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Bird censuses on wooded islands. A method

Lars von Haartman

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Since 1937, the author has censused 38 wooded islands in SW Finland relatively continuously. Only land birds are considered in the present publication. The method was a plot censusing method.

The main question with respect to the method is whether, if a plot is censused more than once in a nesting season, the final result should be given through pooling the single results, or by them.

The main sources of error influencing the plot census will be: (1) overlooking individuals, (2) counting drifting, non-breeding individuals, and (3) counting individuals breeding outside the plot but visiting it, as members of its population.

Errors of type (1) will be amended by the pooling method, whereas it will cause overestimation because of errors of types (2) and (3). Checking the method, (a) repeated censuses within a single breeding season, (b) prolonged single censuses, as well as (c) a normal single census of a thoroughly censused island, were undertaken. These checks confirmed the existence of the error sources but did not permit a final evaluation of their relative importance. As the errors presumably to some extent counterbalance each other, computing averages instead of pooling census results was considered preferable.

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1. Introduction

Since 1937, the author has censused wooded islands in the archipelago around Lemsjöholm in SW Finland (parishes Askainen, Merimasku, and Velkua), c. 30 km W of the city of Turku. The censused islands vary in size from very small (c. 1 breeding pair) to medium (c. 40 pairs). Of them 38 have been censused in many years, up to 40 of the 47 years covered by the investigation, and it is mainly these islands that allow a survey of the avifaunal changes. Fifteen other islands have been censused less often and a considerable number, mostly peripheral or inhabited islands, have been censused only occasionally. The number of yearly visits to the islands has likewise varied, from one to four, in a few cases more.

The aim of the investigation is to obtain absolute numbers, i.e. numbers not only comparable *inter se*. As it has been carried out along with other projects, it has not been possible to apply such time-consuming methods as searching for nests or mapping territories (e.g. Palmgren 1933, Enemar 1959, von Haartman 1971). Not only the land-birds have been censused, but all species, including gulls, waders, ducks, coots, and grebes. Of these groups only *Tringa hypoleucos* and *Scolopax rusticola* are included in the present study, mainly because they breed in the wooded parts of the islands; like the song-birds the former is often censused on the basis of its sound.

Some results of this study have been given earlier (von Haartman 1975, 1978). In the present text only the method will be treated. A few more results will be discussed in another communication (von Haartman 1984).

2. The method. A case description

The way in which birds are censused may differ from one person to another (Palmgren 1930:94). The census taker is the target of a continuous stream of information, usually of *gestalt* character, to which he will react in his own fashion. Even the seemingly more mechanical parts of the census work, such as the way of scrutinizing the terrain, will vary from student to student.

The best way to transmit a census method is therefore to hand down a tradition. A somewhat similar situation

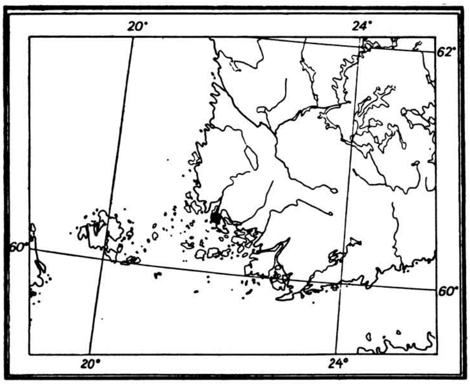

Fig. 1. The position of the censused area.

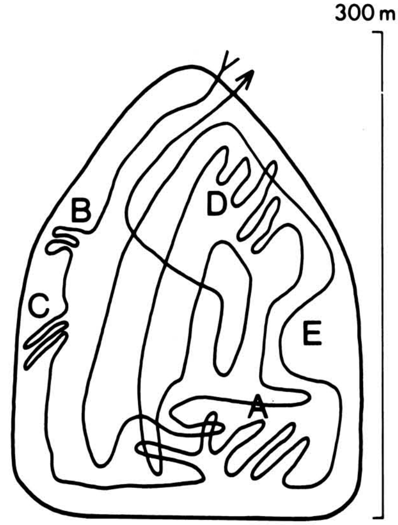

Fig. 2. Schematic representation of surveyor's path in censusing a wooded island. The regular "lawn-mowing" route was abandoned at several sites in favour of maximizing the efficiency of the censusing. For explanation of lettered areas, see text.

exists with, say, the musicians of bygone days. How did Franz Liszt play? Contemporary descriptions give us only a vague indication. We can learn more from the way in which the masters of the Lisztian tradition still play today. I have now carried out a considerable number of censuses together with my grand-nephew Mikael von Numers. He can, therefore, serve as a living document of my method.

