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The Strip Survey as a Complement to Study Area Investigations in Bird Census Work

By

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Svensk sammanfattning: Protokollgångmetoden som komplement till provytearbetet vid taxering av småfågelbestånd.

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Introduction

The study of many problems in population ecology of birds involves the estimation of the size and composition of selected communities over successive years. The so-called mapping method is considered to be a fairly suitable technique for the determination of population numbers in communities of passerine birds (ENEMAR 1959, WILLIAMSON 1964, BLONDEL 1965, JOENSEN 1966) though it cannot be regarded as perfect from all aspects (PETERS 1963, SNOW 1965). The method is based upon census work within study areas of known size. However, the field work will of necessity be fairly tedious when it aims at obtaining population figures which are reliable enough to permit direct comparisons between the results from different seasons. This means that the census must be carried out so thoroughly that the differences between years as regards the weather and other factors which influence the effectivity of the field work will be of no significance for the final census results.

It is obvious that a single ornithologist will be able to work through only a limited area during the relatively short period when breeding passerine bird communities can be successfully investigated if the mentioned demands as regards the reliability should be maintained. Thus the rare species of the community will be represented in such small numbers in the census material that they will often be of little use when statistical comparisons between seasons or habitats are made. Nonetheless, the less abundant species often constitute an important part of the community, no less than half of it in the subalpine birch forests in Swedish Lapland, i.e. the habitat which is the object of this investigation. Obviously this entails a considerable restriction of the usefulness of the mapping method when the population numbers of all components of a bird community are to be followed.

Consequently the field work must be enlarged in some way in order to give a true picture of the population fluctuations of the less abundant species. In Lapland this extension of the field work has so far been attained by carrying out so-called strip surveys (line transects) in the habitat (ENEMAR 1963; ENEMAR, HANSON & SJÖSTRAND 1965). In connection with the field work in 1965 and 1966 a strip survey material was obtained in order to investigate from certain aspects its reliability. The results are presented in this paper[1]).

General view on the strip survey as a bird census method

When a strip survey is carried out the census-taker goes slowly through the wood recording all singing birds and other phenomena which can reasonably be connected with a territory or a breeding pair. In our case the observations are gathered from within approx. 75 metres on either side of the census-taker. This delimitation of the observation distance cannot of course be made exactly in the field. It only serves as a rough guide to prevent the census-taker from gathering observations originating too far off. If long-distance observations are included the composition of the material gathered in the field will deviate unduly from that of the investigated bird community.

The great advantage of the strip survey is that a large field material can be obtained in a rather short time from a large area of the investigated habitat.

The data from the strip surveys are used to calculate the so-called dominance values of the different species, i.e. their percentage share of the total field material. A change in the dominance value of a species may be presumed to reflect a corresponding change in its abundance.

This census technique is, however, burdened with important limitations which will be commented briefly in the following.

1. The material from the strip surveys cannot be used to calculate the bird densities, because the estimation by eye of the distance to the boundaries of the surveyed area is under all circumstances impossible to perform with sufficient accuracy. For density calculations on basis of a strip survey material certain constants which differ between species and habitats are necessary (cf. YAPP 1956, FERRY &

[1]) Dr. INGVAR LENNERSTEDT and Dr. SÖREN SVENSSON participated in the field work of this investigation in 1965. We thank them heartily for their valuable help. The investigation was supported by the Swedish Natural Science Research Council (Grants Nos. 2180-13, 14).

FROCHOT 1958, SEIERSTAD, SEIERSTAD & MYSTERUD 1965). In our census work in Lapland all density calculations are based on the results from the study area investigations.

2. The dominance values which have been calculated from strip survey material are to a certain extent misleading due to differences between the inhabitant species as regards the ease with which they are observed (difference in the conspicuousness of the species, cf. COLQUHOUN 1940). This might be of less importance when the dominance values are used for comparative purpose only, because the errors can be assumed to remain practically constant for each separate census-taker. But when the proportions between the different species in the community are to be investigated one must again refer to the material obtained with the study area technique. A special analysis has shown that the dominance values of some less conspicuous species (Reed Bunting, Dunnock) calculated from the strip survey material are inferior to those obtained in the study areas (ENEMAR 1966). Part of this difference might be due to the fact that non-stationary birds are included in the strip survey material but not in the study area material.

3. If the dominance value of a species increases from one season to the next the explanation may be that the species has increased in number (density). But it is also possible that no change has taken place and that the increase is caused by a decrease in the density of the total community. Obviously the changes in the dominance values calculated from a strip survey material cannot be evaluated if nothing is known about possible changes in the density of the total community. Thus, a thorough knowledge of the density of birds in the habitat, obtained for instance by means of a series of carefully investigated study areas, is an indispensible complement to strip surveys in following the changes in the abundance of the different species. This is true when strip surveys are carried out without precise delineation of the breadth of the surveyed area.

It is apparent that the strip survey of the kind described here is of limited value as an isolated census method. The work in study areas according to the demands of the mapping method remains so far the basis for determination of the density and composition of passerine bird communities in woodland. But it is worthwhile to consider seriously the usefulness of the strip survey as a complement to the study area technique.

