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Waterfowl censusing in environmental monitoring: a comparison between point and round counts

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We censused breeding waterfowl in 58 lakes in SE Finland during 1985–87. Point counts (birds counted from 1–10 fixed points on the shore) and round counts (birds counted from a boat or when walking round the lake on foot) gave almost identical results concerning species number, diversity, evenness and community composition. The species-specific efficiency of point counts with respect to round counts was 0.88–1.11 in grebes, 0.66–1.24 in dabbling ducks and 0.67–1.11 in diving ducks. We do not know, however, the absolute pair numbers in our lakes and, in consequence, the accuracy of the methods is not known. Point counts seem to be suitable for nation-wide monitoring of waterfowl populations, and the field work and sources of error can be standardized more accurately using point counts than using round counts.

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1. Introduction

Waterfowl are an important indicator of changes in the aquatic environment (e.g. Bezzel 1974, Karlsson et al. 1976, Nilsson & Nilsson 1976, Eriksson 1984, Koskimies & Pöysä 1985, Koskimies 1987a). Monitoring can be used in nature protection and in studying the ecological effects of various man-made environmental changes (Koskimies 1988).

Although lakes are one of the most important habitat types in Finland, there has been no coordinated, nation-wide monitoring of waterfowl populations so far. According to Koskimies & Pöysä (1985) one major reason for this seems to be the lack of a suitable census method, which should be as simple as possible but at the same time reliable and efficient. In the traditional round count method (e.g. Linkola 1959, Siira 1959, Kauppinen 1980, 1983), the observer should be experienced and preferably use a boat and allow sufficient time to collect extensive and representative data for monitoring purposes. Different persons interpret the census maps or other records (e.g. the observations of moving birds) in different ways and even the same observer probably has difficulties in keeping his/her interpretation standardized and comparable between lakes and seasons. Furthermore, the reliability and accuracy of the round count method has not been studied (however, see Ranoszek 1983, Haldin & Ulfvens 1987).

Point counts have been developed for a standard monitoring method of breeding waterfowl (Koskimies & Pöysä 1985, 1987). In brief, the observer counts, using binoculars or a telescope, all the waterfowl swimming or resting on a lake or part of a lake, from one or several fixed points on the shore. The limits of the census area must be marked on the map and recognized in the field in subsequent visits. The size of the census area may vary from point to point but the observer must be able to identify all the individuals counted and no extensive sectors where the birds may be hidden should be included. The census should be quite rapid to minimize duplications caused by moving of birds, but systematical and thorough so as not to miss diving individuals.

The accuracy, reliability and efficiency of different monitoring methods must be tested before being used more widely. If different field methods are used in collecting data for monitoring purposes, it is necessary to calculate correction factors based on large and representative samples in order to make the re-

Table 1. The lakes censused by point and round counts in 1985–87.

	No of lakes	Total water area (ha)	Median
Lake sizes:			
below 5 ha	30	45	1.2
5–50 ha	19	387	14.5
over 50 ha	9	3239	260.0
Lake types:			
Oligotrophic forest lake (I)	43	2266	2.5
Deep, partly eutrophicated lake (II)	6	1063	179.2
Eutrophic lake in agricultural area (III)	9	343	23.2

sults comparable. In this paper we report results of our comparisons between point and round counts, both at community and population levels, and discuss the applicability of the two methods in nation-wide monitoring of waterfowl in Finland.

2. Material and methods

Our main study area is situated in Parikkala and Saari, SE Finland, around Lake Siikalahti (61°33'N, 29°34'E). We censused waterfowl by point and round count methods in 43 different lakes (actually, one water area was a bay of a larger lake), seven of them in two years and two in three years (in total 54 counts). In addition, three lakes were censused in Mäntyharju, about 150 km west of the main study area, using identical methods in 1986, six in Lammi, 250 km west, and six in Rautjärvi, 40 km southwest in 1987. We censused small lakes on our own and larger lakes together, except those in Rautjärvi (censused by Jukka Jantunen).

