BIRD SPECIES DENSITIES DERIVED FROM STUDY AREA INVESTIGATIONS AND LINE TRANSECTS

by Anders Enemar & Bengt Sjöstrand

Zoological Institute, University of Gothenburg and Department of Animal Ecology, University of Lund

One of the principal aims of a research programme at Ammarnäs, Swedish Lapland, is to study the dynamics of the total bird community in the rich subalpine birch forests, the so-called meadow birch forests, on the southern slopes of the mountains of Kaissats and Valle.

The composition of the bird community is shown in fig. 1 which demonstrates the percental share of the community for the different species populations. It is remarkable that one single species is so dominant as the willow warbler, when considering that the forest is fertile and inhabited by a fairly large number of passerine species. The number of sparsely occurring species is consequently large. As we want to follow the fluctuations also of the sparse species, special methodological problems are introduced. This report is centred upon them.

The census techniques applied are

1. mapping (study area investigations), giving the density of the stationary populations,
2. line transects (strip surveying), giving the percental share of the community for the different species (proportional values), and
3. netting and ringing, giving an index of the amount of birds belonging to the floating (non-breeding) populations.

The number and size of the investigated study areas 1963 to 1968 are shown in table 1. The dia-

Table 1. The study areas in the rich subalpine birch forests 1963 to 1968. × indicates that the area was investigated.

Study area	Size in square kilo-metres	1963	1964	1965	1966	1967	1968
A 4	0.129	×	×	×	×	×	×
A 5	0.111	×	×	×	×	×	×
A 6	0.122	×	×	×	×	×	×
A 7	0.080		×	×	×	×	×
A 8	0.080				×	×	×
Total area investigated		0.362	0.442	0.442	0.522	0.522	0.522

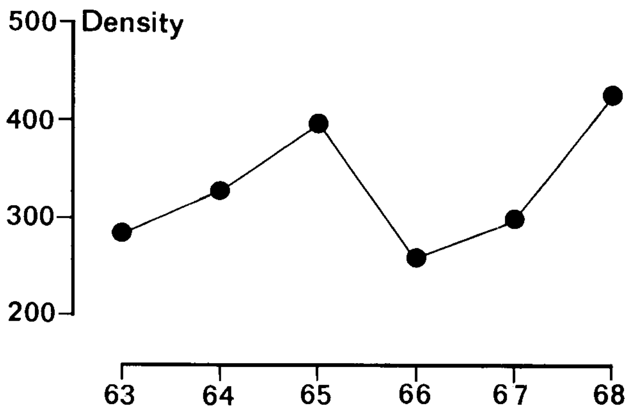


Fig. 2. The fluctuations of the whole community in the study areas in the rich subalpine birch forest 1963 to 1968. Density is expressed as number of stationary males per square kilometre.