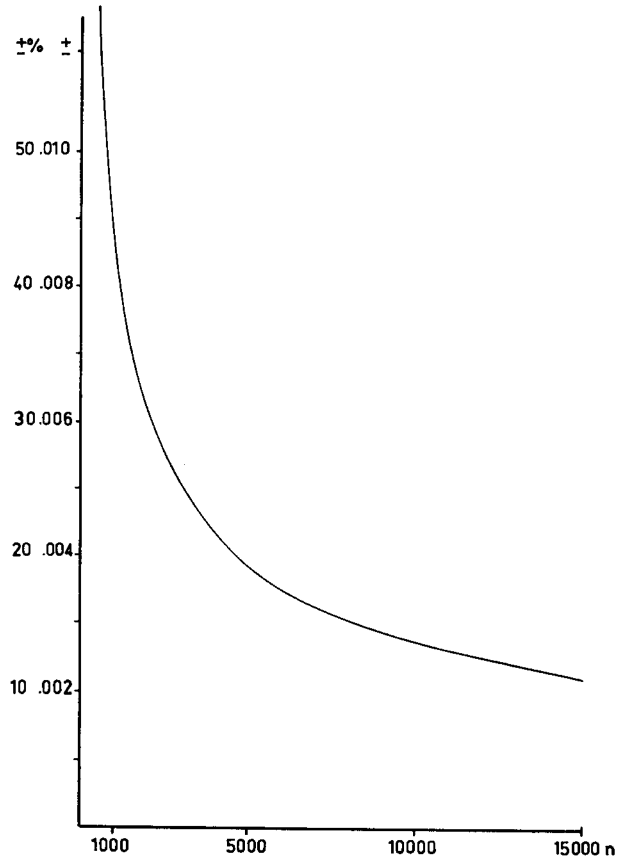

Fig. 1. The change of the confidence interval for $p=0.02$ in relation to sample size. Abscissa: sample size. Ordinate: right sequence of figures = absolute size of confidence interval; left sequence of figures = the same expressed as per cent of p. (*Konfidens-intervallets beroende av antalet observationer för det fall då $p=0,02$. Abscissan: Antal observationer. Ordinatan: högra siffran = konfidensintervallets absoluta storlek; vänstra siffran = samma intervall uttryckt i procent av p.*)

The problem

Before the strip survey can be taken up in the routines of a long-term census project the following two problems have to be clarified.

1. How many observations should be gathered by the separate census-taker to attain a field material that is characteristic in relation to the prevailing status of the community and which permits comparisons between years? The answer depends mainly upon the following factors: a) The "degree of rarity" of the most sparsely

occurring species to be investigated. b) The minimum change in number of that species to be established. c) The chosen probability level of that change. These demands of the census project have to be adjusted against the time available for the field work.

2. To what extent will the census results of different census-takers deviate when the strip surveys have been carried out independently in the same season and in the same area? This question is of importance in deciding whether one census-taker can replace another in the strip survey work of a long-term census project without precluding the accuracy of year-to-year analyses.

The field material of the present study consists of 3000 observations gathered by one member of the team and three samples of 1000 observations, each obtained by one of the other three participants of the project. All strip surveys were carried out in subalpine birch woodland on the southern slopes of the mountains of Kaissats and Valle near Ammarnäs in southern Lapland. The study area covered about eight square kilometres. The census work was carried out independently by the participants during the most suitable period of the breeding season in June 1965. Finally, two members of the team collected 1500 observations each in June 1966.

The sample size required

The strip surveys provide us with proportion values (p) (also expressed as dominance values (d) as mentioned above) of the species.

x=number of observations of one species
n=total number of observations
$p=x/n;\quad d\%=x/n\cdot 100$

These values are estimates of the population proportions of each species – i.e. the "true" values. For large sample sizes p has an approx. normal sample distribution with the mean $E(p)=\pi$ and the standard deviation $D(p)=\sqrt{\frac{\pi(1-\pi)}{n}}$. The approximation is good when $\pi\cdot n>10$.

The formulae above are relevant provided that the census work is carried out under perfectly constant conditions. This means a) that the populations of all species remain numerically constant throughout the census period, and b) that the probability of discovery and registration of the birds present remains constant. This ideal condition never prevails in a passerine bird community. As to a) it should be noted that the bird community consists of two categories during the breeding season: the breeding and the non-breeding ones. The breeding part consists of mated and/or territory-defending males and mated females; the other part of temporary territory-holders and transients. The breeding section of the community can, apart from probably insignificant mortality, be regarded as fairly constant whereas the non-breeding one is more labile. It is reasonable to think that the immigration and emigration of members of this category is, broadly speaking, balanced during the census period for most of the species, and that they do not normally give rise to drastic alterations in the composition of the community. This assumption is supported by experience from the work in our study areas. As regards b) it is evident that the audible manifestations of the community alter during the course of the census period (cf. p. 123). Another source of error of unknown significance is the extent to which a single bird can be represented more than once in the total census material. This error cannot be avoided due to the mobility of the non-breeding birds. This might be of a certain significance from a statistical point of view, but since all specimens have the chance of being registered more than once this error is of minor importance from a practical point of view, compared with the error caused by the differences in the conspicuousness of the species. Double counts of single specimens probably do not contribute much to the distortion of the proportions of the species in the census material.

Obviously the quality of the census material is not in full accordance with the statistical demands, and it would in fact be impossible to obtain such an ideal sample from bird census work. Thus the application of the formulae below must be looked upon as a rather provisional method carried out in order to obtain at least a general indication of the minimum field work required for our purpose.

For present purposes a degree of confidence of 0.95 was considered satisfactory. The corresponding 95 per cent confidence-intervals for different values of p and different sample sizes are found in statistical manuals. They characterize the degree of precision of the estimates. The dependence of the confidence-intervals on sample size is shown in Fig. 1. The dependence is not straight but is represented by a curve which approaches zero assymptotically.

About one third of all observations belong to species with dominance values of 2 to 4 per cent, i.e. that category of species which are of special interest as mentioned above (p. 111). We consider that it is acceptable if a population change of these species (with $p \geq 0.02$) can be demonstrated with appropriate exactitude when their percentage share of the community is at least doubled or halved. As appears from Fig. 1 this is possible when the sample size reaches 1500 observations.