This method can be characterized as a transformed Palmgren (1930) method. After determining the border of his study plots, Palmgren walked backwards and forwards through them in the manner of a man mowing a lawn, along parallel lines with c. 50 m between them, making deviations when necessary e.g. for determination of the species of an observed bird. To a certain extent I have walked in this manner, but with numerous exceptions, so that the procedure is difficult to describe.

The method I use to census a certain island (Fig. 2) may serve as an example. Special attention is given to the shore, where the wood passes into the treeless border between land and sea. Here, as ecological theory predicts ("edge effect") and practice shows to be true, are the greatest chances of finding birds, especially the nests of some ducks (*Somateria mollissima, Anas platyrhynchos* and *A. penelope*), the wader *Tringa hypoleucos*, and small birds of the open country (*Motacilla alba, Oe. oenanthe*). Further, the occurrence of the alder as the dominant tree along the shore makes it more attractive to the majority of the song birds than the dry pine or pine-spruce forest of the interior of most islands. Whether the shore-line is censused first or later is a matter of choice; I usually prefer to eat my dessert first. The following routes run through the inner parts of the island, roughly parallel to each other. Interesting areas are crossed in all directions. Thus (Fig. 2, point A), an area with young spruce was searched through for nests of thrushes and individuals of titmice and *R. regulus*. At points B and C there are fragments of more productive forest which demand special attention, and area D has a number of fine junipers worth checking for nests of *Carduelis chloris, Lanius collurio*, and *Fringilla coelebs*. Area E is more or less avoided, because here the wood consists of young pine, where birds practically never nest and rarely search for food.

As this example indicates, my method is intended to yield as many birds as possible within the time allowed by my schedule.

3. Census results and tests of their accuracy

Several ways have been tried to test whether a census method gives accurate results. The only completely satisfactory method seems to be to compare census results with exact information on bird numbers. L. Tinbergen censused the numbers of singing tit males from a listening point in an area that was devoid of natural holes, but where a helper had placed nest-boxes and counted the numbers of nests without telling L.T. the results. I took part in one of Tinbergen's early morning censuses in 1949, but have failed to find a description of the method in his publications. Palmgren (1930, 1933, 1981) never ceased to study sources of error in bird censusing; in his 1933 publication he established that his earlier results from two study areas tallied well with a prolonged study of the areas carried out a few years later. Nordberg (1947) found the line transect method as reliable as the census plot method. Järvinen & Lokki (1978) used computer simulation to correct incomplete censuses. Haila & Kuusela (1982) compared the result of a single census of an island with the result of mapping, based on 6 visits. Helle & Pulliainen (1983) found that a single line transect covered 50 % of the breeding pairs and equivalents.

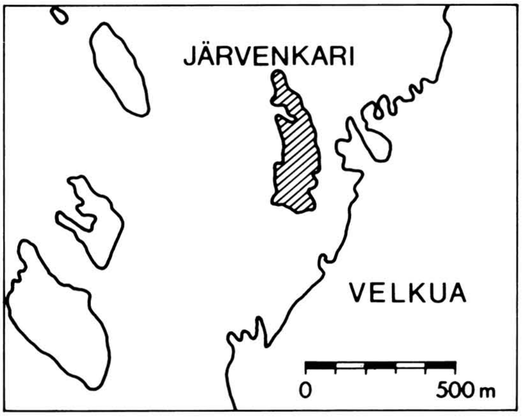

Fig. 3. The position of Järvenkari, used in the study of the census method. See text.

Table 1. Results of censuses of different duration, obtained by two persons.

	LvH, June 12, 12-17 h	MvN, June 14, 11-12 h
Larus canus	1	1
Sterna hirundo	(1)[1]	?[1]
Motacilla alba	2	2[2]
Fringilla coelebs	4[3]	4[3]
Phylloscopus trochilus	1	1
Oenanthe oenanthe	1	1
Muscicapa striata	1	1
Parus cristatus	1	1
Carduelis spinus	1[4]	-
(*Sturnus vulgaris*)	-[5]	-

[1] A somewhat aggressive individual; June 12, possible remnants of nest?
[2] An individual flying from the nearest island to Järvenkari. Only one pair nesting on Järvenkari?
[3] Of the four singing males, one also visited the island of Velkua.
[4] Two individuals, one singing, appeared after 3 1/2 hours at Järvenkari, staying there the rest of the time.
[5] A singing flock, present a shorter time.

