sample are underrepresented the calculated total value will be too high, if the birds with rings are over-represented the value will be too low. There are at least two main factors, the period of capturing (21 July – 30 September) and the direction of autumn migration, that speak for Falsterbo as a convenient site for recapturing a representative sample of the total population.

Important to the present analysis is whether a bird once captured in a mistnet would learn to avoid being captured once again. A permanent mist-net site situated within the territory of a breeding bird, would probably be learnt to be avoided by the bird. This is not likely to be the case for nets in a new position or at a new ringing site. Evidently, it is difficult for a bird to perceive the net as an obstacle for passage, but the bird may learn to avoid passing through the site of the net if it has been captured there repeatedly. In other words, the chance of capturing a migrating Reed Warbler upon its arrival at a new stopover locality, as at Falsterbo, should not be influenced by whether the bird has been captured earlier at another ringing site, or not. It seems not appropriate to reduce the achieved values for this reason.

The probability to capture a bird at a new stopover site is probably largest just at the arrival during the first morning hours. At that time, the chance to capture a bird may be about the same for juveniles and adults. However, adult birds evidently perform their autumn migration faster than juvenile birds (cf. Fransson 1995) and with shorter stopovers (cf. Elle-gren 1991). Therefore, the probability to capture an adult bird at a stopover site is less than the probability of capturing a juvenile bird. Furthermore, the migration period for juveniles leaving Sweden is about twice as long as that for adults. This means that we should expect adults to be underrepresented among the birds recaptured at Falsterbo, and, actually, the recaptures at Falsterbo included only two adults out of 51 recaptured Reed Warblers ringed in the same year at other sites in Sweden. That is only 4% adults.

Obviously, in the sample of recaptures of ringed birds at Falsterbo, adults are underrepresented in comparison with ringed adults in the total population. This indicates that the calculated value for the total population of Reed Warblers, where adults are included, may be somewhat too high.

Ringed juveniles are recaptured in much larger number than adults and are probably represented in the same proportion in the recaptured sample as in the total population. If the proportion of recaptured ringed juveniles, for some unknown reason, is too high, this would mean that the calculated value for the number of juveniles is too low.

In the present study, I estimate the total population size of Reed Warblers leaving Sweden in autumn to

Table 3. Estimated numbers of Reed Warblers *Acrocephalus scirpaceus* leaving Sweden in autumn and their recruitment areas.

Uppskattade antal rörsångare som lämnar Sverige under hösten fördelade på olika rekryteringsområden

Population	Total number	Juveniles	Adults (i.e. the difference between total number and juveniles)
Population	*Totalt antal*	*Ungfåglar*	*Gamla (totala antalet minus ungfåglarna)*
A. Birds leaving Sweden in autumn *Fåglar som lämnar Sverige under hösten*	3,263,727	1,824,448	1,439,279
B. From Finland (5.7%) *Från Finland*	186,032	103,994	82,038
C. From other areas outside Sweden (1%) *Från andra områden utanför Sverige*	32,637	18,244	14,393
D. From Sweden [D = A – (B + C)] *Från Sverige*	3,045,058 (100%)	1,702,210 (55.9%)	1,342,848 (44,1%)

be 3.26 million birds. The number of juveniles was 1.82 million. According to the discussion above it seems reasonable to accept the value for juveniles. The value for the total population is more uncertain because of the low number of recaptured ringed adult birds on migration at Falsterbo.

