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Censusing tetraonids by the Finnish wildlife triangle method: principles and some applications

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Tetraonid birds are censused in August and in January-March in the Finnish Game triangle scheme, which is based on about 1200 permanent triangle-shaped routes, each 12 km in length. We compared the results of late-summer and winter censuses in order to develop transformations for further use. The summer and winter densities were significantly correlated at both the triangle and game district level. When the numbers of observations are compared, the winter figures are on average 20 % of the late-summer figures in the Capercaillie; the corresponding figures are 71, 16 and 125 % for the Black Grouse, Hazel Hen and Willow Grouse, respectively. It should be noted that these are not absolute figures and not fully comparable, since the breadth of the census belt is 60 m in August whereas the belt breadth in the winter census is not known. Using transformations obtained in this study, we transformed the old late-summer brood data (1964–85) from southern Finland to relative winter figures, in order to have data comparable to those for southern Soviet Karelia, where actual winter censuses have been made. All the four species have decreased considerably (–65 %) in Finland, whilst the reverse trend is evident for Karelia (relative change during the period +42 %); the figures of the mid 1980s suggest a similar density in Finland and Karelia. The changes in grouse densities partly accord with the predictions based on changes in habitat distribution and (other) human activities in Finland and Karelia. The paper discusses the possibility of deriving estimates of population density from winter census data obtained from a census belt of unknown breadth, central issues being the basal and lateral detectabilities.

1. Introduction

Breeding bird studies based on quantitative census data have a long history in Finland, going back to the beginning of the 20th century. In this census work particular attention has been paid to Tetraonids for several reasons. These species, Capercaillie (*Tetrao urogallus*), Black Grouse (*T. tetrix*), Hazel Hen (*Bonasa bonasia*) and ptarmigans (*Lagopus lagopus, L. mutus*) have traditionally been hunted intensively, and therefore it has been important to be aware of the (relative) population densities of the species. Secondly, our grouse species show cyclic population fluctuations, and in order to understand this phenomenon and possible underlying mechanisms, numerical census data have been preferred (e.g. Siivonen 1948, Lindén 1989). Forest grouse species are also known to reflect changes in forest structure (e.g. Seiskari 1958) and are therefore species of high indicator value.

General-purpose bird censuses have been designed mainly for Passerines (e.g. the study plot method, point count, line-transect method, winter bird census, see Koskimies & Väisänen 1991), and the data obtained for the grouse species are of doubtful value. The ordinary breeding bird censuses in June are poorly suited to them, especially the Capercaillie and the Black Grouse, which are lekking species in which the sexes are already living separately at the census time (see Merikallio 1946, Järvinen & Väisänen 1984). The winter bird census routes, on the other hand, are mainly located around human settlements and the typical winter habitats of Tetraonids are not covered (Sammalisto 1974).

Special grouse censuses have been started to circumvent the difficulties involved in ordinary census techniques. An extensive monitoring program was started in the early 1960s, based on late-summer censuses in optimal brood habitats (Rajala 1974, Lindén 1981). The August census has several advantages: the broods and single adults are relatively easily observed and counted, and secondly, the proportion of juvenile birds or the proportion of females with a brood gives a handy index of the reproductive success of the grouse species. Three persons walk in a chain 20 m apart from each other, and the belt being covered in the census is 60 m. Very recently a new application of this method was introduced: the census is made along the sides of a randomly distributed triangle, the routes measuring 12 km each (Lindén et al. 1989). Tetraonids are censused along these triangles in August (60 m belt) and in winter (January — March; all the birds observable from the census line are taking into account).

In this paper we compare summer and winter census results of Tetraonid birds from exactly the same census routes. The difference between summer and winter results is presumably due to several factors, such as (natural and hunting) mortality, habitat shifts of the grouse species, and changes in bird behaviour. To evaluate these and also possible geographical patterns in the Tetraonid abundance, we need to make these two censuses comparable. This requires converting the number of individuals observed to absolute density values. There are studies which give data from exactly the same census routes in summer and winter (see e.g. Soveri 1940, Alatalo 1981), but at the moment we lack sufficient data to create relevant coefficient of conversion (but see Danilov et al. 1986) and rigorous tests of census efficiency in winter conditions.

