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On the efficiency of censusing waterbirds by boat

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As waterbirds are both morphologically and ecologically a heterogeneous group, their detectability in censuses tends to vary. Thus, the methods adapted for waterbird censuses are frequently group- or species-specific, in order to increase census accuracy (Andersson 1971, Andersson & Staav 1980; for a recent review on waterfowl census methods, see Koskimies & Pöysä 1985).

However, the time required to census large areas, and the need to minimize disturbance and resulting nest and egg losses are other factors that have to be considered when choosing census methods for waterbirds. There is an evident need for large-scale monitoring of archipelago birds in Finland (Kilpi 1985). Although the precision of such ambitious projects should be maximized, money (i.e. observers) and time are limited, and there is a need for a convenient, standardized and reliable method of censusing large areas rapidly.

Waterbird census by boat is rapid and causes only a small amount of disturbance (Andersson 1971, Andersson & Staav 1980), but the accuracy and reliability of the boat census method are not thoroughly investigated (cf. Koskimies & Pöysä 1985).

Study area and methods

In the summer of 1985 the two authors, without each other's knowledge, both censused waterbirds in the archipelago of Korsnäs on the Finnish west coast (62°49' N and 21°10' E).

MH censused the area once by boat between 2 and 3 June, using a method adapted from those described in Andersson (1971) and Anon. (1975). The study area was divided into plots along natural boundaries, and the plots were censused while the boat proceeded slowly at a distance of 100–200 m from the shore. Larid colonies were startled by "playing eagle" (i.e. slowly moving the arms up and down like an eagle in flight), and the gulls were then counted from the boat (Hanssen 1982). In addition, 13 skerries were censused by the nest count method between 27 June and 4 July.

JU monitored grebe populations by repeated nest counts during the breeding season. The colonies of the Black-headed Gull *Larus ridibundus* were censused once on 31 May, using the nest count method.

The nest count method is the most accurate census method available for most waterbird species, and although the errors involved can be quite large (Ferns & Mudge 1981), we have used the nest counts as direct estimates of the size of the breeding populations.

Results and discussion

The methods were compared by standard regression analysis (cf. Sokal & Rohlf 1981). In Fig. 1, the regression coefficient (b) of the regression of the boat census results upon the nest count results shows the efficiency of the boat census, or the proportion of birds observed (assuming that the intercept of the regression line is zero).

The regression coefficient may be used to correct the boat census result and obtain an estimate of the "true"breeding population (Table 1). For three of the four species tested, the regression coefficient is highly significant. More important, however, is the coefficient of determination (r^2), which shows how well the regression explains the scatter of the points about the line. High r^2 values are required for reliable use of the regression coefficients as correction factors.

For the Black-headed Gull, the boat census efficiency (b=0.91, r^2=97%) was higher than expected (censusing larid colonies includes many sources of error, e.g. Hanssen 1982). Most of the colonies are situated in dense vegetation and when startled the gulls are only briefly visible during a short flight, returning rapidly to their nests. In such cases the boat census results consist of the average of repeated counts of flying birds. Even so, the results obtained by the two census methods are very similar and consistent (Table 1).

The Great Crested Grebe *Podiceps cristatus* (b=0.30, r^2=44%) is more evasive than the gulls,

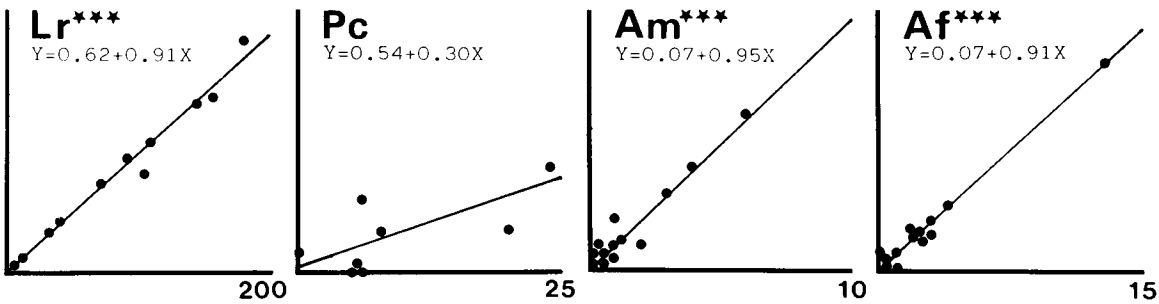

Figure 1. Regression lines for censuses of four waterbird species (Lr = *Larus ridibundus*, Pc = *Podiceps cristatus*, Am = *Aythya marila*, Af = *Aythya fuligula*). Ordinate: boat census results, abscissa: nest counts, scales the same on the two axes. The sample values consist of the numbers of breeding pairs counted in different study plots. *** indicates P<0.001. The regression for Pc is not statistically significant. The regression for Af is significant even when the outlier on the right is excluded (b=0.88, r^2=84%).

Table 1. Comparison between nest counts and boat census results (numbers of pairs) for 11 colonies of the Black-headed Gull. The correction of the numbers was based on the regression coefficient (see text).

Colony	Nest count	Boat census	(error%)	Corrected	(error%)
1	156	135	(–13)	150	(–4)
2	105	75	(–29)	83	(-21)
3	180	175	(–3)	194	(+8)
4	40	40	(0)	44	(+10)
5	145	130	(–10)	144	(–1)
6	11	10	(–9)	11	(0)
7	4	4	(0	4	(0)
8	70	68	(–3)	75	(+7)
9	92	87	(–5)	96	(+4)
10	33	32	(–3)	35	(+6)
11	110	100	(–9)	111	(+1)
Total	946	856	(–10)	947	(0)

hiding in the vegetation or diving and emerging far away from the observer. Its habit of breeding in clusters also increases census errors, as an unknown proportion of the birds are hiding out of sight at any one time.

The high regression coefficients for the Scaup *Aythya marila* (b=0.95, r^2=91%) and the Tufted Duck *Aythya fuligula* (b=0.91, r^2=98%) were expected, as the species are easily detected and counted in the vicinity of their breeding skerries (Hildén 1964, Andersson 1971).

This study indicates that the boat census method offers a rapid and fairly reliable method for waterbird studies, particularly when its reliability has been verified by comparison with independent censuses made by other methods and correction factors for different species (and/or different observers) have been estimated.

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Sammanfattning: **Hur pålitlig är båttaxering av sjöfåglar?**

En jämförelse mellan två olika fågeltaxeringsmetoder utfördes på basen av taxeringsresultat, som författarna oberoende av varandra erhöll i skärgården i Korsnäs sommaren 1985. Taxering från båt av skrattmås, vigg och bergand visade sig vara pålitlig med en precision på 90–100 % av det antal fåglar som en boräkning inom samma områden avslöjade (figur 1, tabell 1). Å andra sidan var precisionen vid båttaxering av skäggdopping låg (figur 1), och resultatet var inte signifikant. Med tanke på miljö-övervakningen i skärgården borde metoderna för sjöfågeltaxering utsättas för fortsatta tester.

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