The relationship between census results and the breeding population of birds in subalpine birch forests

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The passerine bird community (excluding the thrush species) of a study plot of 15 hectares in a subalpine birch forest, Swedish Lapland, was investigated by independently mapping the territories and finding the nests, during two successive breeding seasons. The results of the two techniques agreed fairly well for the total community, the number of territories mapped and nests found being 53 and 57 in one season, and 61 and 62 in the other. Of the two dominant species, significantly more territories than nests were obtained for *Phylloscopus trochilus,* whereas the result was the reverse for *Fringilla montifringilla.* In most cases it was not possible to connect the territories mapped (clusters of records) and the nests found. The time required for the mapping method was only 5 to 7 per cent of that spent on the search for nests.

Introduction

The density fluctuations of the breeding passerine bird community of the rich subalpine birch forests in the Ammarnäs area, Swedish Lapland (65°58′ N, 16° 13′E) have been followed yearly since 1963. The census methods used involve mapping territories in study plots and line transects. A bird density index can be derived from these two sets of data for all species in the community (ENEMAR & SJÖSTRAND 1970). As these studies are in the first place aimed at monitoring fluctuations of the species population levels, it is not necessary to know the relation between the density figures obtained in the study plots and the true density values in the same plots. On the other hand, the problem deserves careful investigation because the study of many problems in population ecology requires detailed knowledge about the true abundance and relative proportions of the various bird species in the community. Further, it is an unsatisfactory situation indeed, after so many years of census work, not to know the reliability of the mapping technique, particularly as this census method has been repeatedly criticized during the last few years (see Discussion). This paper describes an attempt to investigate the accuracy of the census results obtained over two years for the passerine bird community of a study plot of recommended size. A preliminary report of the first year's work has been published elsewhere (ENEMAR et al. 1973).

Methods

The population unit estimated by the mapping technique is the stationary

male or the permanently maintained territory (ENEMAR 1959). The crucial point is that it is virtually impossible to establish the true numbers in terms of this unit in a forest study plot of recommended size. This would require painstaking field work involving colour-ringing of all males appearing in the plot and thereafter daily and close watching of their movements and other activities. Since it may be presumed that most stationary males are breeding, we therefore decided to accept the number of breeding pairs as an approximate estimate of the number of stationary males. The advantage of the breeding pair as a population unit is that its presence in the plot is unequivocally confirmed by the occupation of a nest. As it is a well-known fact that males may defend territories without breeding, it should be remembered that the figures obtained are minimum values compared with those received by mapping territories.

The field work consisted of nest hunting and territory mapping in the same study plot in the breeding seasons of 1972 and 1973. The size of the plot was 15 hectares (300 × 500 m). It was located on the southern slope of the mountain of Kaissats near Ammarnäs, Swedish Lapland. The passerine bird density of this habitat, rich subalpine birch forest, fluctuated between 300 and 500 territories per sq km (ENEMAR & SJÖSTRAND 1972). The mapping of territories in the plot and the evaluation of the species maps were performed by one of the authors (AE) according to the rules recommended by the International Bird Census Committee (SVENSSON 1970). Thus the plot was censused on ten different days each season and a group or cluster consisting of at least three contacts (records) was required to be accepted as indicating a territory or a stationary male. The thrush species *(Turdus pilaris, T. iliacus* and *T. ericetorum)* were not considered in this investigation because their population numbers are estimated within our census program by counting their nests, which are easily discovered in this habitat.

The nest-hunters (SGH, LN, PK) concentrated on intensive nest searching and checking within the plot. The methods, which are described in detail by ENEMAR et al. (1973), comprised examining every birch tree and juniper bush, watching the behaviour of single birds for hours and walking through every square metre of the plot to flush ground-nesting birds. In other words, all possible measures were taken in order to discover the nests. The period of the nest search extended beyond that of the census work, to take advantage of the "guiding behaviour" of the parents feeding young of some late-breeding species. The birds were not colour-ringed and therefore the proportion of repeat nests is not known. Provided that all nests were discovered, the total number of nests accounted for in Table 2 and Fig. 1 may slightly exceed the number of breeding pairs.