This paper addresses and discusses the problems involved. We also discuss the application of the Finnish line transect method (Järvinen & Väisänen 1975, 1983) and its basic models in estimating densities of Tetraonid birds. When the methodological problems have been solved and the wildlife triangle program has been in use for some time, it will be possible to assess the importance of hunting mortality in grouse species.

2. Material and methods

The present method in monitoring Tetraonids in Finland, the so-called wildlife triangle scheme, is based on about 1200 permanent census routes around the country. The program is organised by the Game Division (Finnish Game and Fisheries Research Institute) and run by voluntary hunters in the field. The basic unit in the system is an equilateral triangle of 12 km in length (3 × 4 km). About 1000 triangles have been censused yearly (Table 1). The habitats covered by the triangles are assumed to be chosen at random for two reasons. First, each triangle has to be located within one sheet of a 10 × 10 km topographic map, which means that there is little possibility of a subjective choice of location, since the size of the triangle is considerable compared to the size of the map area. Second, the shape of a triangle is "difficult" in the sense that if it is possible to choose good habitats for one or two sides of it, the route inevitably also samples poorer habitats along other parts of it. It would be possible, of course, to test the validity of the randomness in the habitat distribution in the triangles, but such an approach is not pertinent yet.

Triangle routes are censused twice a year. Tetraonids are censused in the middle of August by a three-man chain: the person in the middle walks along the sides of the triangle, and the two others walk at distances of 20 m from him. The width of the census belt is consequently 60 m, and the densities per km^2 are calculated directly by multiplying the number of birds observed by the area covered. It is recommended that censuses should not be made in poor weather conditions, such as rainy or very windy days. The average census efficiency within this belt is about 80 %, according to radiotelemetric studies on the Capercaillie and Black Grouse in Sweden (Brittas & Karlbom 1990). No such data are available for Finnish conditions, but it is a fair assumption that the efficiency is much the same, at least in southern and central Finland. In northern Finland, the efficiency may possibly be higher, since the visibility in sparse northern forests is better than in the south; this kind of difference in census efficiency has been demonstrated in the ordinary Merikallio-fashion line-transect method (Järvinen et al. 1978).

Table 1. The number of wildlife triangles censused in two late-summer and two winter censuses in the game districts. See Fig. 1 for the location of districts.

District	Summer 1989	Winter 1990	Summer 1990	Winter 1991
1. Etelä-Häme	29	29	34	32
2. Etelä-Savo	52	51	71	63
3. Keski-Suomi	37	48	64	54
4. Kymi	35	38	42	40
5. Lappi	136	152	190	185
6. Oulu	121	116	122	116
7. Pohjanmaa	49	38	65	61
8. Pohjois-Häme	23	21	27	23
9. Pohjois-Karjala	58	57	77	73
10. Pohjois-Savo	44	41	50	48
11. Ruots. Pohjanmaa	5	10	15	16
12. Satakunta	71	62	74	64
13. Uusimaa	13	19	26	25
14. Varsinais-Suomi	21	15	23	19
15. Kainuu	171	167	172	156
Total	865	864	1052	975

Winter censuses are made by skiing along the wildlife triangles in January–March. The main purpose of this census is to count the tracks of mammals crossing the triangle route, but attention is also paid to censusing Tetraonids. All the Tetraonids observed during the census are taking into account, irrespective of their distance from the census route, as in the ordinary winter bird census.

The results for grouse species in the winter census are given as ind. per 10 km of census route. Danilov et al. (1986) introduced a technique for transforming this kind of relative density index to absolute population densities. This was done by collecting data on the distances of the observations from the census route (rectangularly to the census line) and then assessing the mean distances and variances. Danilov et al. (1986) estimated the line breadth from which density values can be calculated. It was 154 m for the Capercaillie, 285 m for the Black Grouse and 75 m for the Hazel Hen. There are no direct measurements on the efficiency of the census for grouse species on belts of these breadths, but the breadths do at least give an idea of the relative observability of grouse species in winter conditions. Again here, there are no such data for Finnish conditions, and caution must be exercised in applying these figures in Finnish studies.