The total water area censused was 3672 ha, or 0.03–968 ha per lake (median 4.7 ha, n =58; measured from maps 1 : 20 000). Our census lakes (Table 1) form a representative sample of all the major lake types and lake sizes existing in the main study area. The census period lasted from 17 to 21 May in 1985 (35 lakes), from 9 to 26 May in 1986 (16 lakes), and from 14 to 29 May in 1987 (18 lakes).

We used the same procedure for every lake. On the basis of maps and field experience we selected a sufficient number of points (1–10 per lake, median 1) from which the whole lake could be observed with the aid of a telescope. When we had several census points in a single lake we determined the limits of subareas beforehand and, in order to avoid double counts, moved to the next point as rapidly as possible without disturbing the birds. We recorded the time needed both for actual counting and moving from one point to the next on the same lake (time budget data from 1985–86 analysed below).

Immediately after finishing the point count, we made a round count by boat (13 largest lakes) or by foot near the shore line, and recorded position and movements of all the waterfowl. We also wrote down the time needed for counting. The field work for both methods and interpretation of observations were carried out according to standard instructions (Koskimies & Väisänen 1988).

All the censuses were made between 0500 and 1300 hrs, and there seemed to be no major changes in the behaviour of birds, in the weather or in other environmental conditions, which could have an influence on the comparison of the results in the same lakes. In the lakes where more than one point was necessary, there was a greater time lag between the beginning of point and round counts. Waterfowl could, at least in theory, have moved from one lake to another during this time. This source of error might markedly affect the results only in the few largest lakes.

The time needed for point counts (including actual counting and moving between points) during 1985–86 was 1294 minutes (in total 86 points) and for round counts 1872 minutes (51 counts, see above), respectively. In lakes where the round count was made by foot (small lakes), the time needed for point counts was only 42% of that for round counts, whereas in lakes where a boat was used (larger lakes) the corresponding value was 88%. Point count data are ready for analysis immediately after the field work, but an observer using the round count method must interpret the results from field maps or other records. This procedure can take as long as the count, especially in eutrophic lakes rich in waterfowl.

Species diversity was measured with the Shannon function (H', corrected for sample size, see Hutcheson 1970). The evenness component (J') of the diversity was measured with the ratio $H'/\ln S$, where S is the total number of species in the sample. 'Community' composition according to point count and round count data was compared with the index rD given by Järvinen & Väisänen (1976). The value of rD ranges from 0 (communities identical) to 100 (communities completely dissimilar).

3. Results

3.1. Community level comparisons

In the total data, the number of species was identical in point and round counts (Table 2). The methods also gave similar total pair numbers (point count efficiency, or pair numbers in point counts per pair numbers in round counts, was 0.97), species diversities (H'), evenness indices (J') and 'community' composition (very small rD). Even in individual lakes, point counts revealed a high percentage of the species and pairs recorded in round counts (n = 60 lakes with birds):

Percentage of species (± *SD*)	91 ± 29
Species per lake in round count (mean, range)	4.1, 1–13
Percentage of pairs (± *SD*)	90 ± 30
Pairs per lake in round count (mean, range)	14.2, 1–108

Table 2. Values of some community parameters calculated from point count (PC) and round count (RC) data and difference in community composition between point and round count in total data and in different lake size and lake type classes (for details see Material and methods and Table 1).

			Lake size (ha)			Lake type		
		Total	<5	5–50	>50	I	II	III
Total number of species	PC	16	10	15	16	11	16	14
	RC	16	10	15	16	11	16	14
Total number of pairs	PC	820	95	302	423	141	210	469
	RC	846	108	317	421	162	203	481
Diversity H'	PC	2.44	1.80	2.15	2.47	2.09	2.08	2.32
	RC	2.42	1.79	2.15	2.47	2.06	2.11	2.30
Evenness J'	PC	0.88	0.78	0.79	0.89	0.87	0.75	0.88
	RC	0.87	0.78	0.79	0.89	0.86	0.76	0.87
Difference in community composition rD (0–100)		0.9	0.2	0.7	1.6	0.4	1.2	1.5

It should be added that in only three lakes the lack of some species in the point count was compensated with the lack of some other species in the round count, a source of error artificially increasing point count efficiency.