Breeding success

It would be possible to estimate the number of breeding pairs from the number of juveniles in the autumn population if we knew the breeding success per pair. Nilsson & Persson (1986) found at a lake in Skåne in 1983 a breeding success of 1.52 fledglings per breeding attempt. Pairs made several breeding attempts per territory and the overall production during the breeding season was 3.64 fledglings/ territory. Cramp (1992) mentions the following values for the number of fledglings per brood: 1.7–1.8 from Poland, 1.31 and 1.85 from England and 2.15 from Bayern. The mean brood size for 155 nests, available at the Swedish Bird Ringing Centre, was 3.4 recorded as the number of nestlings alive at the time for ringing. The frequency of second broods in Sweden is unknown, thus, it is difficult to estimate

the number of breeding pairs needed to produce 1,702,210 juveniles (see Table 3) leaving Sweden. Two juveniles produced per pair corresponds to 851,105 pairs, and 3.4 juveniles per pair to 500,650 breeding pairs. There is also an unknown number of juveniles lost during the period between they leave the nest until they leave Sweden, which implies that the number of fledged birds actually produced should be somewhat higher than 1.7 million and the number of breeding pairs should be higher than half a million.

Survival

An estimate of the number of breeding pairs can also be done from the number of juveniles in the autumn population if we know the survival of juveniles and adults. However, there are few data on survival available. The recoveries, at the Swedish Bird Ringing Centre, of Reed Warblers found dead indicate a first year survival of 26% and an adult survival of about 50%. Bensch (1983) found at Kvismaren a somewhat higher adult survival of 58.6% from controls of living birds, and he also mentions 56% and 51% from two British studies. Balmer & Peach

(1998) report an adult survival of 49.6% from Britain and Ireland.

For a constant population size and an annual adult survival rate of 50% one adult in each pair has on average to be replaced by a juvenile bird. If the survival of the juveniles from the time they leave Sweden and until they return next year is only about 26%, this means that the size of the juvenile population, at that time, should be almost twice as large as the adult population (67% juveniles and 33% adults).

Assuming that the survival rate of juveniles is 26%, 442 thousand of those from Sweden will return each spring from their African winter quarters. If we also assume that this number corresponds to those adults that each year are replaced by first year breeders the population in Sweden would consist of 442 thousand pairs. If the survival of the juveniles during the period outside Sweden is larger than 26%, the number of pairs will be larger than 442 thousand. Probably, the survival rate of first year Reed Warblers is not equally distributed over the months, however, assuming this is the case, the survival during nine months should be larger than for a full year (35% instead of 26%). A survival rate of 35% for the 9 months period would correspond to about 596 thousand birds returning to Sweden the following year. With one adult annually being replaced by a juvenile, this would result in a breeding population of about 600 thousand pairs.

Pair density and reed area

For passerine songbirds, national estimates of numbers of breeding pairs are mainly based on counts of singing males within restricted areas. A calculated density of singing males is then combined with a nation-wide estimate of the available area of the breeding habitat preferred by the species. In the case of the Reed Warbler, estimates of pair density are also derived from the density number of nests. Nilsson & Persson (1986) report from a study area of 0.9 ha at Lake Björkesåkrasjön in Skåne a density of 28 pairs/ha reed, and from other studies they cite densities between 7 pairs/ha and 30 pairs/ha, in one extreme case 61 pairs/ha. In lake Tåkern, Nilsson et al. (1982) found a density of 19.6 nests/ha. I have not found any specific estimate of the total area of reeds in Sweden, but Ulfstrand and Högstedt (1976) mention, in connection with their population estimate for the Water Rail, that the reed area is about 1,000 km^2. A more recent estimate made by Torsten Larsson (pers. comm.) is in the range 1,000–2,000 km^2. Tjernberg (1996) assumes a mean breeding density

of 300 pairs per km^2 which would mean a breeding population of 300,000–600,000 pairs.

Earlier estimates

Information on the numbers of breeding pairs of Reed Warblers is available for many countries in northern Europe. For the Reed Warbler Glutz (1991) mentions 10,000 pairs for Finland. Cramp (1992) lists 1,500–3,000 pairs for Norway, 15 000 pairs for Finland and 8,000–10,000 pairs for Estonia, all three estimates from the late 1980s. Koskimies (1993) gives 15,000–20,000 pairs for Finland and 1,000–10,000 pairs for Norway. The most recent population estimate in Finland is 15,000 pairs with an annual range of 12,000–20,000 pairs. About 2,000 of those 15,000 pairs breed in lakes, the rest on coastal bays (Väisänen et al. in press).