In order to test the possible geographical effect in the difference between the results in autumn and winter censuses, we used the latitudinal division presented in Fig. 1.

3. Comparison of late-summer and winter censuses

First we compared results of late-summer censuses and winter censuses made on wildlife triangles in the game management districts. We ran two analyses, namely late summer 1989 vs. winter 1990 and late summer 1990 vs. winter 1991. It should be noted that in this comparison the late-summer figures are absolute densities (ind./km^2) whereas those of the winter censuses are relative figures (ind./10 km). The correlations are linear and all of them are significantly positive (Fig. 2). The correlations for the Capercaillie for the consecutive comparisons are 0.77 and 0.67. The cor-

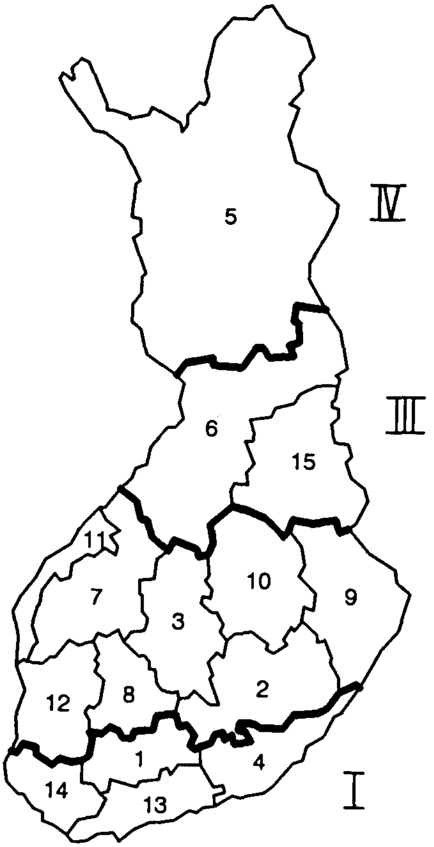

Figure 1. Game management districts in Finland, the areal division used in this study; see Table 1 for further information. In the analyses Finland has been divided into four latitudinal zones (I-IV).