According to our experiences in the field about 30 man-hours work is needed to collect 1500 observations by strip surveying, an effort quite compatible with other tasks within the census programme.

Comparison between the strip survey results of different census-takers

The analysis is based on samples of 1000 observations each, collected by three census-takers independently and 3000 observations collected by one census-taker (cf. p. 115). The results have been arranged in contingency tables in which all species which have a p value of 0.02 or more are accounted for separately. The four census-takers are denoted by the letters A, S, I, and B. The material has been tested for homogenity by chi-squared analysis (χ^2). The results are seen in Table 1. The χ^2-value turns out to be very high. The probability that random fluctuations alone have caused this lack of homogenity is less than 0.05 per cent. Each census-taker has contributed to about the same extent to the total sum.

The results of the tests between the census-takers two by two are shown in Fig. 2. The discrepancy is smaller between S, I, and B than it is between each of them and A. Only the relation S-B shows a difference small enough to be caused by random variation alone.

The 3000 observations collected by A have been divided into three successive portions consisting of about 1000 observations each. When they are tested for homogenity a high χ^2 is arrived at ($\chi^2 = 79.27$, $df = 24$, $P < 0.05$). The mentioned portions of the census material were collected on 12–17.VI, 17–22.VI and 22–25.VI, respectively. The demonstrated lack of homogenity is undoubtedly caused partly by the successive change in conspicuousness (audible manifestations, behaviour) of the species during the part of the breeding cycle covered by the census period, partly by differences between the three periods as to the weather conditions with consequent deviations in the activity

Table 1. Homogenity test by χ^2 analysis of the strip survey material obtained by the four ornithologists *A*, *S*, *I*, and *B*. (*χ^2 test rörande graden av överensstämmelse mellan erhållen och väntad fördelning mellan arterna i protokollgångmaterialet från de fyra ornitologerna A, S, I och B.*)

Species	A			S			I			B			
	obs. value	exp. value	χ^2	obs. value	exp. value	χ^2	obs. value	exp. value	χ^2	obs. value	exp. value	χ^2	$\Sigma\chi^2$
Parus atricapillus	74	56.71	5.26	15	19.60	1.08	9	19.62	5.75	18	20.07	0.21	12.30
Turdus pialris	115	96.30	3.63	30	33.29	0.33	31	33.32	0.16	21	34.08	5.02	9.14
Turdus ericetorum	93	75.28	4.17	23	26.02	0.35	11	26.05	8.69	27	26.64	0.00	13.21
Turdus musicus	212	209.23	0.01	54	72.33	4.65	71	72.40	0.03	91	74.04	3.88	8.57
Phoenicurus phoenicurus	117	100.22	2.81	23	34.64	3.91	37	34.68	1.55	28	35.47	1.57	9.84
Sylvia borin	73	86.04	1.98	28	29.74	1.02	42	29.77	5.02	33	30.49	0.21	8.23
Phylloscopus trochilus	1357	1429.42	3.67	530	494.13	2.60	517	494.60	1.01	520	505.85	0.40	7.68
Ficedula hypoleuca	115	101.68	1.74	25	35.15	2.93	40	35.18	0.66	28	35.94	1.75	7.08
Prunella modularis	93	93.86	0.00	35	32.45	0.20	27	32.48	0.92	37	33.22	0.31	1.43
Anthus trivialis	126	122.21	0.12	42	42.25	0.00	36	42.29	0.94	46	43.25	0.17	1.23
Fringilla montifringilla	338	358.82	1.21	154	124.04	7.24	122	124.16	0.03	120	126.98	0.38	8.86
Emberiza schoeniclus	104	100.70	0.11	34	34.81	0.02	30	34.85	0.67	38	35.64	0.16	0.96
Remaining species	232	218.52	0.83	61	75.54	2.80	82	75.61	0.54	72	77.33	0.37	4.54
Total	3049		25.54	1054		27.13	1055		25.97	1079		14.43	93.07

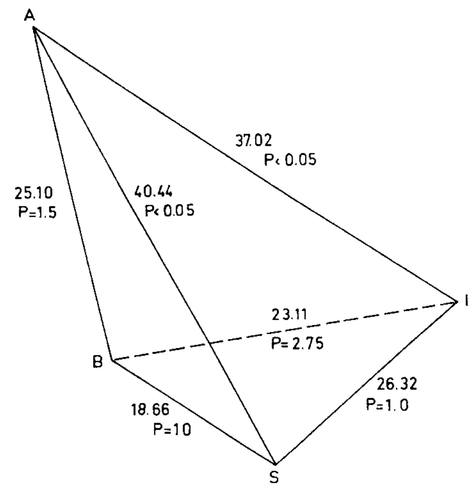

Fig. 2. Homogenity test of the strip survey material for each pair of the census-takers *A*, *B*, *I*, and *S*, who are represented by the corners of the tetrahedron. The discrepancy within pairs of observers is approx. proportional to the distance between corresponding corners. The relevant values of χ^2 ($df=12$) and *P* are presented in the figure. (*Homogenitetstest på protokollgångmaterialet parvis mellan observatörerna A, B, I och S. Dessa är representerade av tetraederns hörn och graden av bristande överensstämmelse inom varje par är ungefärligen proportionell mot längden av mellanliggande kantlinje. Motsvarande värde för* χ^2 ($df=12$) *och P har satts ut i anslutning till resp. kantlinjer.*)

of the birds. Moreover, when the strip surveys carried out by *A* were sorted into three groups so that early and late surveys of the season are represented in all of them, a homogenity test of the resulting three samples of observations gives a lower χ^2 value, implying that there is no significance different at hand ($\chi^2=29.78$, $df=24$, $P=20$ per cent).