The time periods and numbers of

TABLE 1. The field work.

	Territory mapping		Nest-hunting	
	Period	Man-hours	Period	Man-hours
1972	15—29 June	21.5	10 June — 8 July	420
1973	9—24 June	20.5	13 June — 11 July	300

TABLE 2. Number of nests found and territories mapped for passerine birds except thrushes in the study plot in 1972 and 1973. The number of contacts made in the plot is given within parenthesis.

	1972		1973	
	Nests	Territories	Nests	Territories
Parus montanus	1	1 (5)	0	0 (1)
Phoenicurus phoenicurus	4	2 (13)	2	3 (16)
Luscinia suecica	3	1 (5)	2	3 (13)
Phylloscopus trochilus	19	26 (202)	16	22 (143)
Muscicapa striata	1	1 (3)	3	2
Ficedula hypoleuca	1	1 (7)	2	2 (10)
Prunella modularis	3	2 (13)	4	4 (23)
Anthus trivialis	2	2 (13)	1	0 (2)
Carduelis flammea	3	5 (22)	6	5 (24)
Fringilla coelebs	1	0 (5)	1	1 (7)
Fringilla montifringilla	16	10 (72)	23	19 (128)
Emberiza schoeniclus	3	2 (12)	2	0 (3)
Totals	57	53 (372)	62	61 (377)

hours spent on field work are summarized in Table 1.

The census-worker did not receive any information whatsoever from the nest-search group until the census work and the analysis of the species maps was finished. The nest-hunters, on the other hand, had access to all information from the census work which could be of help in their own work.

Results

The numbers of nests found and territories mapped are given in Table 2. The distribution of the nests found and territories mapped of the two most abundant species, the Brambling and the Willow Warbler, are shown in Fig. 1.

Discussion

Number of nests found and territories mapped

A perfect agreement between the number of nests and mapped territories could hardly be excepted, due to theoretical as well as practical reasons. The mapping of territories covers not only the breeding males but also those who defend territories without breeding. The results of the census work should therefore exceed those of the nest-hunting, particularly as some few nests may remain undiscovered. This tendency is however counteracted by the fact that some repeat nests may have been counted and that the mapping of territories also involves an unavoidable loss, as the effectivity of the census work (ENEMAR 1959, HOGSTAD 1966/67, BLONDEL 1965, JOENSEN 1965, WILLIAMSON 1964) or the discovery chance (MYSTERUD 1968) for most species is only 30 to 70 per cent, for some species even less (JENSEN 1974). This means that a certain, though limited number of the stationary males, even after ten visits to the plot, will be recorded less than three times and consequently lost. We ought also to remember that the analyst of the species maps meets many difficulties caused by visiting males, polyterritorial