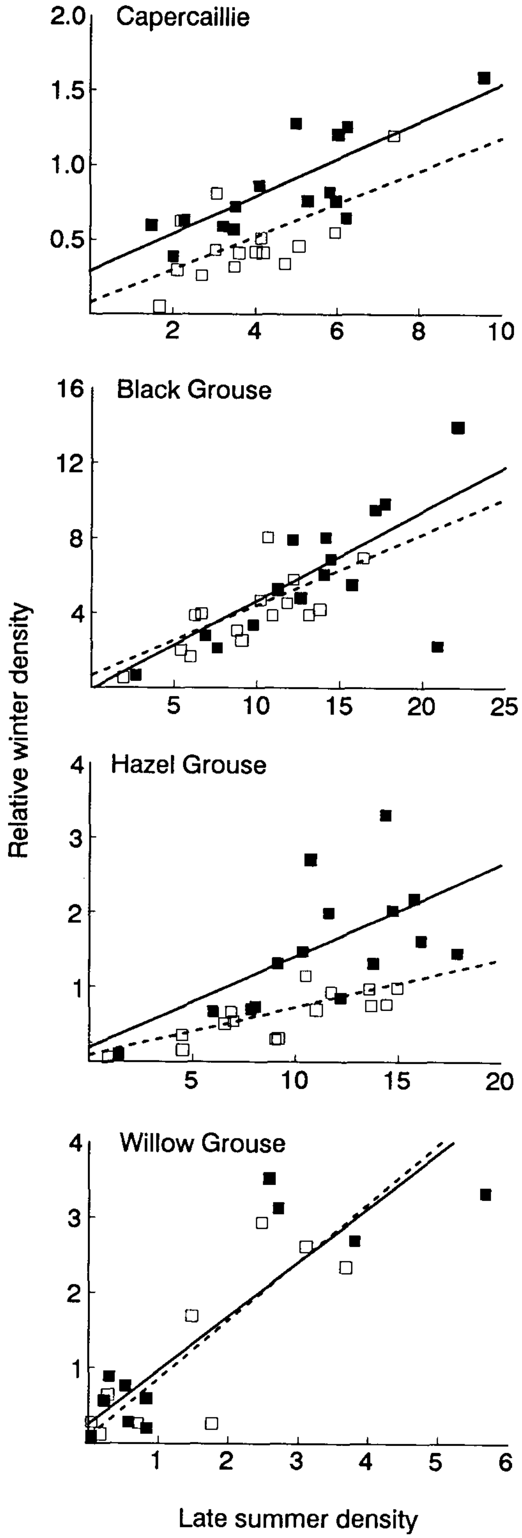

Figure 2. Relationship between relative density in winter census (ind./10 km, y-axis) and absolute density in late-summer census (ind./km^2, x-axis) of forest grouse. Each dot indicates one game management district (see Table 1). The filled squares and solid lines indicate the comparison late summer 1989 vs. winter 1990 and open squares and dashed lines indicate late summer 1990 vs. winter 1991.

responding figures for the Black Grouse, the Hazel Hen and the Willow Grouse are 0.70 and 0.73, 0.64 and 0.80, and 0.89 and 0.90, respectively. The coefficients of correlation for the three first mentioned species are about the same, whereas for the Willow Grouse they are clearly higher. The Capercaillie and the Hazel Hen reveal a similar pattern: the regression line for the first comparison (89/90) lies significantly higher than that for the second one (90/91); the regression coefficients do not deviate significantly from each other, however. The difference means that the relative winter population densities of these species were higher in winter 1990 than in winter 1991 for a given late-summer population level. It is not possible to judge without special investigation whether this is due to lower mortality in the former autumn than in the latter or to some other reason.

The Black Grouse and the Willow Grouse show a similar pattern (Fig. 2). The regression lines for the two comparisons are nearly identical in the two species. In the Black Grouse there is one outlying point, namely game management district 11 (see Fig. 1), situated on the western coast of Finland; the relative winter density here is surprisingly low compared to the late-summer density, which was the second highest in late-summer census 1989. The Willow Grouse is also somewhat problematic, since the 1989–90 observations (filled squares in Fig. 2) from two separate clusters.

We also compared individual triangles in late summer and winter, in order to check for sampling and scaling effects. The Spearman's coefficients of correlation between the two estimates are relatively low, typically between 0.1 and 0.3, for all the species and both summer vs. winter comparisons. The statistical significance is even higher than those in the analyses run at the management district level, which is due to the huge sample size (N=714 for the first comparison and 876 for the second one). The low r values, on the other hand, show that there is a large amount of noise in the results at the triangle level. One reason is that the number of observations per triangle is relatively small and therefore easily affected by stochasticity. The proportion of null observations is also high (for the Capercaillie 39.9%, Black Grouse 28.9%, Hazel Hen 45.9% and Willow Grouse 69.9% on average in the four censuses 1989–1991). The distribution of the number of individuals observed per triangle is strongly skewed, Fig. 3 shows the case of the Capercaillie in late-summer census 1989 and winter census 1990 as an example.

In order to obtain a more adequate comparison we transformed the results of late-summer censuses to make them comparable to the winter figures, that is, to numbers of individual birds per 10 km census route. Table 2 shows the basic parameters of the comparisons made on this basis. To summarize the regression equations, we observed that there have been on average 5.1

Table 2. Basic parameters of the comparisons of results of late-summer censuses and winter censuses in wildlife triangles (see Fig. 2). Y-axis is winter and X-axis summer density.