Less favourable results were also obtained. Haukioja (1968) compared the numbers of two passerine species obtained by the line transect method with the numbers known from population studies. The results agreed poorly. Similar methods were used by Snow (1965) and Bell et al. (1968; a large-scale study) with a similar result. Enemar & Sjöstrand (1967) considered the line transect method of little use in determining bird numbers. Lehtonen (1978) considered the method unreliable and abandoned it after 10 years of work. It seems almost impossible to explain these contradictory results (cf. discussion in Gustafson 1976).

I never had the opportunity to repeat Tinbergen's test. The closest I could come was a test carried out in 1983 together with Mikael von Numers. We chose the island of Järvenkari on the outer side of the large island of Velkua (Fig. 3). Järvenkari is relatively islolated, lying almost 500 m from the nearest smaller island and 100 m from the forest of Velkua. It should be noted that Järvenkari is an island with dry pine forest and extensive rocky or stony shores, and consequently has a small bird population. Censusing an island with denser forest and more birds may or may not give less consistent results.

Järvenkari was censused by me during 5 hours, which meant that there was time to make a "normal" census several times and to search repeatedly through every tolerably promising spot for nests and hiding birds. Towards the end of the five-hour period the work became very monotonous, and I would not like ever to repeat it. After two days, in almost identical conditions, M.v.N. repeated the census without knowing the earlier result, now using only one hour, which is the normal time spent by us in censusing a relatively sterile island of this size. The result of the censuses (Table 1) accorded quite satisfactorily, even in some bizarre details, such as an aggressive tern without a nest, and a *Fringilla coelebs* male making trips to the island of Velkua. The main difference was the appearance in the fourth hour of the prolonged census of a pair of *Carduelis spinus*. This species is a notorious problem because of its vagabonding habits.

4. Sources of error

If an area is censused repeatedly throughout the breeding season, new species will appear at later censuses, and others will appear in larger numbers than before. A fictive example (Table 2) will demonstrate the difficulties arising when one tries to judge the "true" population size from these data.

Palmgren, naturally, took for granted that, in a census plot, one may miss some birds, e.g. silent or hiding ones. He concluded that the real population size should therefore be larger than the one found at a single census. By com-

Table 2. Example (fictive) of the results of repeated censuses of a single island.

	Census number 1	2	3	4
Fringilla coelebs	1	1	1	2
Phylloscopus trochilus	-	1	-	1
Parus cristatus	1	1	2	-
Motacilla alba	-	1	-	1
Sum	2	4	3	4[1]
Pooled sum	2	4	5	6[2]

[1] Average of sums = 3.25
[2] According to Palmgren's method this value should be corrected by a small addition (see text).

paring the pooled results of 1, 2, 3, and 4 censuses he found that the increase of the computed population decreased every time the census was renewed. Thus, as censusing was repeated, the population size asymptotically approached a value which is the theoretical value of an infinite number of censuses, and which he considered to be the true population size. For details of the method of computing the asymptote, the reader is referred to Palmgrens original (1930) publication and a later (Palmgren 1981) description. At the fourth census he found that the asymptote was almost reached.

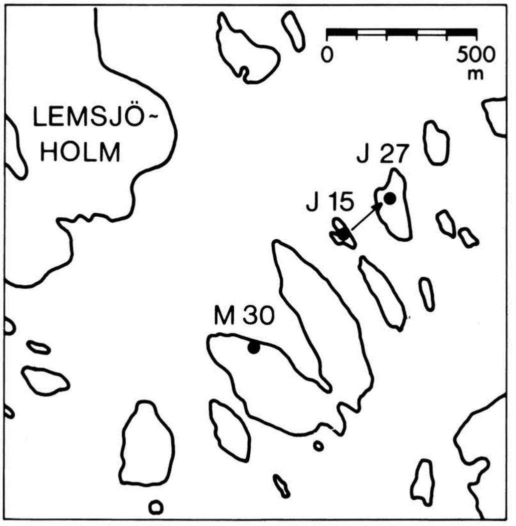

Fig. 4. Territories of a male *Fringilla montifringilla* on 30 May and 15, and 27 June 1983. On 15 June the point indicates the main part of the territory, the arrow indicates occasional song on the island NE of it. On 27 June the male sang only on the neighbouring island. If the population is computed by pooling, the male will count as a pair/equivalent of a pair on 3 different islands. If the averages are computed, all islands being censused 4 times, the SW island and the central one will receive 0.25 pairs/equivalents each, and the NE island 0.5 pairs/equivalents, and the census will give a reasonable result.

