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A comparison of different methods in censusing the hazel grouse

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The breeding and late summer densities of the hazel grouse *Bonasa bonasia* were studied in two southern Finnish forest areas. In Lammi in South Häme the breeding density obtained by the mapping method was clearly higher (8.8 pairs/km^2 in 1979, 14.3 pairs/km^2 in 1980) than in Kirkkonummi in Uusimaa (5.3 pairs/km^2 in 1980).

The average efficiency of the line transect method compared to the mapping density was 46 % for the main belt and 54 % for the survey belt. Compared to the brood census densities, the efficiency of this method (survey belt) was 47 % in Lammi but only 11 % in Kirkkonummi. The latter result indicates that sometimes the line transect efficiency for the hazel grouse may be very low.

The late summer densities obtained by brood censuses (made on straight compass lines) were of about the same magnitude, or somewhat higher, than the mapping densities, and higher than the densities obtained by route censuses (not compass lines) made in nearby areas. The results suggest that satisfactorily reliable estimates of breeding densities of the hazel grouse may be obtainable with late summer brood censuses.

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1. Introduction

A large number of late summer tetraonid counts are annually made by route census method in Finland (Rajala 1974, Lindén & Rajala 1981). The same method has been used also in Sweden (Angelstam 1979), Norway (Sørensen 1977) and Estonia (Viht 1974). Results of this method have not earlier been compared with breeding densities obtained by the mapping method and the line transect method. We present such a comparison concerning the hazel grouse *Bonasa bonasia*. We shall also discuss some general ideas about the applicability of these methods.

2. Study areas

Tetraonids were counted in connection with a larger census programme in the surroundings of Lammi Biological Station (61° 03′ N, 25° 03′ E) in South Häme (see Tiainen et al. 1980), and in Kirkkonummi (main area 60° 05′ N, 24° 33′ E) in Uusimaa near the northern coast of the Gulf of Finland. In addition, we also used the results of the tetraonid censuses carried out in 1980 by the Finnish Game and Fisheries Research Institute, Game Division (abbreviated GRI below) in the game management districts of South Häme (Etelä-Häme) and Uusimaa.

The study area in Lammi contained 4.56 km^2 of forests. These were mostly closed, mature, and spruce-dominated, with smaller areas dominated by deciduous trees. A bushy understory of spruce and deciduous trees was characteristic. The soil is mostly fertile, resulting in more productive and rich vegetation than average in South Häme. The forests were fragmented by fields and roads into smaller parts and patches.

The main study area in the municipality of Kirkkonummi, called Porkkala below, covered 1.5 km^2 of forest area. The forests were of two main types: mainly closed mature spruce stands on mesotrophic soils and barren pine forests on rocky hills, often intermingled in a mosaic-like manner. Deciduous trees were less characteristic than in Lammi, and the bush layer was not so dense and prevailing. The area enclosed some small meadows, and edges of fields and of a larger open bog. In the surrounding areas (called Kirkkonummi below), where only line transect and brood censuses (see below) were conducted, the forests resembled those of the main area.

A more detailed description of the study areas can be found in Tiainen et al. (1983).

3. Material and methods

We performed the following censuses:

(1) *Mapping of breeding birds*. In Lammi, the forests (4.56 km^2) were visited nine times (many small isolated patches only five times) between May 12 and July 3, 1979. In 1980, two smaller parts (0.52 km^2 and 0.38 km^2) of this area were visited 12 times between April 28 and June 27. In Porkkala, 12 visits were

made between April 22 and June 28, 1980. All observations of tetraonids as well as other birds were recorded on visit maps. The number of "pairs" of the promiscuous capercaillie *Tetrao urogallus* and black grouse *Tetrao tetrix* were determined on the basis of the number of females. Simultaneous records of neighbouring pairs were scarce in all the three tetraonid species, and the interpretation of pairs had to be based on concentrations of observations.

(2) *Line transect censuses of breeding birds.* In Lammi, the same census routes of 36.75 km were counted between May 31 and June 19 each year in 1978-80. Of these, 16.85 km and 4.35 km were situated in the forests of the mapping areas of 1979 and 1980, respectively. Additionally, 5.95 km were counted twice (on June 5-6 and 17-18, 1980) in the 1980 mapping area. In Porkkala 7.00 km were censused in the forest of the mapping area, and an additional 31.10 km in the forests of the nearby areas. The additional 5.95 km in Lammi and all transects in Porkkala and Kirkkonummi were made on straight compass lines, while other routes in Lammi ran freely, partly following small paths.

All observed birds were recorded on the main and supplementary belts within and outside 25 m of both sides of the walking route. Survey belt (main belt + supplementary belt) densities were calculated following Järvinen & Väisänen (1977b).

(3) *Late summer censuses.* Two sets of data were used: firstly, our own census data from Lammi and Kirkkonummi, referred to as *brood censuses,* and secondly, the tetraonid censuses in 1980 in the districts South Häme and Uusimaa (Rajala & Lindén 1982), referred to as *route censuses.* In both census types, a group of three observers covered a 60 m broad belt.