Species	Summer 1989 vs. winter 1990	Summer 1990 vs. winter 1991
Capercaillie	$y = 0.125x + 0.291$ $r = 0.786$	$0.110x + 0.079$ 0.637
Black Grouse	$y = 0.477x - 0.109$ $r = 0.703$	$0.379x + 0.635$ 0.731
Hazel Hen	$y = 0.123x + 0.183$ $r = 0.635$	$0.064x + 0.086$ 0.801
Willow Grouse	$y = 0.719x + 0.719$ $r = 0.894$	$0.776x + 0.081$ 0.899

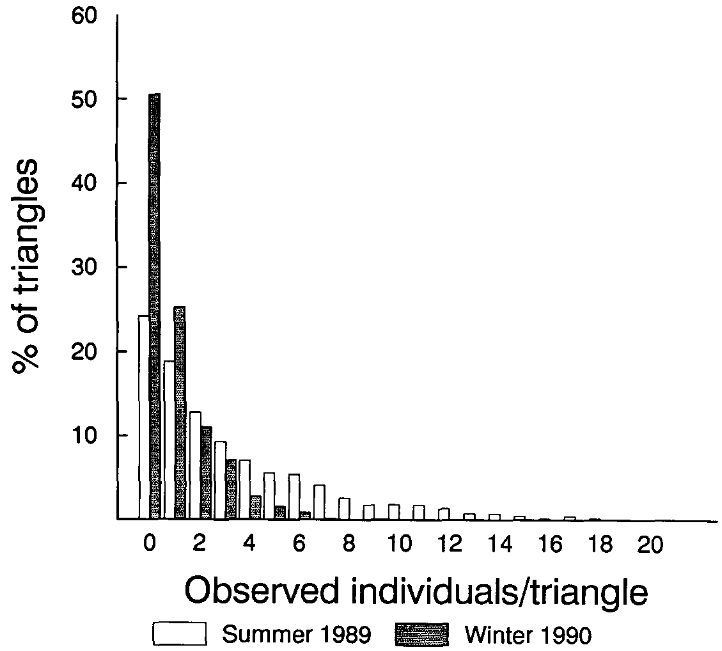

Figure 3. Percentage distribution of the number of Capercaillie observed per triangle in censuses in late summer 1989 and winter 1990 (see also Table 1).

times more Capercaillie along the triangles in late summer than in winter. The corresponding figures for the Black Grouse, Hazel Hen and Willow Grouse are 1.4, 6.4 and 0.8. It should be noted, however, that these figures are not fully comparable: the width of the census belt in August is 60 m, that in January-March is not known. The coefficients obtained for the Capercaillie and the Willow Grouse in the two years are very close to each other; the Black Grouse shows more variation and in the Hazel Hen the difference is considerable. Again, the Capercaillie and the Hazel Hen behave similarly, as do also the other pair of species, the Black Grouse and Willow Grouse.

Table 3. Coefficients of correlation between the ratio relative summer to winter density and relative latitude (see Fig. 1) for the species and study periods.

	Summer 89/ winter 90	Summer 90/ winter 91
Capercaillie	0.594	–0.120
Black Grouse	–0.003	0.111
Hazel Hen	–0.073	–0.124
Willow Grouse	0.113	–0.329

Previous analyses showed that the summer and winter densities were correlated. To investigate whether or not there was any geographical pattern in this relationship, we examined the relation between the ratio of the relative summer and winter densities and the relative latitude (see Fig. 1 and Table 3.). One of the eight comparisons shows a significant correlation (Capercaillie, 1989/90 comparison). Since the other correlation coefficients are far from significant (and five of them are even negative!), we conclude that latitude has no effect upon the summer/winter density ratios with this technique. In the significant case, the percentage of variation explained is 35 %, so even here the major part of the variance originates from other source than latitude.