There may, however, be other sources of error than (1) overlooking birds. Such sources are (2) the "drifting" population of non-breeding individuals; in some species also the appearance of potentially polygynous males in secondary territories, (3) birds breeding outside the area, but entering it, and (4) an assumed effect of the population size of different species upon the census (Enemar 1959). Point (1), of course, tends to cause underestimation of the population, point (3) overestimation, whereas point (2) tends to cause overestimation if the pooling method is used, being neutral if the method of averages is used. Point (4) was assumed to facilitate the censusing of rarer species. The situation is visualized in Fig. 5.

The existence of non-breeders (point 2, above) has been emphatically denied by many ornithologists, whereas others accept it according it considerable importance in population censusing (Enemar 1959). As a rule it is not possible to decide whether an observed individual is breeding or not. Only under fortunate circumstances is a decision possible, as when a bird is individually recognizable or the species so rare that an individual belonging to it can safely be assumed to be the same one, even if it has changed its site (Fig. 4). It is easy to see that the pooling method tends to cause overestimation with such non-breeders, whereas computing the average will be correct.

If the census plots are small in relation to bird territories, intruders (point 3) may cause considerable difficulty (von Haartman 1945). If the pooling method is used, the population in Fig. 5A will, after sufficiently many censuses, appear to be 5 instead of 2–3 pairs, the estimate overshooting the mark by c. 100 per cent.

Enemar assumed that a further source of error (point 4) is involved in the pooling method. He concluded that the situation in Fig. 5A and B will need many more censuses to "catch" all individuals than the situation in Fig. 5C and D. The pooling method will, according to Enemar, distort the relative abundance of rarer and more abundant species, favouring the former.

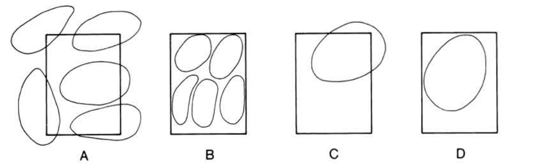

Fig. 5. Schematic presentation of relations of bird territories or domiciles to a census plot. (A) Study plot part of a continuum. More males than those nesting there will have part of their territories in the plot. With repeated censusing, using the pooling method, the 5 males will sooner or later appear within the area, and the final result of the census will "overshoot" the true number by c. 100%. Though islands are seemingly isolated, the separating waters will often be crossed by birds. Situation (A) therefore also applies more or less to islands in the archipelago studied here. Computing averages of censuses may yield a better result than pooling. (B) Territories on an isolated island. Here, the pool number would equal the true number. (C) and (D) A rare species in a continuum and on an isolated island. In situations (B) and (D), Enemar's (1959) formula, given to show that the fewer individuals there are of a species, the more swiftly will its abundance be revealed, will be correct only if the birds sing independently of each other (see text).

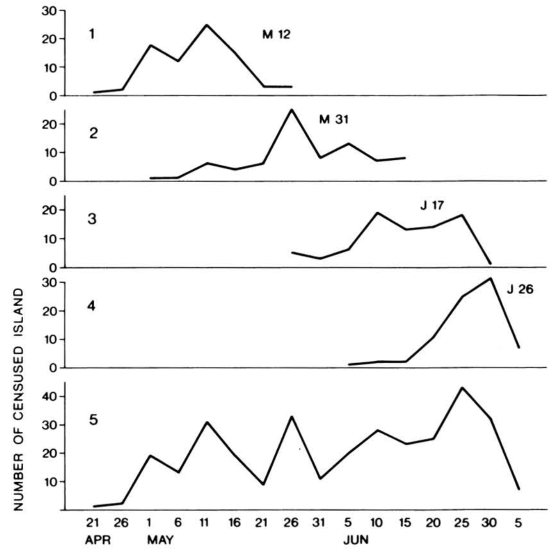

Fig. 6. Dates of censusing 19–22 wooded islands during 4 breeding seasons. 1, 2, etc. = 1st, 2nd, etc. census. Averages of the 1st, 2nd, etc. census are given (M 12 = 12 May, J 17 = 17 June, etc.). Curve at bottom = sum of curves 1-4.