Comparison between 1965 and 1966 as regards changes in the numerical data from the study areas and the strip surveys

The results of this comparison between two successive seasons are presented in Fig. 3, which is based on the strip survey results obtained by census-takers *A* and *B* in 1965 and 1966, and on the results from the study area investigations in the same habitat, carried out by three members of the team. Only those species which are more or less sparse in the habitat are considered, i.e. species with *p*-values

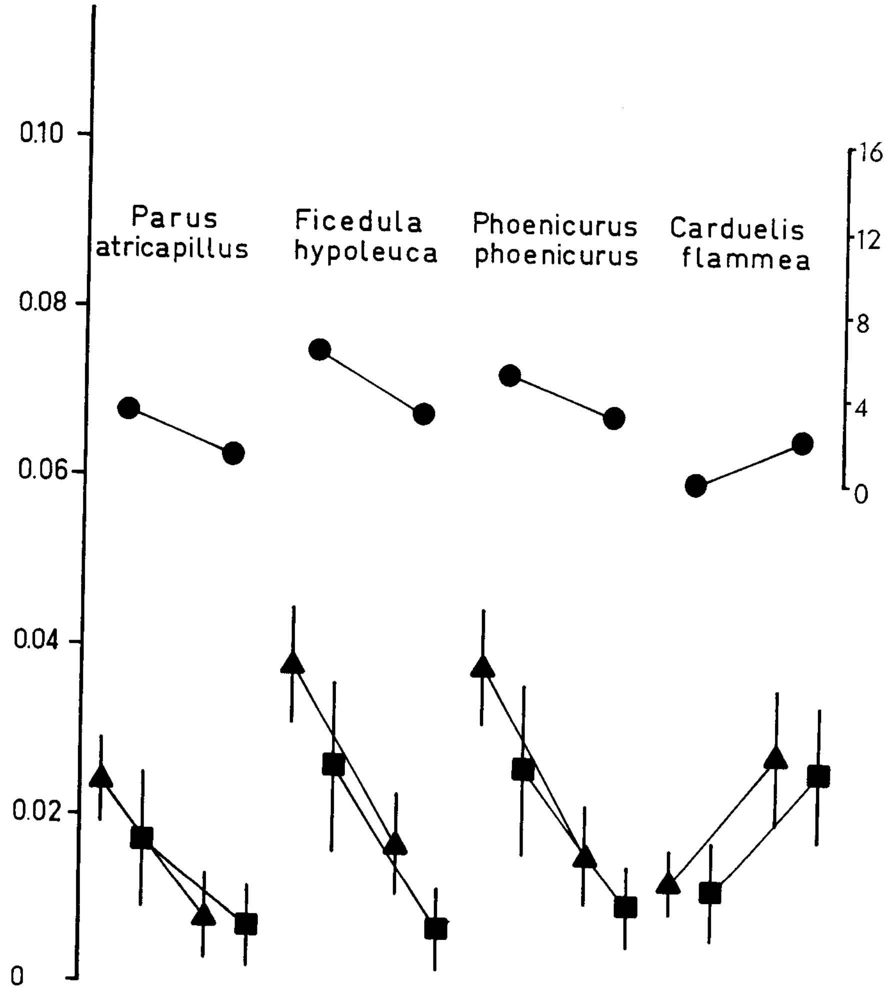

Fig. 3. The change in population size from 1965 to 1966 for eleven species as established by means of study area investigations on one hand and by strip surveying on the other. The total field work has been carried out in subalpine birch forests of the Ammarnäs area, Swedish Lapland.

● = number of territories (scale to the right) as established by three census-takers in four study areas.

▲ = *p*-value (scale to the left) according to the strip surveys of census-taker *A* (sample size: 3000 in 1965; 1500 in 1966).

■ = *p*-value according to the strip surveys of census-taker *B* (sample size: 1000 in 1965; 1500 in 1966). Vertical bars represent the 95 per cent confidence interval.

(Ändringen i populationsstorleken från 1965 till 1966 för elva arter enligt provyteundersökningarna å ena sidan och protokollgångarna å den andra. Hela fältarbetet stammar från samma område i den subalpina ängsbjörkskogen i Ammarnäsområdet.

● = *antal revir (högra skalan) enligt tre ornitologers arbete i fyra provytor.*

▲ = *p-värde (vänstra skalan) enligt de protokollgångar som utförts av A (antal observationer: 3000 1965, 1500 1966).*

■ = *p-värde enligt de protokollgångar som utförts av B (antal observationer: 1000 1965 1500 1966).*