The brood censuses were conducted on 46.0 km in Lammi and 64.1 km in Kirkkonummi between July 29 and August 6, 1980. In Lammi 28.7 km of the routes ran parallelly in straight SW-NE directions at a distance of 140 m from each other. We assumed that the probability of encountering the same broods or individuals several times on parallel routes was not increased because of previous encounters, which was supported by the scattered distribution of field observations. The rest of the routes in Lammi, totalling 17.3 km, belonged to those on which also breeding birds were counted by the line transect method. In Kirkkonummi, all brood censuses were made in straight compass directions. 36.1 km of them had been censused by the line transects during the breeding season.

The brood census results were transformed, both to density as ind./km^2, and to density as pairs/km^2, assuming that each observation of broods or single birds represented a breeding pair. Some few hazel grouse groups seemed to comprise juveniles of different ages (suggesting association of, and interpreted as, two broods), but otherwise the observations seemed to justify this assumption.

The route censuses were performed by voluntary co-workers (mainly hunters) of the GRI. Twenty-nine routes, a total of 891 km, were counted in South Häme, and 426 km on 11 routes in Uusimaa. These censuses differ from our brood censuses in that the routes are planned to cover the best brood habitats, and they are not straight compass lines. Also in Lammi, 10.3 km of the brood census routes, following the line transect routes, were not made on straight lines. However, these line transects had been planned as being representative of the whole land bird community.

4. Results

Only the hazel grouse occurred in the study areas in Lammi, but in Kirkkonummi also the capercaillie and the black grouse were recorded. The number of observations of the two latter species was so low that they were excluded from this analysis. The breeding density of the hazel grouse obtained with the mapping method was about two and a half times higher in Lammi (smaller area) than in Porkkala in 1980 (Table 1). In the smaller study area in Lammi, the density was clearly lower (nine pairs corresponding to 10.0 pairs/km^2) in 1979 than in 1980. The increase in the density from 1979 to 1980 was probably partly due to higher mapping efficiency in the latter year, as a result of, e.g., the censuses beginning earlier in spring. On the other hand, this also implies that the density estimate for the whole area in Lammi in 1979 may be a slight underestimate. In any case, the mapping data are so scarce that no definite conclusions can be drawn about possible population changes. Line transects (36.75 km) censused each year in 1978-80 did not indicate any significant population changes during these years (number of observations on the survey belt 6, 7 and 4, respectively).

The survey belt efficiency compared to the mapping result in Lammi was 58 % in 1979 (whole area) and 45 % in 1980 (smaller area). In Porkkala, not a single hazel grouse was recorded in the line transects, though eight pairs bred in the study area according to the mapping result. One must remember, however, that the length of the transects was only 7.0 km in that area, which means, e.g., that if one pair had been observed the survey belt efficiency would have been 46 %!

Table 1. Hazel grouse densities (pairs/km^2 of forest area; also given transect lengths as km) obtained by different census methods in mapping areas in Lammi and Porkkala (forest areas given), and in Kirkkonummi (includes results from Porkkala). Numbers of territories or observations are given in brackets.

Census	Lammi, whole area (450 ha) 1979	1980	Lammi, smaller area (90 ha) 1980	Porkkala (150 ha) 1980	Kirkkonummi – 1980
Mapping	8.8 (40)	–	14.3 (13)	5.3 (8)	–
Line transect					
main belt	5.9 (5)	3.5 (5)	3.7 (3)	0.0 (0)	0.6 (1)
survey belt	5.1 (5)	5.4 (9)	6.4 (6)	0.0 (0)	0.5 (1)
length	16.85	28.70	16.25	7.00	38.10
Brood census	–	11.6 (32)	13.7 (12)	8.9 (4)	5.5 (21)
length		46.0	14.6	7.5	64.1

If we combine the three mapping results, the resulting average density of hazel grouse is 8.8 pairs/km^2. Combining the line transects in a similar way the resulting main belt density is 4.0 pairs/km^2 and the survey belt density is 4.7 pairs/km^2. Compared to the mapping density these values correspond to efficiencies of 46 % and 54 %, respectively.

The brood census density of the hazel grouse was quite the same as the mapping density in Lammi (smaller area) and clearly higher than the mapping density in Porkkala in 1980 (Table 1); notice, however, the small sample sizes in the latter area. In the whole study area in Lammi, the brood census density of 1980 was somewhat higher than that of the mapping censuses in 1979. If, for methodological reasons, the 'true' breeding density in 1979 was higher than recorded by mapping (see above), the brood census density in 1980 was quite consistent with the breeding density in 1979.

The density obtained in the brood censuses was about twice as high as that of line transect censuses in Lammi both in 1979 and 1980. Surprisingly, only one hazel grouse was recorded in the line transects in Kirkkonummi! Consequently the brood census density is about ten times higher than the line transect density in that area (Table 1).

The late summer density of hazel grouse was about four times higher in Lammi than in other parts of South Häme (Table 2). Also the juvenile percentage was clearly higher. In Kirkkonummi, the late summer density was slightly higher than elsewhere in Uusimaa, but the percentage of juveniles was somewhat lower.