5. Repeated censuses

Palmgren (1930) censused a number of plots repeatedly, as described in the preceding section. Following his method, I censused 19–22 wooded islands four times in each of four summers (1976, 79, 80, and 83). Only 3 small islands with a poor bird population were not censused throughout all four years.

Because of other projects, and because some ducks breed early, I had to spread the censuses over as long a period as possible (Fig. 6). The first census was often carried out at a time when late arriving species (such as *Phylloscopus trochilus,* not to speak of the genus *Sylvia*) were not present. This explains why the first census gave a lower result than the later ones, whose results were almost the same (Fig. 7).

The first census was excluded and the pooling method applied to the three following censuses here designated 1, 2, and 3 (Fig. 8). The population found at the first of these is given the value 1. The asymptote (accepted by Palmgren as the correct population size) is c. 1.8, whereas in Palmgren's study it was 1.6. The difference contradicts the assumption that the isolation of the islands reduces intrusion of

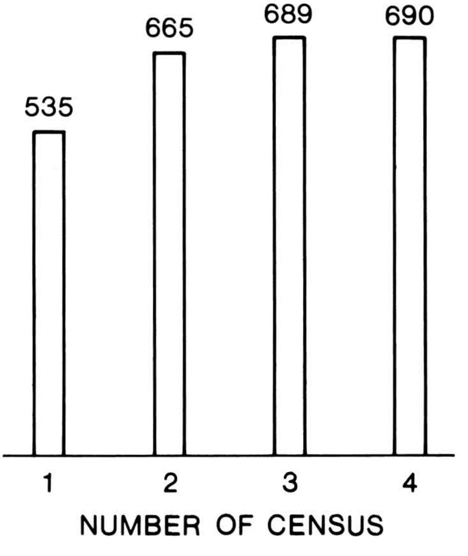

Fig. 7. Total numbers of birds recorded on 19-22 islands censused 4 times in each of 4 summers, 1, 2, etc. = 1st, 2nd, etc. census. The number found at the first census is lower than the figures of the later censuses because it was carried out before all the migrants had arrived.

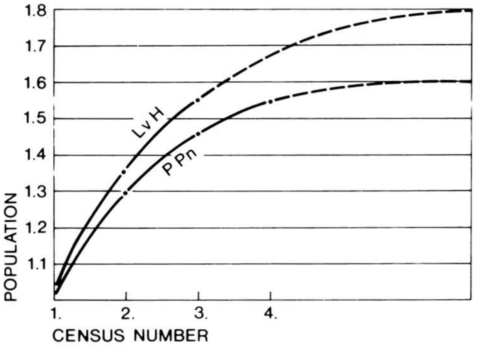

Fig. 8. Increase of pooled population during consecutive censuses of 19-22 wooded islands in 4 summers (L.v.H.) and of forest study plots according to Palmgren (1930). The population was computed as the sum of the maximum numbers of every species at any census. The number at single census was given the value 1 (in my study 678 pairs or equivalents, after 2 censuses 914, and after 3 censuses 1060). The asymptote, or theoretical abundance after an endless number of census repetitions, is likely to overshoot the true abundance owing to the accumulated effect of intrusion of allochthonous birds. The difference between the two sets of censuses supports the result of an earlier comparison (von Haartman 1945). It may be due to (1) individual differences between the two census takers, (2) a slight difference in computing the asymptotes (for Palmgren's method, see his original publication), and (3) the fact that my islands were on an average smaller than Palmgren's study plots (cf. the Appendix).

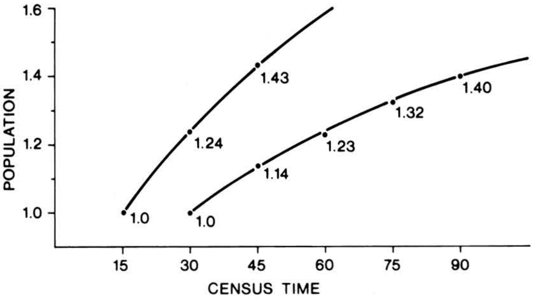

Fig. 9. Increase of population recorded on smaller (left) and larger (right) wooded islands with prolongation of census time (in minutes). Asymptote curve drawn by eye; the asymptote model may be unsatisfactory. Note that the smaller islands were usually censused for 30, not 15 minutes, and the larger ones for 60, not 30 minutes.