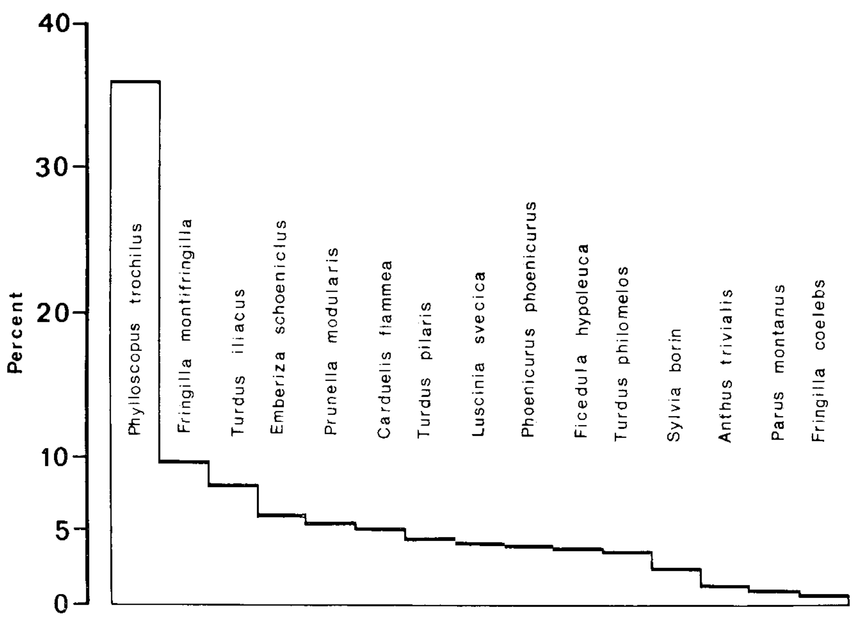


Fig. 1. The composition of the stationary passerine bird community in the rich subalpine birch forest according to the results of the mapping work in study areas. The proportional values (per cent) are average figures for the six-year period 1963 to 1968. The presented species constitute almost 99 per cent of the whole stationary community.

gram of fig. 2 demonstrates the fluctuations in the density of the stationary community of the study areas during the same sequence of years. The density in the rich birch forests is slightly more than 300 stationary males per square kilometre on the average, but the fluctuations between years can be remarkable. The number of mapped territories in each separate study area 1963 to 1968 is shown in fig. 3. It is evident that the different areas coincide well as to the direction of the fluctuations. From this we conclude that the density fluctuations in the study areas reflect the true density changes in the habitat as far as *the whole bird community* is concerned.

This conclusion cannot, however, be extended to each of the species populations, at least not to the sparsely occurring species. The mapping method and the line transect method are both insufficient. The mapping may fail for species which are represented by so few stationary males in the study areas that their numbers will be strongly influenced by chance. Consequently no conclusion can be drawn as to the direction or amplitude of the fluctuations in the surrounding habitat. With the line transect method, on the contrary, a large sample of observations of even the sparsely occurring species can be gathered in the habitat in a rather short time (cf. Enemar and Sjöstrand 1967). The proportional values calculated from this material are therefore more reliable than those calculated from the study area material. But they are nonetheless insufficient because they are not related to density. A change in the proportional value of a species means a corresponding change in density only if the density of the total community remains constant. If not, the proportional value must be adjusted to the density change of the bird community in some way before it is used for analysis. And we have, in fact, to consider that the community density may change remarkably between years (fig. 2).

We have tackled the problem of following the fluctuations of the sparse species by combining the best values of the two census methods, that is the density value of the whole bird community as determined by mapping in the study areas, and the proportional values of the separate species as obtained from the line transects. With the aid of these parameters the species density can be calculated by simply multiplying its proportional value by the density value of the community. The result is called "the derived density" in this report. The density directly determined in the study areas is called "the study area density".

It is a complication of unknown significance that the community density of the study areas is related to the stationary populations of the species, whereas the proportional values of the line transects concern