4. Comparisons to other winter census data

Annenkov (1986) has described variations in the abundance of the grouse species revealed by winter censuses in 1961–85 in Southern Soviet Karelia. The method used was exactly the same as that employed in the Finnish triangle scheme. The Karelian study area covers all the main habitats in the area, where the landscape corresponds roughly to that in Finland directly after World War II. Since then, modern, mechanized forestry and intensive agriculture have invaded into Finland, whereas Soviet Karelia has remained more or less unchanged; the traditional methods of agriculture and cattle grazing have their own impact upon the environment. In view of these contrasting development trends and our knowledge of the habitat selection of grouse species, we would expect the total density of the grouse species to have developed more favourably in Karelia than in Finland. In addition, the hunting pressure has probably been harder in Finland. The response of different species may have been different, however. By cutting old stands, forestry would have a detrimental effect on the Capercaillie in Finland compared to Karelia, whereas, by creating large areas of young successional stands, it might be beneficial to the Black Grouse (see Angelstam 1983).

We transformed the Finnish late-summer brood census data from 1964–85 to relative winter densities — to correspond to the Karelian data — in the following manner. First, a comparison from 1988 suggests that the brood census and triangle census in August give a relatively similar information on bird densities. There are certain deviations in some areas and species, but this generalization is usually justified (Lindén et al. 1989). Second, in order to have an estimate of relative winter densities, we used the coefficients obtained in this study, that is, the winter numbers along the routes in winter are on average 20 % of the late-summer densities in the Capercaillie, 71 % in the Black Grouse, 16 % in the Hazel Hen and 125 % in Willow Grouse (see Table 2). Since we had to make two transformations in order to obtain comparable data, many sources of error are possible. We wish to stress, however, that although the "computed" relative densities of species may be biased, the trends revealed are probably correct. The study period is 1964–85 and we calculated linear regressions for the relative winter densities. This was necessary to obtain a general long-term trend for both areas, although the correlations were not always high.

Table 4. Comparison of long-term trends in relative grouse densities in Southern Finland and Southern Soviet Karelia. The figures are the numbers of individuals observed per 10 km in winter censuses and they are predicted from regression equations fitted to the data. The Soviet figures are real census data, the Finnish figures are derived from late-summer censuses (see text for further explanations).

Species	Area	1964	1985
Capercaillie	Finland	1.87	0.66
	Karelia	0.74	0.92
Black Grouse	Finland	10.45	6.13
	Karelia	4.75	8.24
Hazel Hen	Finland	1.62	1.16
	Karelia	1.18	1.12
Willow Grouse	Finland	2.06	1.16
	Karelia	0.73	0.25

Table 4 summarizes the results of the comparison: the figures shown are the relative densities (ind./10 km) of the species predicted from the regression equations for 1964 and 1985. In the beginning of the period, the Capercaillie was considerably more abundant in southern Finland than in Karelia, the difference being about 2.5-fold, but in the middle of the 1980s the situation was reversed. In the course of study period the change in the relative density in Finland was about –65 % and about +25 % in Karelia. The Black Grouse showed roughly the same pattern; in Finland it decreased by about 40 %, whereas in Karelia it increased by about 75 %. In the beginning of the period the density in Finland was about twice that in Karelia; at the end of period the situation was almost the opposite.

The changes in the density of the Hazel Hen during the study period were fairly similar in Finland and Soviet Karelia. The Karelian long-term trend suggests no change; in Finland the relative change was about –30 %. The densities in general are of the same magnitude. The Willow Grouse also shows similar temporal patterns in the two areas. Southern Finland had somewhat higher densities than Karelia, but in both areas there has been a decline, by about –50 %. The total density of grouse species has increased in Karelia and clearly decreased in Finland. In the beginning of the 1960s the Finnish density was more than twice that in Karelia; now the densities are about equal. It is not possible to judge without additional data, e.g. on the habitat distribution, why the Finnish grouse populations were much denser in the early 1960s than those in Karelia.

The results of the comparison are mainly in accordance with our predictions, which suggests that changes in habitat distribution caused by forestry and agriculture are responsible for the changes observed. The difference in the hunting pressure has had a similar effect, but without additional, quantitative information we cannot estimate the importance of hunting.