Table 3. Number of pairs registered before and after the censuses had been prolonged by 15 min.

Island size	Duration of census (min) 15	30	45	60	75	90
Larger		830	946			
			883	960		
				495	531	
					194	206
Smaller	442	546				
		503	586			

foreign birds in comparison with census plots in mainland forests. The movement of birds to and from the islands is considerable, and the lack of isolation was a disappointment (see also von Haartman 1945). Are most of the islands in the Baltic archipelagoes really islands in a biological, or only in a geographical sense? The restricted site tenacity of the young birds and sometimes of the adult females, and the extension of many bird's domiciles from one island to another, seem to justify such a question. Other parameters, however, such as the types of habitats offered by islands as compared with the mainland (Haila 1983) may contribute more to the insular quality than the isolation as such.

6. Prolonged censuses

Another method of checking the reliability of censuses is to prolong the time spent on the study spot; time is probably the most important parameter of the census method.

A number of smaller islands were censused during 15, 30, and 45 minutes, and some larger ones (population number, established at single censuses, between 20 and 55 pairs) during 30, 45, 60, 75, and 90 minutes. The results are shown in Table 3 and Fig. 9.

The asymptote of the population on larger islands is c. 1.5, and should almost be reached after c. 3 hours of work. It should be borne in mind that these islands were usually censused for 60 or at least 45 minutes, in which case the gain of prolonging the census is much smaller (the necessary data can easily be computed from Table 3). On the smaller islands the census work was evidently discontinued too early. Birds can be expected to be less easily overlooked on smaller than on larger islands. The surprisingly high number of additional birds found on the smaller islands if an extra 15-min. period is added to the census time after 30 minutes of work, would indicate that the traffic of birds to and from small islands forms the major source of error in censusing rather than overlooked individuals.

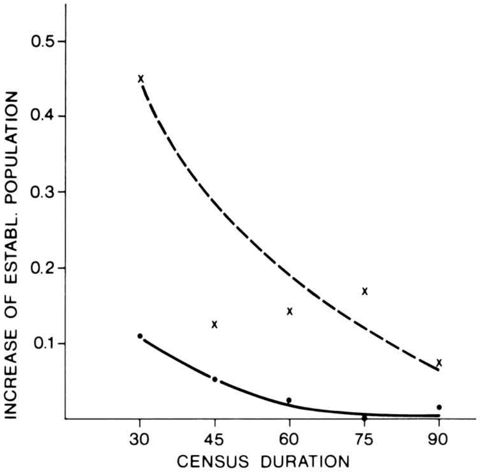

Fig. 10. Increase of population of *Fringilla coelebs* (continuous line) and all titmice (dashed line) recorded on larger islands as a function of census duration. Though much smaller, the titmice population lends itself less well to rapid censusing. For discussion, see text.

Enemar's (1959) assumption that Palmgren's summative method would census the rarer species more swiftly than the commoner ones was also tested by the prolonged census method. The numbers of *Fringilla coelebs*, the most numerous bird in this archipelago, and the titmice (*Parus*), 5 poorly represented species, were chosen for this comparison (Fig. 10). The result rather reverses Enemar's assumption. Whereas the final number of *Fringilla coelebs* was reached almost at the beginning of the census, the titmice were registered only slowly. This may be partly because titmice are relatively silent at this time of the year, and partly because censusing the more numerous species (*Fringilla coelebs, Phylloscopus trochilus*) blocks censusing the poorly represented species. There is, however, a third, and probably even more important factor involved.

Enemar's model involves the unspoken assumption (in the situation visualized in Fig. 4B and D) that the males of a species behave independently of each other. If they do not (if, for example, the song of one male will release a reply from the other males present) the entire population will in principle be as easy to census as a single individual. Or even easier, as singing may be more intense as a consequence of mutual stimulation. If the reply of the other individuals is not obligatory, the censusing will be less easy but still easier than assumed by Enemar.

On the islands with their restricted population it is easier than on the mainland to establish the interdependence of the males' singing. An example from last summer: I waited 20 minutes on an island for one of the Chaffinches *Fringilla coelebs* to sing. Then, when one male started, within a single minute the two others and the single male *Phyllsocopus trochilus* answered and so it went on for the remaining ten minutes I spent on the island. One had the feeling of listening to the bidding in a game of bridge: one club — one spade — two diamonds — pass!, etc., etc. The biological function of this signalling, well after territorial disputes have generally been settled, may be to show that no danger, e.g. a strange male intruding or a predator, is present.