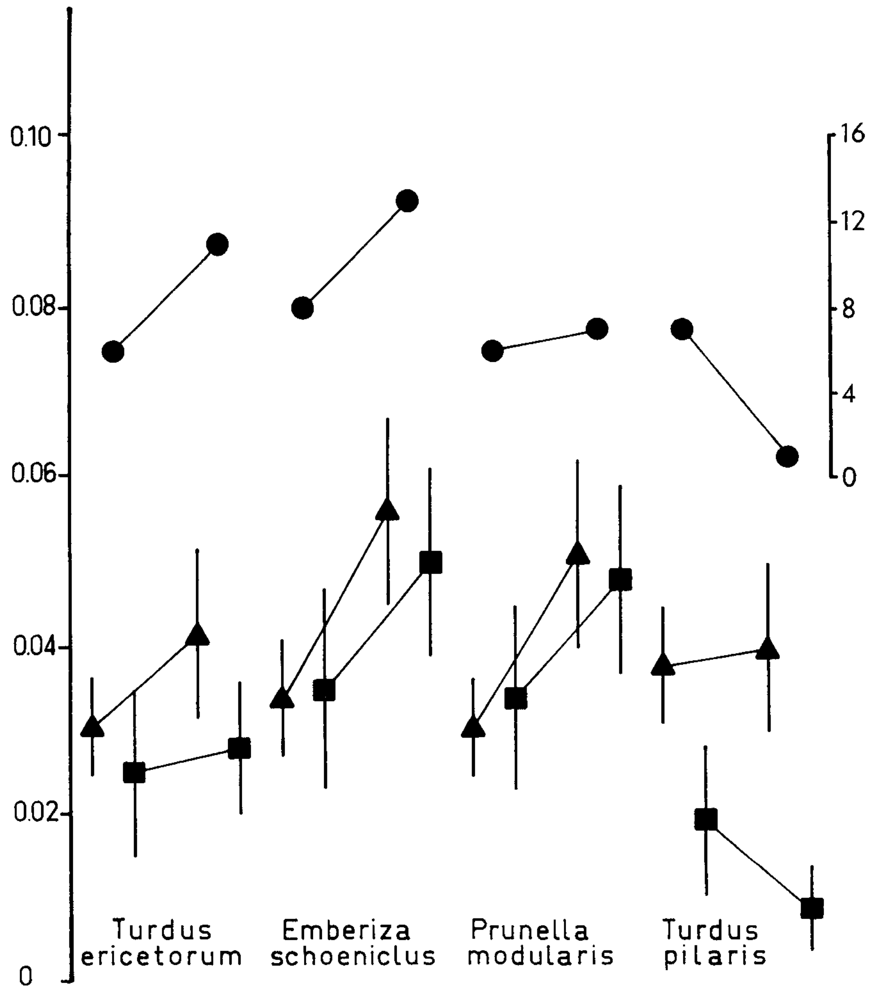

Fig. 3 b

ranging from 0.01 to 0.06. Thus the Willow Warbler and the Brambling which are very abundant are excluded. The p-values are used directly without correction, because the density change of the total community in 1966 compared with 1965 appeared to be of only minor importance for the p-values of the actual order of magnitude.

Obviously census-taker A and B coincide with only few exceptions as to the direction of the change of the obtained p-values between

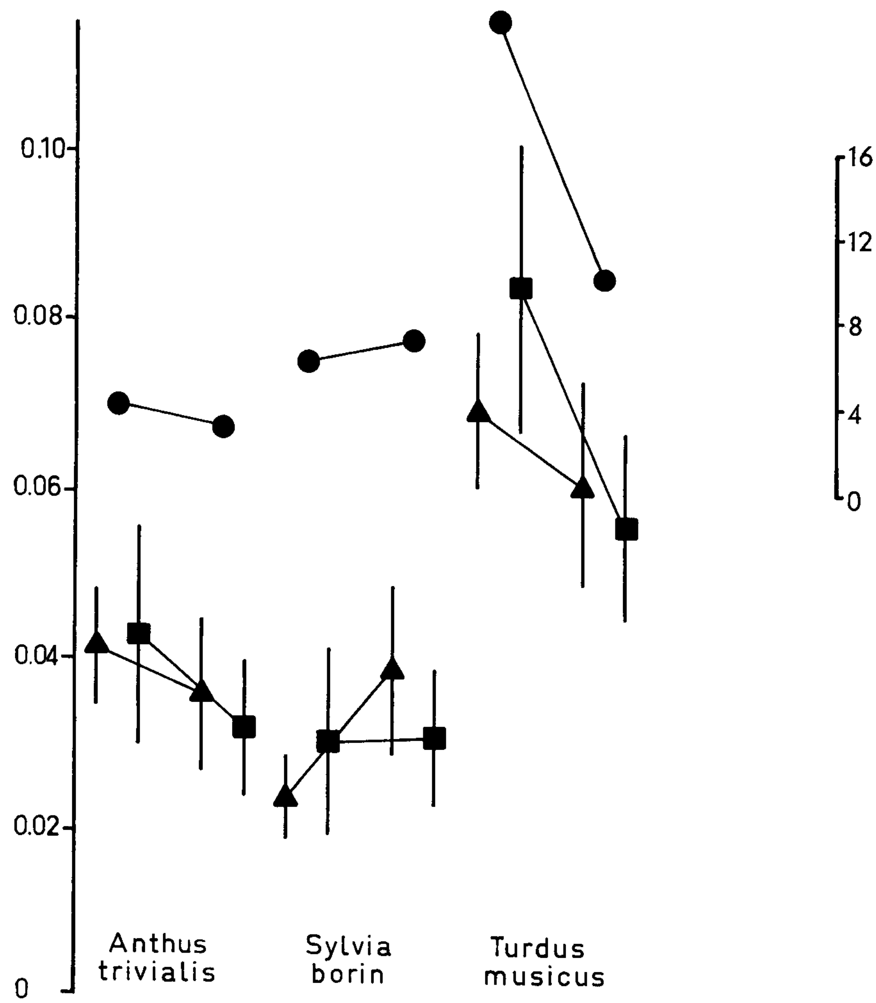

Fig. 3 c

the two seasons. Both of them demonstrate a significant decrease of the Willow Tit, the Redstart, and the Pied Flycatcher. The Redpoll and the Reed Bunting show a clear increase. It is notable that the population change as established within the study areas is in accordance with the mentioned results from the strip surveys, despite that the number of specimens is so low. For species as the Dunnock, the Garden Warbler and the Bluethroat only the values of census-taker A show significant increases, while B gives values showing minor increases. The figures for the thrushes are difficult to interpret. It is to be expected that the strip survey results would be of less accuracy for a gregarious species, such as the Fieldfare. No doubt this species had decreased considerably in number in 1966 as established by counting the nests in the colonies, a change reflected in the values of census-taker B alone. The unequivocal decrease of the Redwing as established by counting the nests in the study areas is in full accordance with the field material of census-taker B. The Song Thrush had increased clearly in density in 1966 according to the same census technique in the study areas, but this change was not confirmed by the strip survey material.