For the Reed Warbler in Sweden, Ulfstrand & Högstedt (1976) suggested 100,000 pairs and Cramp (1992) mentions 150,000 pairs. Koskimies (1993) suggests a breeding population of 250,000–500,000 pairs for the year 1987. The latter number was compiled by a working group set up by the Nordic Council of Ministers in 1985 to obtain the most accurate information on population sizes in the early 1990s. The method used for the Reed Warbler is not described in detail, however, it is based on the inventories and censuses believed to give the most suitable nation-wide estimate. Tucker & Heath (1994) give the same number of pairs as Koskimies. According to a graph in Hagemeijer & Blair (1997), the Swedish population is the second largest in Europe after the Romanian, which is about five times as large as the Swedish.

Conclusion

The number of juvenile Reed Warblers leaving Sweden in autumn is estimated to be about 1.8 million birds. Out of those, about 1.7 million birds are assumed to be of Swedish and about 100,000 of Finnish origin. Adult birds are recaptured at Falsterbo less frequently than expected. This is probably caused by a faster migration with shorter stopovers than in juveniles. Recaptures of juveniles are much more frequent and are thought to be in the same proportion as there are ringed juvenile birds in the total population. On the basis of the results and calculations given in the present study it seems reasonable to estimate the mean breeding Swedish Reed Warbler population to be between 500,000 and 600,000 pairs.

The Swedish Reed Warbler population has previously been estimated at between 250,000 and 500,000 pairs (Koskimies 1993). The size of the Reed Warbler population can be estimated in different ways, and all methods are associated with errors. This is inevitable, because of the annual variation in population size and the temporal and geographical variation in survival and breeding success. However, different calculations in the present study all point to estimates of the same order of magnitude, i.e. about 500,000 – 600,000 pairs as a mean annual value for the period 1988–1993. This is a somewhat larger number of pairs in Sweden than previously assumed.

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Sammanfattning

Den svenska populationen av rörsångare Acrocephalus scirpaceus *uppskattad med fångst-återfångst teknik*

Att uppskatta en populations storlek med hjälp av fångst-återfångst går i korthet till på följande sätt. När vi fångar, ringmärker och åter släpper ett känt antal fåglar kommer hela populationen att bestå av ett antal fåglar med ring och ett antal utan ring. För att uppskatta hela populationens storlek behöver vi veta hur stor andel av fåglarna som är ringmärkta. Den andelen kan uppskattas om vi återfångar ett slumpvis stickprov och förutsätter att återfångsten innehåller samma proportion ringmärkta fåglar som i hela populationen.

Av rörsångare ringmärktes ett stort antal i Sverige under månaderna juli – september 1988–1993. När fåglarna under samma tidsperiod sedan lämnade Sverige på flyttning mot sydväst återfångades ett stickprov ur populationen i Falsterbo där fångst av rörsångare dessa år bedrevs dagligen från 21 juli till 30 september. Ur fångsten vid Falsterbo kunde andelen fåglar med och utan ring bestämmas.

Genom att använda fångst-återfångstteknik har vi alltså en möjlighet att uppskatta det antal rörsångare som årligen lämnar Sverige under höstflyttningen. För att sedan beräkna storleken på det häckande beståndet i Sverige behöver vi dra ifrån det antal fåglar som på sin väg mot vinterkvarteren flyttar genom Sverige från främst Finland men i någon mån också från Norge och Estland. Möjligheten att få någorlunda bra uppskattningar ökar om gamla fåglar och årsungar kan särskiljas.

Material

För beräkningarna användes två serier av data, båda insamlade under åren 1988–1993. I den första serien ingick alla rörsångare ringmärkta dessa år (Tabell 1). Siffrorna hämtades från Ringmärkningscentralens årsrapporter (Stolt et al. 1991, 1992a, 1992b, 1993, 1994, 1995), där dock årsungar och äldre fåglar inte är åtskilda i årssummorna. I den andra serien ingick endast årsungar fångade och ringmärkta inom ett särskilt forskningsprojekt, ACRO-projektet, initierat av EURING, den europeiska ringmärkningsunionen, och med ett 20-tal fångstplatser i Sverige under åren 1988–1993 (Tabell 2). Fångstplatsernas fördelning i Sverige framgår av Figur 1.