The Finnish winter bird censuses have been made since the 1950s using the method employed in the triangle winter census. We compared the triangle and winter bird census data from winter 1989/90 to demonstrate the importance of the habitats studied. Notice that both data are massive. We used averages of the mid-winter (24.12.–6.1.) and spring censuses (21.2.–6.3.) in order to obtain as comparable data as possible (Hildén & Väisänen 1989). The Hazel Hen and the Black Grouse show the smallest difference between triangle and winter bird data: the ordinary winter censuses report 49% of the density obtained on triangles (Table 5). The average figure is 15% for Capercaillie and 9% for Willow Grouse. Since the methods used are otherwise identical, the only explanation of the difference is different habitat distribution. The triangles are located at random, whereas in the ordinary winter bird census scheme the distribution is strongly biased. Urban and rural settlements, garbage dumps and fields contribute no less than 55% and forest only 37% of the length of the routes in winter bird censuses (Väisänen & Koskimies 1989).

5. General discussion and prospects

We have compared here the results of censuses of grouse species on the same routes in August and January–March. We were able to compare different grouse species and geographical areas using relative indices of abundance. True late-summer and winter densities were more difficult to obtain. First, we do not know the census efficiency. Second, the area covered in the winter census is also unknown (but see Danilov et al. 1978).

Line transect censuses in general involve two kinds of detectability (e.g. Emlen 1971), namely basal detectability and lateral detectability. These are the two basic concepts used in deriving density estimates from data originating from transect of unknown belt breadth (see also Järvinen & Väisänen 1975). Basal detectability refers to census efficiency on the census line, i.e. the probability of detecting a bird right on the census line, which in any case is lower than one. There are practically no data on this efficiency for the grouse species: the late-summer test using radiotelemetry made by Brittas & Karlbom (1990) is an exception. Winter census efficiency has not been studied in any detail. The other concept, lateral detectability, refers to census efficiency perpendicular to the census line. This detectability decreases with increasing distance, but may do so in different fashions, however. The new application of the old Finnish line transect method takes all the observations into account, irrespective of their distance from the census line (Järvinen & Väisänen 1975, 1983). The idea is that the densities of species are calculated using correction coefficients derived from the ratio of the observations made in the main belt (breadth 50 m) to the total observations. The model assumes that detectability decreases as a linear function of distance. Other functions were also tested and they gave the same results for most species. Some species with a high proportion of observations from the main belt, however, such

Table 5. Comparison of relative grouse densities (ind./10 km) according to wildlife triangles (WT) and winter bird census results (BC) in 1989 (see also text).

Capercaillie		Black Grouse		Hazel Hen		Willow Grouse	
WT	BC	WT	BC	WT	BC	WT	BC
0.87	0.13	6.15	2.99	1.56	0.77	1.10	0.10

as the grouse species, may not show this linearity. The models assuming a linear decrease in detectability were developed for censusing breeding birds, and modifications are presumably needed when they are applied to Tetraonid birds and winter censuses. When Järvinen (1978) compared the relationship between basal and lateral detectability using empirical data, he found a negative relationship between the basal detectability and the proportion of observations made in the main belt. The vast majority of the observations of the grouse species come from the main belt and according to this result, the census efficiencies for the species grouse should be low. However, Järvinen's conclusion was based on observations of relatively abundant passerine birds.

In order to obtain estimates of winter densities, a modification of the Järvinen-Väisänen model could be developed. The data needed are the distances of observations from the census line — all the mathematical applications are probably directly applicable from the Järvinen-Väisänen model. This application makes it possible to use all the observations irrespective of the distance, but in order to obtain realistic estimates of densities, census efficiency tests are needed. Radiotelemetry seems to be the most efficient and accurate method here although time-consuming. Theoretically, the winter densities of the grouse species should be 40–50 % of those in August according to the mortality estimates (e.g. Lindén 1981). When density estimates are available for the winter as well it will be possible to assess the importance of hunting (taking place in September–October) to the autumn mortality of the grouse species. Furthermore, due to its scarcity the Capercaillie, for example, will not be hunted in many game management areas, and it would be of great importance to compare the autumn survival in areas with and without hunting. The new technique would also help us to develop bag allotment for grouse species in the different phases of the population cycles, which is one of the main goals of the Finnish game triangle scheme.