The p-values of A exceed in most cases those of B in 1965 as well as in 1966, although the difference with few exceptions is not significant in each separate case. The explanation is that – apart from the effect of personal differences in ability to register the birds – the material of B contains a larger proportion of Willow Warblers, probably because B has performed more surveys at times of the day with a marked song activity of that species. Consequently, a less clear picture of the population changes would have been obtained in a case when one had been forced to make the comparison on basis of the field material of B in 1965 and that of A in 1966.

Discussion and summary

This investigation, though based on rather restricted material, clearly demonstrates the limitations of the strip survey method which was after all, to be expected. The size and composition of the investigated bird community is not the same the census period throughout, but the changes in number are not too extensive according to the experience from the work in the study areas. Moreover, the strip survey technique is mainly based upon the audible manifestations of the birds, and this "audible picture" of the community does not only deviate from the original true community of the habitat, it is also far from stable. It alters with the weather conditions, the time of the day, and with the progress of the breeding cycle. Consequently the composition of the three samples of observations which were obtained by the same census-taker from three different periods of the breeding season appeared to differ significantly (p. 117). But it is hopeful that this discrepancy is reduced to an insignificant level when the material was re-arranged so that the three samples contained observations from the whole of the census period (p. 119). No doubt it is recommendable to perform the strip survey work as uniformly as possible at every season with regard to time of day and period of breeding cycle, though impossible it would be to obtain a perfect coincidence between seasons.

When samples of the same size are obtained by different ornithologists they differ considerably, despite that the strip surveys of all census-takers are distributed over the same period of the breeding season and are carried out within the same restricted area (p. 117). This implies that a personal factor causes part of the difference between the results. To what extent such a factor interferes is unknown, because the census-takers of this experiment did not carry out the strip surveys together on the same occasions. This would have been necessary when investigating the qualities of the different participants which was, however, not the aim of the experiment. On the contrary, each member of the experiment had to act completely independently as if he had been taken up in the team to save the strip survey project by replacing another member who had been prevented from participating. We know that any two ornithologists who work through a study area together will differ to a certain extent as regards the composition of their field notes (ENEMAR 1962) but the causes of this discrepancy have not been fully explained. However, as regards the ability of skilful ornithologists to watch and register the stream of migrating birds the influence of pure personal qualities on the results has been clearly demonstrated (ENEMAR 1964). It remains to be proved that this is the case also when censusing breeding bird communities. If so, the strip survey results of different ornithologists obtained in the same community at the same time will differ irrespective of the size of the collected samples. Therefore the comparative analysis between years should be based on the material of the same census-taker(s) in the first place. Thus it is wise to let two or more census-takers carry out strip surveys in a long-term project in order to secure more than one possibility to perform reliable comparisons between pairs of years.

The direction of the population changes from 1965 to 1966 appeared to be the same in the study area material and in the strip survey material to a surprisingly great extent (Fig. 3, p. 120). Full agreement on every point between the results obtained by the two census techniques is not to be expected mainly for two reasons: 1) It can be said on pure theoretical grounds that a population change is not always adequately reflected in the dominance values (cf. p. 113). 2) The population figures from the study area investigations concern the "stationary" or territory-bound part of the community, whereas the strip survey material includes the "floating" or non-stationary part of the community as well, and the composition of the two parts may of course differ. Nonetheless, as a complement to the study area investigations the strip survey material may often be of great value when evaluating the significance of registered changes of the population figures of the less abundant species.

To sum up, the strip survey material must be handled with great care when used to follow the fluctuations of bird populations. In our population studies in Lapland the strip survey technique is applied subject to the following conditions:

1. The strip survey material is used for calculation of dominance values only (percentage share of the total community) of the species.

2. The evaluation of population changes shown by the dominance values is made with necessary consideration to possible changes in the density of the total bird community as established by means of study area investigations, although this control of the total community is restricted to its territory-bound component.

3. The results of the strip surveys serve as a complement to the study area investigations to establish at least the direction, and in some cases the amplitude of the population fluctuations of the less abundant species.

4. This analysis is restricted to species with dominance values from about two to ten per cent.

5. At least 1500 observations are gathered by each census-taker yearly which means that a population change of the most sparse species considered is established with fair reliability when the population number is at least doubled or halved from one season to the other.

6. The comparison between years, according to the demands mentioned above, is based on the results of the same census-taker who has to attempt to perform so uniform a field work as possible every season.

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Svensk sammanfattning: **Protokollgångmetoden som komplement till provytearbetet vid taxering av småfågelbestånd.**

Studiet av många populationsekologiska problem fordrar skattningar av storlek och sammansättning av avgränsade populationer under en längre följd av år. För småfågelsamhällen torde den s.k. karteringsmetoden vara det bästa hjälpmedlet vid beståndsbestämningen. Metoden bygger på upprepade inventeringar inom provytor av känd storlek. Eftersom metoden medför ett tidsödande fältarbete är det endast en relativt liten areal som kan genomarbetas under den korta period, som lämpar sig för inventering av häckande småfågel. Därigenom kommer de sparsamt förekommande arterna, vilka kan utgöra en stor del av populationen, att bli representerade i så låga tal att de från statistisk synpunkt inte blir användbara, då jämförelser mellan säsonger eller biotoper skall utföras. För att övervinna denna begränsning i karteringsmetodens användbarhet, har vi vid undersökningar i södra Lappland utvidgat inventeringarna med s.k. protokollgångar. Material från 1965 och 1966 ligger till grund för föreliggande test på dessas tillförlitlighet.