Ungfåglar fångas i större antal än gamla fåglar. Detta är särskilt påtagligt under flyttningen och på grund av det ringa antalet återfångade gamla fåglar vid Falsterbo har ingen serie med enbart gamla fåglar använts för beräkningar.

Upptagningsområdet för rörsångare fångade under flyttning i Falsterbo är i huvudsak Sverige. Detta framgår av den samlade mängden ringmärknings-återfynd (Figur 2 och 3). Det är emellertid tydligt att även en del utländska fåglar, främst finska, ingår. Sju rörsångare märkta i Falsterbo är funna i Finland och 115 i Sverige. Detta tyder på att åtminstone 5,7% är från Finland. Från Norge och andra länder, främst Estland, kommer en mindre andel, som uppskattas till mindre än 1%.

Resultat

För enskilda år varierar antalet återfångster en hel del och siffrorna är låga vissa år, särskilt 1988, 1991 och 1993 (Tabell 1 och 2). Beräkningarna för enskilda år är därför mycket osäkra. Beräknat för enskilda år varierar den totala populationen som lämnar Sverige mellan 2,4 miljoner och 6,6 miljoner fåglar. Medelvärdet för de sex åren är 3,26 miljoner med 95% konfidensintervall ±0,86 miljoner eller 2, 4 miljoner – 4,1 miljoner (Petersen estimate, enligt Coughley 1977).

Motsvarande siffror för enbart ungfåglar som lämnar Sverige varierar mellan 1,4 miljoner och 5,3 miljoner. Medelvärdet är 1,82 miljoner och 95% konfidensintervall ± 0,63 miljoner eller 1,20 miljoner – 2,45 miljoner (Petersen estimate, enligt Coughley 1977). Ett totalt antal rörsångare på 3,26 miljoner varav 1,82 miljoner ungfåglar betyder att 1,44 miljoner eller 44,1% är gamla fåglar. Minskar vi siffran för gamla fåglar med det antal som förmodas komma från utlandet finner vi att de svenska fåglarna bör vara 1,34 miljoner gamla fåglar vilket motsvarar ungefär 670.000 par.

Diskussion

Ett viktigt antagande är att återfångsten i Falsterbo innehåller ringmärkta fåglar i samma proportion som i hela populationen. Rörsångarnas flyttnings-riktning och flyttningsperioden från slutet av juli till början av september talar för att fångsten i Falsterbo ska utgöra ett bra stickprov ur hela populationen. Ingenting har heller framkommit som pekar på att unga rörsångare, som fångats en gång och ring-märkts, skulle ha lärt sig att undvika att bli fångade en andra gång på ett nytt ställe. Återfångsterna i Falsterbo innehöll emellertid endast 2 gamla fåglar utav 51 återfångade rörsångare märkta tidigare sam-

ma år på annan plats i Sverige. Detta är endast 4 % gamla fåglar och uppenbarligen en mindre andel än vad som märkts i hela populationen. Förklaringen till det låga antalet gamla fåglar i återfångsten är förmodligen ett snabbare flyttningsförlopp (jfr Fransson 1995) med kortare rastuppehåll (jfr Ellegren 1991). Vi vet också att perioden för de unga rörsångarnas bortflyttning från Sverige är ungefär dubbelt så lång som de gamlas (Stolt et al. 1993). Det låga antalet återfångade gamla innebär att det beräknade värdet för totalpopulationen i Sverige, där gamla fåglar ingår, kan vara något för högt. Ringmärkta årsungar återfångades i mycket större antal och antas vara representerade med samma andel i återfångsten som i hela populationen. Antalet ungfåglar beräknades till ca 1,8 miljoner. Det förefaller rimligt att acceptera denna siffra, medan däremot värdet för hela populationen är mer osäkert beroende på det ringa antalet gamla fåglar i återfångsten.