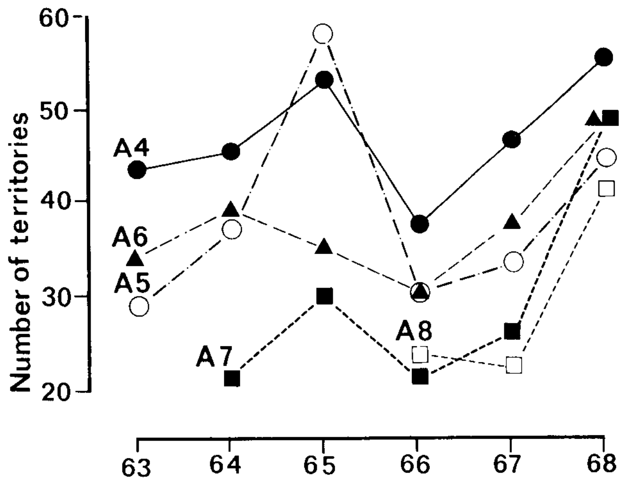


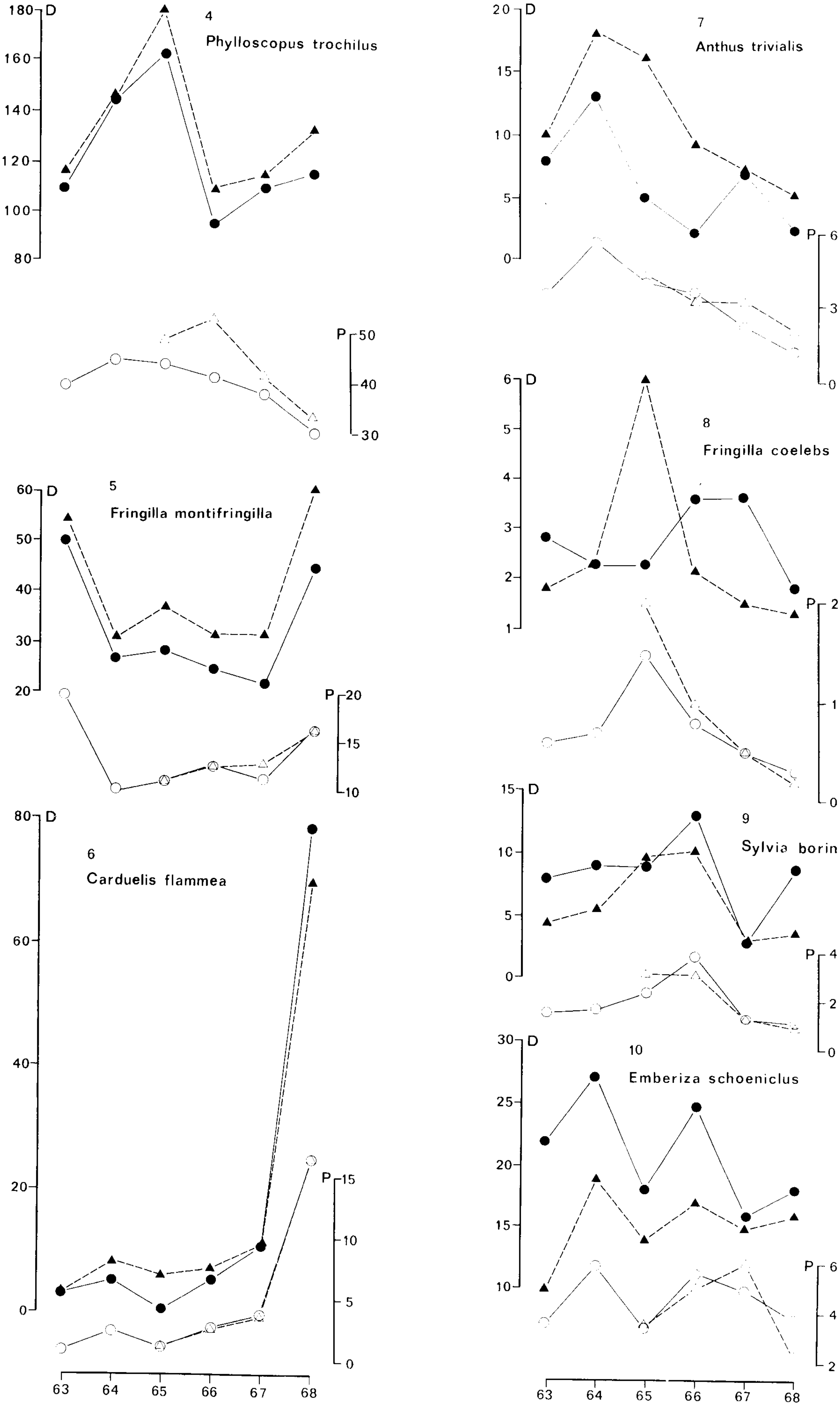
Fig. 3. The number of stationary males on mapped territories in the five study areas which are listed in Table 1.