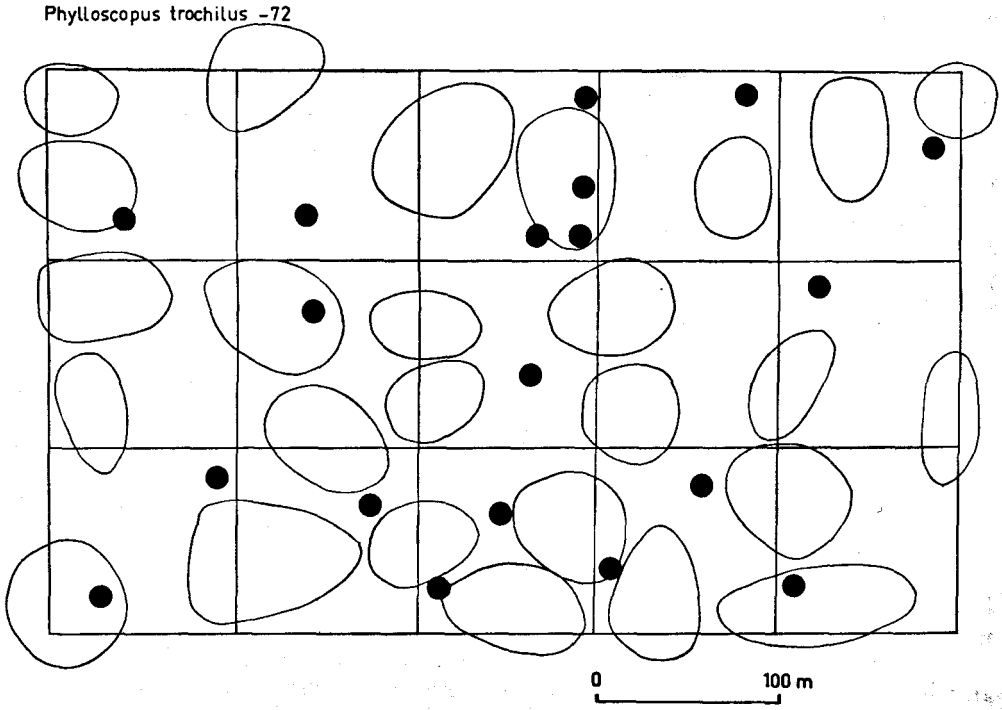
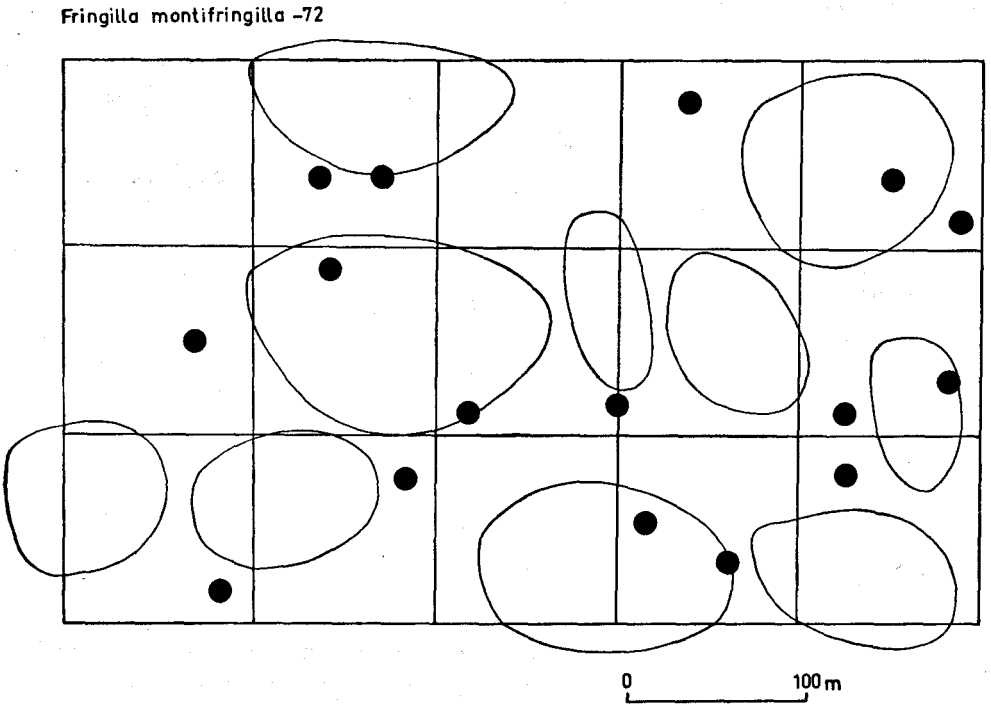


FIG. 1. The study plot showing the position of the nest founds (black circles) and the position and extension of the mapped clusters of records ("territories") (irregular open circles) of the Willow Warbler and the Brambling in 1972.

males and by "non-ideal" behaviour of stationary males, which contributes to the uncertainty of the results. Nevertheless, according to the results of the present investigation (Table 2), mapping of territories during two successive breeding seasons in subalpine birch forests gave density values of the whole investigated passerine bird community which were close to the density of breeding pairs as established by the number of nests found.