Med kännedom om rörsångarens häckningsframgång skulle det vara möjligt att uppskatta hela populationen utifrån antalet ungfåglar som lämnar Sverige på hösten. Cramp (1992) nämner från ett antal studier mellan 1,31 och 2,15 flygga ungar per kull. Antal levande ungar per bo vid ringmärkningstillfället var 3,4 i ett material på Ringmärkningscentralen omfattande 155 bon. Räknar vi med 3,4 ungar per par, vilket förmodligen är högt, ger detta 500.650 par. Antagligen har också ett antal ungar gått förlorade från de blir flygga till de lämnar Sverige på sin första höstflyttning vilket också tyder på ett högre antal häckande par än en halv miljon.

Med kännedom om överlevnaden för unga och gamla fåglar skulle antalet häckande par också kunna uppskattas utifrån det antal ungfåglar som lämnar Sverige på hösten. Antalet svenska återfynd av rörsångare märkta som årsungar och påträffade döda är 126. Åldersfördelningen ger 26% överlevnad första året med gräns första juli och en överlevnad på ca 50% för äldre fåglar. Med 50% överlevnad för gamla fåglar behöver varannan gammal fågel ersättas årligen för att bibehålla en konstant populationsstorlek. Om vi antar 26% överlevnad för ungfåglar kommer 442.575 av de från Sverige att återvända efter ett år. Eftersom fåglarna inte är borta från Sverige 12

månader utan endast under 9 månader kan vi, om vi antar att överlevnaden är jämnt fördelad mellan månaderna, räkna upp siffran till 595.774. Med 50% överlevnad för gamla fåglar och samma resonemang som ovan skulle vi alltså få nästan 600.000 häckande par.

I litteraturen finns en rad uppgifter om partäthet eller antal bon inom begränsade ytor. Nilsson & Persson (1986) fann 28 par/ha vass i Björkesåkrasjön i Skåne och Nilsson et al. (1982) fann 19,6 bon/ha i Tåkern. Tjernberg (1996) antar en genomsnittlig täthet av 300 par/km2 vass i Uppland. Jag har inte funnit någon publicerad studie av den svenska vassarealen men Torsten Larsson (pers. comm.) har uppskattat vassarealen till mellan 1.000 och 2.000 km^2. Siffrorna är naturligtvis osäkra, men med 300 par/km^2 får vi för hela landet 300.000 – 600.000 par.

Bland tidigare publicerade uppgifter om antalet häckande par av rörsångare i Sverige kan nämnas 100.000 par (Ulfstrand & Högstedt 1976), 150.000 par (Cramp 1992), 250.000 – 500.000 par (Koskimies 1993) och samma siffror (Tucker & Heath 1994). Enligt ett diagram i Hagemeijer & Blair (1997) är det svenska beståndet det näst största i Europa efter det rumänska, som är fem gånger större än det svenska.

Sammanfattningsvis har antalet ungfåglar som lämnar Sverige på hösten uppskattats till 1,8 miljoner av vilka 1,7 miljoner antas vara svenska och 100.000 vara finska fåglar. Med en förmodad överlevnad på 35% under de nio månader det dröjer innan fåglarna återvänder till Sverige får vi en populationsstorlek på ca 600.000 par om det antas, enligt resonemanget ovan, att en gammal fågel varje år måste ersättas av en ny för att upprätthålla en konstant populationsstorlek.

Rörsångarens populationsstorlek kan uppskattas på olika sätt. Resultaten blir ofrånkomligen ganska grova uppskattningar beroende inte minst på den stora variationen mellan år och på variationen i tid och rum i häckningsframgång och överlevnad. Trots osäkerheten kan vi konstatera att de uppskattningar som här gjorts på olika sätt alla slutar på ungefär samma nivå, ungefär 500.000 – 600.000 par rörsångare i Sverige under perioden 1988–1993.