Allmänna synpunkter på protokollgångmetoden som inventeringsmetod för småfågel. Protokollgång innebär att inventeraren sakta går genom den utvalda biotopen och registrerar alla sjungande fåglar och andra

livsyttringar som rimligen kan sättas i samband med häckning eller revirhävdande. Observationerna begränsas till terrängavsnitten ca 75 m i sidled från observatören.

Protokollgångförfarandets stora fördel ligger i att det möjliggör insamling av ett stort fältmaterial på kort tid från en stor areal. Det erhållna siffermaterialet används för att räkna fram s.k. dominansvärden för de olika arterna; dvs. deras procentuella andel av hela fätlmaterialet. En förändring i dominansvärde återspeglar under vissa förutsättningar en förändring i artens talrikhet. Denna inventeringsmetod har emellertid viktiga begränsningar som kommenteras nedan.

1. Materialet kan inte användas för att beräkna täthetsvärden, eftersom avgränsningen i sidled är omöjlig att utföra med tillräcklig noggrannhet. Vid vårt inventeringsarbete är alla täthetsberäkningar baserade på resultat från provyteinventeringar.

2. Man bör komma ihåg att dominansvärden grundade på protokollgångmaterial i viss grad är missvisande beroende på arternas varierande registrerbarhet. Därför bör beräkningar av arternas »sanna» proportioner i beståndet fotas på provyteinventeringar.

3. Om dominansvärdet för en art har ökat från en säsong till en annan, kan detta bero på att arten har ökat sin numerär. Men det är också möjligt att arten hållit sig konstant och att den procentuella ökningen är en följd av att den totala fågeltätheten minskat. God kunskap om täthetsförändringar i hela beståndet är nödvändig för att kunna utvärdera protokollgångresultaten och använda dem vid studier av olika arters abundansförändringar.

Det är tydligt att protokollgångförfarandet som isolerad metod är av mycket begränsat värde. Vi anser det emellertid värt att pröva dess användbarhet som ett komplement till provyteinventeringarna.

P r o b l e m s t ä l l n i n g e n. 1. Hur många observationer skall den enskilde inventeraren samla för att erhålla ett fältmaterial som ger en god bild av småfågelsamhällets sammansättning och som tillåter jämförelse med resultaten från andra säsonger? Svaret påverkas av bl.a. följande faktorer: a) hur pass sällsynt förekommande arter man vill kunna följa, b) vilken minsta numerära förändring man vill kunna konstatera, c) den valda signifikansnivån för denna förändring. Dessa krav får vägas mot den arbetstid, som finns tillgänglig för fältarbetet.

2. I vilken grad kommer inventeringsresultatet att variera när olika inventerare har arbetat oberoende av varandra under samma säsong och inom samma område? Frågan är av vikt, när man skall avgöra huruvida olika inventerare kan vikariera för varandra under loppet av ett flerårigt inventeringsprojekt.

Fältmaterialet till den föreliggande undersökningen består av 3000 observationer insamlade av en medlem i gruppen samt tre prov på 1000 observationer vardera insamlade av tre andra gruppmedlemmar. Protokollgångarna har företagits i ca 8 km^2 ängsbjörkskog på sydsluttningarna av Kaissats och Valle nära Ammarnäs i södra Lappland. Inventeringarna har ägt rum under den lämpligaste perioden av häckningssäsongen i juni 1965. Slutligen insamlades 1500 observationer vardera av två observatörer i juni 1966.

B e r ä k n i n g a v e r f o r d e r l i g p r o v s t o r l e k. Protokollgångmaterialet förser oss med proportionstal (p), även uttryckta som dominansvärden (d) (dvs. $d = p \cdot 100$) för de olika arterna. Dessa värden utgör skattningar av de faktiska proportionstalen för varje art. För stora stickprov kan p antas vara approximativt normalfördelad med medelvärde $E(p)=\pi$ och standardavvikelse $D(p)=\sqrt{\frac{\pi(1-\pi)}{n}}$. Formlerna är relevanta om populationen är konstant under inventeringsperioden. Denna ideala situation torde aldrig realiseras i ett småfågelsamhälle. Dock antas in- och utflyttning av icke-häckande individ vara likstora, samt mortaliteten negligerbar under inventeringsperioden. Däremot torde sannolikheten att upptäcka och registrera en fågel inte vara densamma under hela inventeringsperioden, ty det är uppenbart att den akustiska »bilden» av småfågelsamhället, som vi söker registrera, ändras under häckningstidens gång. En annan felkälla av okänd storlek är graden av dubbelregistreringar av en enskild fågel.

Även om vårt material inte är i full överensstämmelse med de statistiska kraven, anser vi oss dock kunna använda gängse statistiska formler för att få åtminstone en allmän uppfattning om det minimum av fältarbete som krävs. Som mått på precisionen i våra skattningar av proportionstalen har vi använt 95% konfidensintervall. (Deras beroende av stickprovets storlek framgår av fig. 1.)

Omkring en tredjedel av alla observationer härrör från arter med dominansvärden på ca 2–4%; det är den artkategori som har speciellt intresse för oss. Vi anser det vara rimligt om vi med acceptabel säkerhet kan konstatera en fördubbling eller halvering av deras proportionstal. Som ses på fig. 1 är detta möjligt om provstorleken uppgår till 1500 observationer. Det åtgår enligt vår erfarenhet i runt tal 30 arbetstimmar för att insamla 1500 observationer, vilket går att förena med övrig inventeringsverksamhet.