Only two species of the community were abundant enough to provide useful data on the relation between the mapped and breeding population numbers, viz. the Willow Warbler and the Brambling. More Willow Warbler territories than nests were estimated by the census work whereas the results were quite the reverse for the Brambling. These differences cannot be convincingly explained at present. Investigations in progress may reveal whether Willow Warbler territories defended by unmated males or by males breeding elsewhere occur regularly and thus raise the number of mapped territories. In the case of the Brambling, the average number of contacts per nest made during the census work is far below that of the Willow Warbler, indicating that lower census effectiveness can explain at least in part the low number of territories mapped.

The remaining species are represented by too few pairs within a plot of only 15 hectares to give useful figures for



comparisons. It should be noted, however, that the difference between the number of nests found and territories mapped is more than one in only 4 out of 20 comparisons (Table 2). In cases when both sets of data change from 1972 to 1973 (nine species) the direction of this change is the same in all comparisons but two (Redstart and Bluethroat).

The position of nests and territories mapped

Fig. 1 shows the distribution of the nests found and the territories mapped (or, more adequately, clusters of mapped records) for the Willow Warbler and Brambling in the study plot. In most cases it is impossible to see to which cluster each separate nest belongs. Surprisingly, the majority of nests are located outside the cluster areas, which indicates that the breeding males regularly have their song-posts away from the nest-site and its close neighbourhood (cf. PETERS 1963).

A consequence of this failing connection between the mapped territories and the nests found is that one is easily misled, when trying to combine these two sets of information in order to attain a better estimate of the true number of stationary males, at least as far as relatively dense species populations are concerned (cf. however WILLIAMSON 1971). If, for instance, two nests are found and two territories are mapped for the same species in a study plot, it could be quite impossible to decide from the map whether this information indicates two, three or four territories.

Obviously some nests in the study plot can be expected to belong to clusters outside it, and vice versa. This

explains part of the differences between the number of nests and mapped territories, especially for species which are few in number in the plot. For the abundant species there is a high probability that the loss and gain over the boundary are equal. Therefore the differences found between the results of the nest-hunting and the mapping census can be considered true and worth further analysis for Willow Warbler and Brambling in this investigation.

The relation between the position of the nest and the cluster of records of a stationary male no doubt deserves further study in order to clarify the mechanism of the mapping census.

The time required for the field work

Nest-hunting is rather time-consuming work and this method cannot normally be used in census work (cf. SNOW 1965) although a census technique based on a search for nests was worked out long ago (SCHIERMANN 1930). No less than 420 man-hours were spent on the nest-search in 1972, an amount of time which could be reduced to 300 man-hours in 1973, when the team was more experienced and familiar with the study plot and the nesting habits of its bird species (Table 1). This meant a "discovery rate" of one nest every five hours (thrush nests not counted) in 1973, when the field work was most efficient. Three quarters of the nests were found during the first half of the period, with a fairly constant number of nests found per unit time (on average one nest every three or four hours). The discovery rate fell rather abruptly and only eight nests were found during the last 100 hours of hunting, which might indicate that very few nests were left undiscovered at the end of the field work.

The time spent on the mapping census (approx. 21 hours, Table 1) was only 5 to 7 per cent of that required for the nest search work. Even if only the most successful set of 20 hours' nest-hunting is considered, the result was only 11 nests found, i.e. ca. one fifth of the final total.

Other investigations

A large-scale investigation of the relationship between census results and breeding populations of the farmland bird community in England gave more territories than nests for some species (*Turdus merula, Prunella modularis, Fringilla coelebs*) and more nests than territories mapped for other species (*Turdus ericetorum, Sylvia communis, S. curruca, Chloris chloris*), but the results were in many instances inconclusive, due to incomplete nest-finding (SNOW 1965).