Even within lake size and lake type classes (see Table 1) point and round counts gave similar values for different community indices and also a similar 'community' composition (Table 2). There were no statistically significant differences in total pair number between lake size ($\chi^2 = 0.80, P > 0.75$) or between lake type classes ($\chi^2 = 1.32, P > 0.50$). Similarly, the difference in H' between point counts and round counts was not significant in any of the lake size and lake type classes (t-tests, $P > 0.20$ or greater in all cases, Hutcheson 1970). In fact, the H' values were nearly identical.

3.2. Population level comparisons

Total pair numbers obtained for different species from point and round counts are given in Table 3. Point counts gave a higher pair number for eight species and round counts a higher number for another eight species. The efficiency of point counts (the number of pairs counted from points compared with that from round counts) was smallest for the teal *Anas crecca* (0.66) and highest in the coot *Fulica atra* (2.44). Among grebes (*Podiceps* spp.), the efficiency of point counts ranged from 0.88 to 1.11, among dabbling ducks (*Anas* spp.) from 0.66 to 1.24 and among diving ducks (*Aythya* spp., *Bucephala clangula*) from 0.67 to 1.11.

Table 3. Total pair numbers of waterfowl species in point (PC) and round counts (RC) and the efficiency of point count with respect to round count.

	Pair number in PC	Pair number in RC	PC/RC
Black-throated diver, *Gavia arctica*	16	15	1.07
Great crested grebe, *Podiceps cristatus*	70	63	1.11
Red-necked grebe, *P. grisegena*	14	16	0.88
Slavonian grebe, *P. auritus*	53	48	1.10
Mallard, *Anas platyrhynchos*	71	87	0.82
Teal, *A. crecca*	101	154	0.66
Garganey, *A. querquedula*	16	23	0.70
Wigeon, *A. penelope*	147	127	1.16
Pintail, *A. acuta*	14	15	0.93
Shoveler, *A. clypeata*	31	25	1.24
Tufted duck, *Aythya fuligula*	41	42	0.98
Pochard, *A. ferina*	36	54	0.67
Goldeneye, *Bucephala clangula*	149	134	1.11
Red-breasted merganser, *Mergus serrator*	11	15	0.73
Goosander, *M. merganser*	16	14	1.14
Coot, *Fulica atra*	34	14	2.44

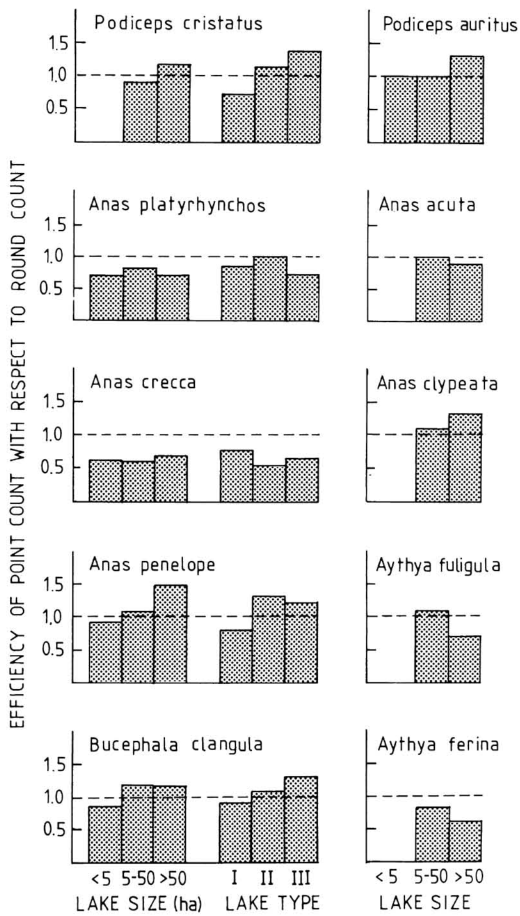

Fig. 1. The efficiency of point counts with respect to round counts in different lake size and lake type classes (for total number of pairs, see Table 3).