The difference in the ease with which different species can be censused is itself a problem, but will not be treated further here.

7. Summary and conclusion

The choice of census method should be determined by the time available, the purpose of the census, and the degree of correctness which can be obtained with any method, as stated repeatedly by Palmgren (1930, 1933, 1981). What one gains in exactitude one loses in time and therefore in sample size. The most exact methods may give results of restricted value, if they do not permit representative samples. And, finally, how should we evaluate, for instance, a breeding pair that lost their brood and may or may not have renested elsewhere? — to mention only a single example of the dilemmas, indicated by Palmgren.

The main question raised here was the following. If a census plot, in this case an island, is censused repeatedly, should then the final result be computed as the pool or the average of the different censuses (in the former case possibly corrected by the asymptote method of Palmgren 1930, which stands for the theoretical result of an infinite number of censuses of the plot)?

The main sources of error in censusing a plot are (1) overlooking birds present, (2) a drifting population of non-breeding birds, including the case of polyterritorial polygamy, and (3) birds breeding outside the plot but visiting it at times. Although all these factors were shown to play a role, their respective influence upon the census result could not be disentangled. It is easy to see that errors of type (1) will be amended by using the pooling and asymptotic method, whereas errors of type (2) and (3) will tend to cause overestimation of the population if this method is used. The method of computing averages will be exact if the antagonistic sources of error balance each other, and even when factors (2) and (3) together more than outweigh factor (1), this method will still be preferable to the summative method, although giving inflated figures. The agreement between a normal census and a thorough census of the same island (Table 1) together with numerous *imponderabilia* have made me choose the method of averages.

Soikkeli has (1978) accused ornithologists of neglecting to make appropriate corrections of their data. Theoretically, the source of error consisting of foreign birds visiting the census plot (point 3) could be corrected for by either using more isolated islands for censusing, or continuosly watching the birds flying to and from the islands. The former alternative was out of the question, as there were no more isolated islands within easy reach of my home. The second alternative demands hundreds of hours of observation of birds arriving at and leaving the islands.

It may, in fact, often be preferable to leave the data found in ecological studies of birds uncorrected for several reasons. (1) Owing to the restricted numbers of bird individuals, ornithological ecology is time- and data-consuming, and possible corrections will often be based on restricted data. (2) Corrections may well lull the correctors into a false sense of security, while they should, instead, be brooding over the problem of dropping or correcting the corrections. (3) In the present case, the extra hundreds of hours necessary to obtain the corrections were just not available. Life is shorter than most people believe.

The censusing of most non-passerines demands quite different and often species-specific methods. Some hints on these methods have been given recently (von Haartman 1975, 1980, 1982).

Appendix

The relation between the indigenous population and visitors in census plots of different size.

Most census methods will have to struggle with two kinds of populations, the indigenous or autochthonous population of the surveyed area, and the visitors from outside, the allochthonous population. The former is the real subject of the study, the latter is mainly a kind of disturbance.

Areas of similar form relate to each other as the squares of their circumferences. Thus, the larger the surveyed area, the fewer visitors it will allow in relation to the indigenous population. Empirical proof of this assumpiton can be obtained from Palmgren's (1930) data (Fig. 11), his abundance values decreasing clearly, though not quite regularly, with increasing size of the plots. With respect to islands the situation may be different, as they are surrounded by water, i.e. an area birdless with respect to forest species.

Even in strip surveys outside visitors should play a role, though a much larger area is censused much faster than in surveying a plot. Thus, Helle & Pulliainen (1983), when carrying out a strip survey on a large island with relatively few species, recorded no less than six species which were probably not breeding at all on the island.

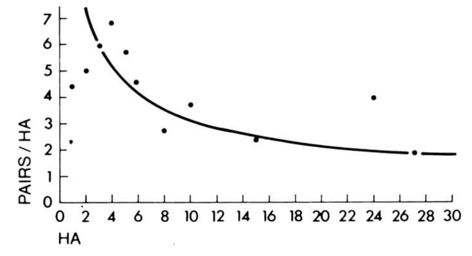

Fig. 11. The average bird abundance of census plots (N = 62) of different size but constant type (*Sanicula* type on the Aland islands) according to Palmgren's data (1930). The asymptote curve drawn for the relation circumference to area in plots of similar form but different size shows some similarity to the findings on plots ≥ 4 ha.

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