Jämförelse mellan protokollgångresultaten från olika inventerare. Analysen baseras på 6000 observationer, varav en inventerare svarar för 3000, tre andra inventerare för 1000 vardera. Inventerarna har arbetat helt oberoende av varandra. Resultatet redovisas i tabell 1, i vilken varje art med ett p-värde lika med eller större än 0,02 har presenterats separat. De fyra inventerarna betecknas med bokstäverna A, S, I och B. Materialet har testats för homogenitet med χ^2-analys. Som framgår av tabellen är χ^2-summan mycket stor. Sannolikheten för att enbart slumpvariation skulle ha orsakat ett lika stort eller större χ^2-värde är mindre än 0,05%.

Resultatet av parvisa test mellan inventerarna visas i fig. 2. Likheten är större mellan S, I och B än mellan var och en av dessa och A. Endast relationen S-B visar ett så lågt χ^2 att det kan anses vara orsakat av enbart slumpvariation.

Homogenitetstest med χ^2-analys på tre successiva portioner av A:s 3000 observationer ger ett så högt χ^2-värde att chansen för att det enbart är orsakat av slumpen är mindre än 0,05%. Denna brist på homogenitet torde till stor del bero på den successiva förändring i fågelsamhällets registrerbarhet som skett under inventeringsperioden; till en viss del på väderleksskillnader mellan inventeringstillfällena. Eliminerar man tidsfaktorn genom att fördela tidiga och sena observationer någorlunda jämnt i de tre portionerna erhåller man ett betydligt lägre χ^2-värde, och ingen signifikant skillnad kan iakttas mellan portionerna.

Jämförelse mellan resultat från 1965 och 1966 av protokollgångar och provytor. Resultaten av denna jämförelse visas i fig. 3. De är baserade på protokollgångmaterial insamlat av inventerarna A och B under

1965 och 1966, samt på provyteinventeringar i samma biotop utförda av fyra medlemmar i arbetsgruppen. Endast arter med *p*-värden på 0,01–0,06 är medtagna. Som framgår av fig. är överensstämmelsen god mellan *A* och *B* vad beträffar riktningen av iakttagna förändringar mellan säsongerna. Både demonstrerar en signifikant minskning för talltita, rödstjärt och svartvit flugsnappare, och en säkerställd ökning för gråsiska och sävsparv. För järnsparv, trädgårdssångare och blåhake visar bara *A*:s värde på signifikanta ökningar; *B*:s värden antyder ökningar av mindre omfattning. Trastarna ger siffror som är svåra att tolka. De minskningar för björktrast och rödvingetrast som boräkning i provytorna givit vid handen, återspeglas i *B*:s resultat enbart, medan den ökning som med samma teknik uppenbarats för taltrast inte bekräftas av protokollgångresultaten.

D i s k u s s i o n o c h s a m m a n f a t t n i n g. Denna undersökning visar tydligt begränsningarna hos protokollgångmetoden. Storleken och sammansättningen av det undersökta småfågelsamhället är inte konstant under inventeringsperioden. Metoden är baserad huvudsakligen på fåglarnas akustiska livsyttringar och denna »akustiska bild» av fågelsamhället är inte bara avvikande från det faktiska fågelsamhället, utan också långt ifrån konstant. Den varierar med väderlek, tid på dagen och med häckningscykelns fortskridande.

Jämförelsen mellan resultaten från olika ornitologers protokollgångar inom samma område och samma tidsperiod visade på stora diskrepanser. En del av dessa torde orsakas av personliga olikheter i ornitologernas sätt att uppfatta omgivningen; i vilken utsträckning så är fallet vet vi dock ej, eftersom vårt experiment inte genomfördes med tanke på att demonstrera dessa skillnader.

Resultaten av provyteinventeringarna och protokollgångarna överensstämde i förvånansvärt hög grad vad beträffar riktningen på populationsförändringarna från 1965 och 1966. Full överensstämmelse kan inte förväntas av framför allt två skäl: 1. en populationsändring kommer inte alltid att återspeglas i dominansvärdena av rent teoretiska orsaker (se sid. 113). 2. medan provyteinventeringarna endast omfattar den revirhävdande, stationära delen av fågelsamhället, inkluderas även den mer »flytande», icke-revirhävdande delen i protokollgångmaterialet. Sammansättningen av dessa båda delar kan givetvis vara olika. Icke desto mindre anser vi protokollgångmetoden som komplement till provyteinventeringarna ofta vara av stort värde för att utvärdera funna ändringar i populationsstorlek för mindre talrikt förekommande arter.

Vid våra populationsstudier i Lappland tillämpas protokollgångmetodiken enligt följande:

1. Protokollgångmaterialet används enbart för att beräkna arters dominansvärden.

2. Utvärdering av ändringar i storlek och sammansättning hos populationer görs med tillbörlig hänsyn till eventuella täthetsändringar i hela småfågelsamhället påvisade med hjälp av provyteinventeringarna.

3. Protokollgångresultaten tjänar som komplement vid fastställandet av åtminstone riktningen, i relevanta fall även storleken av populationsändringar för de mindre talrika arterna.

4. Denna analys inskränks till arter med dominansvärden på ca 2–10%.

5. Minst 1500 observationer insamlas av varje inventerare årligen för att vi med rimlig säkerhet skall kunna konstatera åtminstone dubblering eller halvering av de aktuella arternas andel i småfågelsamhället.

6. Jämförelser mellan säsonger baseras på resultat av en och samme inventerare, vilken skall sträva efter att genomföra så likartat fältarbete som möjligt varje säsong.

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