For some species we had at least 5 pairs in two or three lake size and lake type classes, and could make preliminary comparisons between point and round counts in different lake size and lake type classes. There was some variation in point count efficiency among lake size and lake type classes, respectively, in the species studied (Fig. 1), but sample sizes were fairly small and the differences were not significant (χ^2-tests, $P > 0.10$ or greater).

4. Discussion

Point and round counts gave very similar values for the community indices studied. The community composition derived from point and round count data was also similar, as suggested by the small value of the index *rD* (see Järvinen & Väisänen 1976). This general result holds true both in the total data and in the different lake size and lake type classes, even though the results for the size and type classes were preliminary because of small sample sizes.

Point and round counts seemed to be equivalent in describing waterfowl communities also on eutrophic lakes and larger oligotrophic waters, where the need and 'accuracy' of the round count was especially stressed by Kauppinen (1986). However, he did not present any data to support his claim. There is the question (e.g. Järvinen 1985, Götmark et al. 1986) how valid conglomerative community indices (used e.g. by Bezzel 1974, Bezzel & Reichholf 1974, Nilssoñ & Nilsson 1976) are for conservation and monitoring purposes. Many sources of error may affect community indices (see Järvinen et al. 1977, Järvinen & Lokki 1978). Both conservation and monitoring of waterfowl should be concerned primarily with population sizes of individual species, not with community characteristics, which are more suitable for ecological research.

At the level of single species, differences between point and round counts were in some cases pronounced. Somewhat unexpectedly, point counts tended to give greater estimates than round counts. However, the accuracy (relationship to actual population size) of neither method is known.

Differences between species in point count efficiency may be due to differences in species-specific behavioural traits and differences between census methods in sensitiveness to these traits. For instance, the coot, and probably some other species, readily hide in emergent vegetation when disturbed by a boatman and may thus remain undetected in round counts but not in point counts in which disturbance is minimized. In contrast, dabbling ducks hiding among vegetation often take flight when disturbed and may thus be more easily observed in round counts than in point counts. This disturbance, however, may bring about serious sources of error when interpreting pair numbers. The landing site of disturbed individuals may remain unknown, and it may be impossible to keep track on individuals already counted. Disturbed individuals flying over the census area often lure other individuals to take flight, increasing confusion and demanding continuous observation of all flying individuals which is difficult in waterfowl-rich habitats. In fact, disturbance in round counts may be a more serious problem than previously expected.

Point count, of course, has other problems which decrease its efficiency in some species. According to our experience from Lake Siikalahti (e.g. Pöysä 1983, 1984) and other similar, highly eutrophic lakes rich in waterfowl, the most suitable method for censusing the total waterfowl community are successive point counts over the open water areas and then checking the smaller pools hidden by vegetation.

There is no single waterfowl census method which could give the most reliable result in all situations. Different methods should be applied for different species and for different purposes. We should not rely upon untested methods. Both the point count and round count method should be compared with the absolute pair numbers obtained by nest counting, individual marking and continuous observations, which has not been the practice. This deficiency is present in our study and almost all other research on bird census methodology (summarized e.g. by Berthold 1976 and Verner 1985). The few studies comparing waterfowl census results with actual numbers (Ranoszek 1983, Haldin & Ulfvens 1987, Koskimies & Saarinen 1988) show that both of the present methods give inaccurate results for a high number of species. Of course, comparisons of results obtained by relative methods are also needed to make them comparable if different methods are used in monitoring.

Our results show that the point count is a suitable method for a nation-wide monitoring programme of breeding waterfowl species and communities. Point counts are rapid, easy and interesting for amateur bird watchers. The field work can be highly standardized in different regions, habitats and observers, and there is little room for personal variation in field work and interpretation of results, which can also be checked from the primary data much more rapidly than in the round counts. For monitoring population changes from year to year it is not necessary to count whole lakes to obtain data on the interspecific relationships in numbers as we have done. It is enough to monitor a large number of sample points from year to year to calculate species-specific population indices. The total number of sample points in Finland can easily be raised up to thousands (see Koskimies 1987b, Lammi et al. 1988). Thus, point count results can fulfill two basic requirements for using waterfowl populations as a tool of monitoring in aquatic environments: large and representative samples of different regions and habitat types.

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