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Selostus: **Metsäkanalintujen laskennat Suomen riistakolmioarvioinnissa: periaate ja eräitä sovellutuksia**

Nykyisessä riistakolmiolaskennassa metsäkanalinnut lasketaan kahdesti vuodessa: elokuussa (60 m:n laskentakaista) ja tammi–maaliskuussa (kaikki mukaan etäisyydestä riippumatta). Laskennan perusyksikkö on maastoon satunnaisesti sijoitettu ja pysyvästi merkitty tasasivuinen kolmio (3 × 4 = 12 km), joita verkostoon kuuluu n. 1200 kpl (taul. 1, kuva 1). Vertasimme kesä- ja talvilaskennan tuloksia näillä reiteillä (kesä 89 vs. talvi 90 ja kesä 90 vs. talvi 91) saadaksemme muutoskertoimia vertailevia tutkimuksia varten. Kesäiset ja talviset runsausindeksit ovat riistanhoitopiiritasolla merkitsevästi korreloituneet korrelaatiokertoimien ollessa lajeittain 0,67–0,90 (kuva 2). Metsolla ja pyyllä talvirunsaus on edellisenä talvena merkitsevästi korkeampi kuin seuraavana talvena samallakin kesätiheydellä; teerellä ja riekolla tällaista eroa ei ole. Kun verrataan absoluuttisia havaintomääriä, kertyy talvella havaintoja kesälaskentoihin verrattuna lajeittain seuraavasti: metso 20, teeri 71, pyy 16 ja riekko 125 %. On syytä korostaa, että linjan leveys loppukesällä on 60 m ja laskentatehokkuus noin 80 %, kun taas talvitilanteesta ei ole tietoa linjan leveydestä eikä tarkasti laskentatehokkuudestakaan. Myös kolmiotasolla kesä- ja talvitiheydet korreloivat erittäin merkitsevästi. Sattuma tuottaa kuitenkin paljon vaihtelua, sillä kolmiokohtainen havaintomäärä on alhainen (kuva 3). Maantieteellisellä sijainnilla ei ollut vaikutusta lajeittaiseen kesä/talvirunsaussuhteeseen.

Tutkimuksessa kehitettyjen muunnoslukujen avulla voimme muuntaa Suomen vuosien 1964–85 ns. poikuearviointien tulokset suhteellisiksi talvitiheyksiksi ja siten vertailukelpoisiksi Neuvosto-Karjalassa samalla ajan jaksolla tehtyjen laskentojen kanssa. Kaikki neljä lajia ovat vähentyneet Suomessa huomattavasti (jakson kuluessa lajit yhteenlaskien −65 %), Karjalassa kehityssuunta on ollut päinvastainen (+42 %). Suomen kanalintutiheys oli 1960-luvulla olennaisesti korkeampi kuin Karjalan, 1980-luvun puolivälissä kannat olivat samalla tasolla (Taul. 3).

Suomen talvilintulaskennassa menetelmä on sama kuin riistakolmioiden talvilaskennassa.

Talvilintulaskentareitit painottuvat kuitenkin asutuksen tuntumaan ja antavat tästä syystä huomattavasti alhaisempia runsausindeksejä kuin satunnaisesti maastossa olevat riistakolmiot. Talvilintulaskennassa teeren ja pyyn suhteellinen runsaus on 49 %, metson 15 % ja riekon 9 % riistakolmioiden antamista arvioista (Taul. 4).

Tärkein menetelmällinen edistysaskel riistakolmioiden talvilaskennassa on muuttaa suhteelliset talvitiheydet (esim. yks./10 km laskentalinjaa) absoluuttisiksi tiheyksiksi. Tutkimuksessa kartoitetaan muunnosten edellytyksiä ja mahdollisuuksia. Tiheysmuunnoksen pohjalta olisi mahdollista tarkastella syksyisen metsästyksen vaikutusta metsäkanalintukantoihin, mikä on riistakolmiolaskentojen tärkeimpiä päämääriä.

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