5. Discussion

Each of the tetraonid species involves very different census problems because of their different breeding and territorial systems. They are certainly one of the most difficult groups of breeding land birds to census with the mapping or the line transect method.

The mapping method is — at least in principle — applicable to censusing hazel grouse, because this species is monogamous and territorial. According to our experience, the hazel grouse does not belong to the most difficult species concerning this particular census method. The number of observations is rarely a problem, because hazel grouse are usually quite easily observable (especially in April — May). The greatest difficulty concerns the interpretation of the territories from the observations combined on the species map (this is often difficult even with many strictly territorial passerines, see e.g. Svensson 1974). To a great extent these problems of interpretation are due to difficulties in obtaining simultaneous records from neighbouring pairs. Such observations give objective criteria for the interpretation of territories and are therefore of crucial importance (Tomiałojć 1980).

The line transect method is based on single visits. The census efficiency varies between species (Järvinen 1978, Tiainen et al. 1980). With the aid of empirical correction coefficients (k), which correct differences in lateral detectability, the whole survey belt data can be used in calculating density estimates (Järvinen & Väisänen 1975, see also Vickholm 1982). This reduces the variance of density estimates, especially in the case of rare species (Järvinen 1976). The coefficients were calculated from data which were collected in a standardized form (see Järvinen & Väisänen 1977a) in the whole country and the whole census period (June 1-20 in southern Finland). Small sets of data often cover only a part of the census period, and then the utilization of the coefficients may lead to erroneous densities if the lateral detectability of the species changes greatly during census period. The validity of the coefficients can, however, be easily tested.

Compared to the mapping density, the average efficiency of the main belt and survey belt censuses were 46 % and 54 %, respectively. These values are slightly lower than our earlier results of the average efficiency of these methods for all species in forest habitats (see Tiainen et al. 1980). On the basis of the high main belt percentage (the main belt observations as a proportion of the total number of observations), this kind of result could be expected (see Järvinen 1978). When evaluating these results, one must remember that the 'true' efficiency of the line transect method may be lower, because it is possible that mapping results are also underestimates. In any case, the very much lower efficiency of the line transect than brood census results in Kirkkonummi (Table 1) indicates that in some situations the efficiency of the former method may be low. Female hazel grouse are incubating and hence very inconspicuous in early June, and this surely decreases the detectability of this species at that time.

The difference in late summer densities between Lammi (brood censuses) and South Häme (route censuses) (Table 2) is probably to a great extent due to a true regional difference. However, both this difference, and the difference between Kirkkonummi (brood censuses) and Uusimaa (route censuses), suggest that the densities given by brood censuses are higher than those of route censuses, and hence represent breeding densities more reliably. Lindén & Wikman (1976, 1983) conducted a three-year

Table 2. Hazel grouse densities obtained with the brood census method in Lammi and Kirkkonummi, and the route census results of the GRI in the districts of South Häme and Uusimaa in 1980.

	Density (birds/km^2)	Number of observations	Percentage of juveniles
Lammi	41.3	114	74
South Häme	10.9	583	58
Kirkkonummi	11.2	47	44
Uusimaa	9.0	230	55

study in western Uusimaa, and there the hazel grouse density was 41 % higher in brood than in route censuses.

The route censuses, although planned to pass through the best grouse habitats, are probably chosen in preference to capercaillie and black grouse, and, consequently, the habitats of the hazel grouse are sampled less representatively, because it does not have the same game value (Lindén 1981, see also Linkola 1974). In any case our results (remember that the brood census densities fit quite well to the mapping densities) do not agree with those of Rajala (1966), who estimated that the actual average density is about one third of the density observed in the route censuses in the northern province of Oulu.

6. Concluding remarks

The census methods examined by us have been developed for different purposes, the mapping method and the line transect method for studies of most land bird species in the breeding season, and late summer censuses for tetraonids only. Our comparisons support the following general ideas of the applicability of these methods:

(1) The mapping method is quite well applicable to censusing the breeding population of the hazel grouse. Regrettably, no tests are available concerning its efficiency for this species. In general, this method is valuable in local studies, especially if accurate density estimates are required. In regional approaches, as well as in studies requiring representative data from several habitat types, it is enormously laborious. This fact also reduces its applicability to monitoring purposes.

(2) The line transect method is especially applicable to regional studies, for which it was developed (e.g. Järvinen & Väisänen 1980, 1981). In addition it is an effective method for monitoring purposes. Its efficiency is, on average, at least somewhat lower for the hazel grouse than for other forest birds.

(3) The results of brood censuses (on randomly or systematically chosen straight compass lines) fit well with those of the mapping censuses. It is therefore possible that satisfactorily reliable estimates of densities of breeding hazel grouse are obtainable by brood censuses. On the other hand, route census results can be regarded as density indices valuable in the study of population changes or long-term trends (see Lindén 1981). They are also valuable in assessing the age and sex structure of tetraonid populations.

Our study is the first large-scale comparison of the commonly used mapping, line transect, and late summer census methods. In spite of the large areas censused, our results were not at all sufficient for methodological comparisons concerning capercaillie and black grouse. More comparative studies of methods are urgently needed.

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