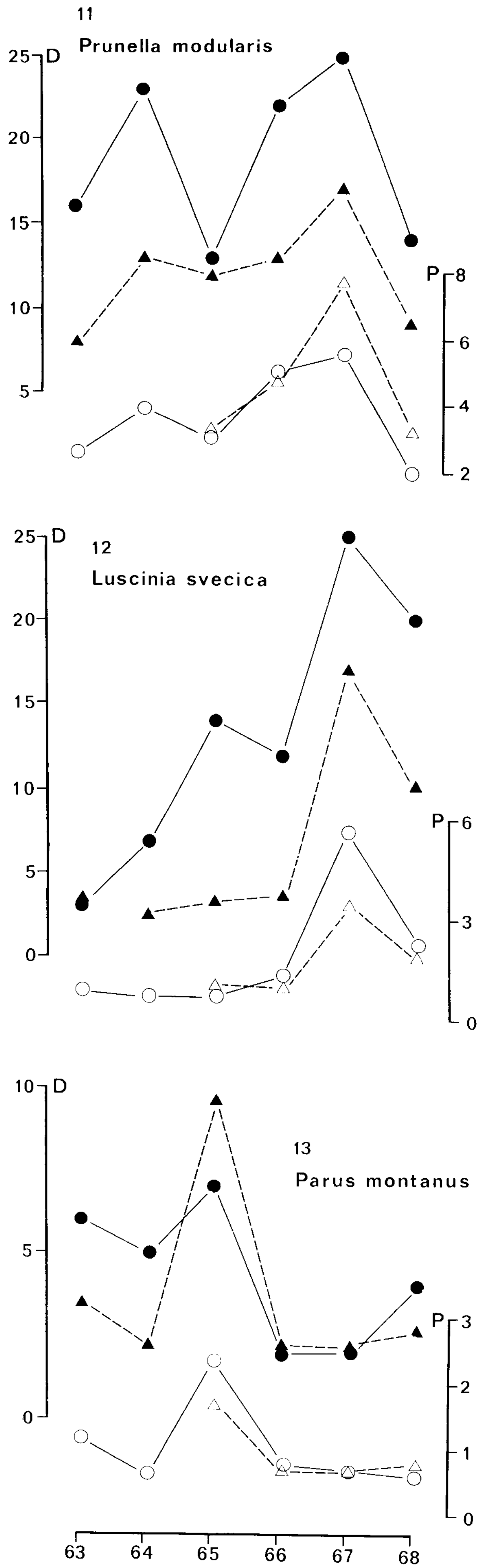
the total populations, i. e. the sum of the stationary and the floating populations. This means the introduction of a source of error which should not be forgotten even if its order of magnitude is not possible to estimate so far.

The fluctuations of the derived density values for some selected species are shown in the diagrams of figs. 4 to 13, together with the fluctuation curves of the study area density and of the proportional values.

A minimum demand of the present method—i. e. calculating density figures from combined line transect and study area material—is that the fluctuation pattern of the derived density and the study area density should coincide for the abundant species. The outcome for the two most abundant species, the willow warbler and the brambling, is shown in figs. 4 and 5. There is good coincidence for both species, even in cases when the proportional values do not follow the change in the study area density as for the willow warbler (fig. 4). So far the applied method seems to work.

The conspicuous species which are easily discovered during the line transecting will be presented first of the sparsely occurring species. They will be overestimated in number in the line transect material compared with the less conspicuous species, and therefore the derived density values will exceed those of the study area density. The redpoll (fig. 6) shows a very good coincidence in all parameters and the enormous increase in the study area density in 1968 is evidently representative of the habitat. The tree pipit (fig. 7) shows a steady decrease in density since 1964. The increase in study area density in 1967 probably does not reflect the true population development in the habitat according to the information from the derived density material. The number of chaffinches (fig. 8) is so small in the study areas


4
Phylloscopus trochilus
D
180
160
140
120
100
80
P
50
40
30
5
Fringilla montifringilla
D
60
50
40
30
20
P
20
15
10
6
Carduelis flammea
D
80
60
40
20
0
P
15
10
5
0
63
64
65
66
67
68
7
Anthus trivialis
D
20
15
10
5
0
P
6
3
0
8
Fringilla coelebs
D
6
5
4
3
2
1
P
2
1
0
9
Sylvia borin
D
15
10
5
0
P
4
2
0
10
Emberiza schoeniclus
D
30
25
20
15
10
P
6
4
2
63
64
65
66
67
68



that the obtained figure material is of practically no value when studying population fluctuations. The derived density values, however, differ remarkably from those of the study area density. The conclusion from the diagram is that the chaffinch had a peak year in 1965, otherwise the species remained at the same very low population level throughout the period. The garden warbler (fig. 9) is difficult to interpret, but apparently the population number decreased from 1966 to 1967.