BELL et al. (1968) very carefully determined the number of pairs of three species (Reed Bunting *Emberiza schoeniclus*, Sedge Warbler *Acrocephalus schoenobaenus*, Reed Warbler *A. scirpaceus*) in special population studies. Independent census work by mapping territories (eight visits) overlooked one quarter of the Reed Bunting and Sedge Warbler territories and three quarters of the Reed Warbler territories. HAUKIOJA (1968) also found that mapping Sedge Warbler and Reed Bunting territories covered the population incompletely, although he did not estimate the size of the loss. In a special investigation WILLIAMSON (1971) mapped more territories of the Dunnock *Prunella modularis* than the number of nests found. JENSEN (1971, 1972, 1974) received the most discouraging results when testing the reliability of mapping territories in a Danish marsh area. The true population

numbers were established with the aid of colour ringing and/or nest-hunting for some 15 species. Several ornithologists independently censused the area by mapping and they usually recorded less than half the number of the existing territories. Finally, MANNES and ALPERS (1975) investigated 23 hectares with 140 nest-boxes by mapping according to the international rules, and overlooked one-third of the number of breeding pairs of tits and Pied Flycatchers.

According to the investigations cited, a mapping census tends to underestimate the number of territories of most species. Compared with our investigation, the overall great loss reported by JENSEN (op.cit.) is in fact remarkable and hard to explain. It is not likely that many nests have been overlooked in our study and certainly not so many as to explain the difference in the accuracy of the territorial mapping found in the two investigations. However, part of the difference can be explained by the fact that the results of our mapping census are compared with the breeding population only. The mapping includes the unmated stationary males as well as the breeding birds and this will produce a false increase in the efficiency of the census. The frequency of unmated territorial males must have been very high on our plot, and constituted at least half the number of territories in the community, to lower the efficiency of our census work compared with that found by JENSEN. This would, however, require an unbelievably high density of territories in the subalpine forests.

We have to accept that the accuracy of the mapping census may vary widely in different regions, habitats, and bird communities. The community of the Swedish subalpine birch forest may belong to the easily investigated ones whereas the reverse might be true for the Danish marshes. In fact, JENSEN (1974) concludes "that the mapping method is useless in marshes". Moreover, species which are underestimated by the mapping census in the subalpine birch forests obviously counterbalance those overestimated, so that the total density of the mapped community will agree fairly well with the density of breeding pairs (nests). So in our opinion there is no reason, as far as concerns the census work in birch forests, to deny the statement by SVENSSON (1974) "that the (mapping) method seems to provide the best compromise available today between the demands of precision in the estimate of population size and the amount of field work required".

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Selostus: Vertaileva tutkimus kartoitusmenetelmän ja pesienetsinnän soveltuvuudesta pesimälinnuston laskentaan subalpiinisissa koivumetsissä

Ruotsin Lapissa laskettiin kahtena peräkkäisenä kesänä subalpiinisessa koivumetsässä sijaitsevan 15 ha:n tutkimusalueen varpuslinnusto (lukuunottamatta rastaita) kahdella toisistaan riippumattomalla menetelmällä: (1) kartoittamalla reviirit lähinnä laulavien koiraiden mukaan ja (2) etsimällä pesät. Reviirien ja pesälöytöjen määrät vastasivat toisiaan varsin hyvin: ensimmäisenä kesänä kokonaisluvut olivat 53 ja 57, toisena 61 ja 62. Kahdesta valtalajista pajulinnun reviirejä kartoitettiin merkitsevästi enemmän kuin pesiä löydettiin, kun taas järripeipon osalta tulos oli päinvastainen. Useimmissa tapauksissa kartoitettujen reviirien (= havaintorykelmien) sijainti ei täsmännyt pesälöytöihin. Kartoitusmenetelmän vaatima aika oli vain 5—7 % pesien etsintään kulutetusta ajasta.