Figs. 10 to 13 present corresponding diagrams for four less conspicuous species. For these the derived density tends to be less than the study area density. The reed bunting (fig. 10) shows a decreasing tendency in the study areas but this is not supported by the derived density and is therefore questionable. There is, however, a good coincidence in the directions of the fluctuations. The dunnock (fig. 11) had a peak year in 1967 and showed a clear increase and decrease in 1964 and 1968, respectively. The pronounced drop in the study area density in 1965 cannot definitely be considered representative of the habitat, since it did not appear clearly in the derived density figures. The bluethroat (fig. 12) certainly had a peak year in 1967. The increasing tendency shown by the study areas 1963 to 1966 is not supported by the derived density values. But the bluethroats are easily overlooked after the beginning of the breeding and may have been too few in the line transect material. It is therefore not possible to say anything with certainty about the population change during the first four years. The willow tit (fig. 13) is found in the study areas in very limited numbers which are of no use when studying the fluctuations in its population number. But according to the derived density figures the species had a peak year in 1965, for the rest the density remained at a low and rather constant level.

Figs. 4—13. The population fluctuations of ten species in the rich subalpine birch forest during the six-year period 1963 to 1968.

○———○ = proportional value in per cent according to the line transect material of A. Enemar.

△— — —△ = proportional value in per cent according to the line transect material of B. Sjöstrand.

●———● = study area density (stationary males per square kilometre)

▲— — —▲ = derived density based on the line transect material of A.E.

D = Density; P = Percent.

Evidently the derived density values can provide interesting information as regards the population fluctuations of the sparsely occurring species. We believe that for the conspicuous species the fluctuation pattern of the derived density is closer to the real fluctuations than that of the study area density. This does not hold unequivocally for the less conspicuous species which are not so efficiently observed during the line transects as they are mapped in the study areas. But when both types of density values change in the same direction we are apt to accept the change as a real one.

The method of calculating derived densities is necessary also when estimating the population fluctuations of colonial or semi-colonial species, for which the study area figures of course may appear completely misleading. But this special case will not be treated in this preliminary report.

It should be stressed that the derived density value is an index which is *useful for following fluctuations only*. To assess the real density of a species, if this is possible, we are referred to mapping in study areas. It is an advantage of the method of this report that the density factor is determined exclusively in study areas and that the line transects are carried out only in order to assess the proportions of the species. Therefore the area covered by the transect is not considered which means that one important source of error is avoided.

It is a painstaking work, indeed, to obtain reliable information concerning the fluctuations of *all* species of a bird community solely by mapping in study areas. We believe that it is possible to reach acceptable results with a limited amount of field work by combining data from mapping in comparatively small sample areas with line transect data from a much larger area, at least in cases when the habitat of the investigated bird community is extensive and rather homogeneous. The method may deserve further study to test statistically its usefulness and limitations.

We want to mention, finally, that essentially the same method of deriving bird species densities was first introduced already sixty years ago by the Swede Axel Klinckowström (1909) although he did not describe his technique in great detail. He carried out bird census work in subalpine birch forests and on alpine heaths in northern Sweden. He used the population of the most abundant species, the meadow pipit, as a density reference, not the whole community as in this report. He determined the density of the breeding pipit population by counting nests, and after having estimated the number of the other species of the habitat relative to the meadow pipit he could calculate the species densities.

REFERENCES

ENEMAR, A. and SJÖSTRAND, B. (1967): The strip survey as a complement to study area investigations in bird census work. *Vår Fågelvärld* 26, 111—130.

KLINCKOWSTRÖM, A. (1909): En sommar i Frostviksfjällen. *Fauna och Flora* 4, 1—18, 53—70, 191—120.