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Line transects of waders in an alpine area: a methodological study

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The Finnish line transect method was tested on breeding waders in 1981 at 3 different times of the season (3 June, 5 July, 24 July) in a 6 km² study area where the number of wader nests were known on the basis of previous studies. The study area was located on Hardangervidda, S. Norway, in the middle alpine zone. The species involved were Golden Plover *Pluvialis apricaria*, Dotterel *Charadrius morinellus*, Purple Sandpiper *Calidris maritima*, and Dunlin *Calidris alpina*. The line transect method gave in general too high density estimates (line transects/nests totally = 0.8–5.6) and the variation in relation to the time of the season was extensive (max line trans./min line trans. = 2.4–5.1). We consider the method, however, useful, provided the "1000k" values are specificially calculated for the different stages in the breeding cycle. The census efficiency is evaluated in relation to each species' breeding phenology and variation in behaviour through the breeding season. For Golden Plover, Purple Sandpiper and Dunlin we consider the time between territory establishment and onset of incubation the best period for censusing. Also in Dotterel the best results may be obtained before egg-laying, but polyandry and an extremely long egg-laying season in Dotterel populations limit the usefulness of the line transect method in estimating breeding numbers.

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1. Introduction

Several methods have been used to estimate bird densities (cf. Palmgren 1933, Enemar 1959, Emlen 1971, Järvinen & Väisänen 1975, Statens Naturvårdsverk 1978). The Finnish line transect method (Järvinen & Väisänen 1973, Järvinen 1976) has become very much used. It is a convenient method for covering large areas in a short time, as it is not based on repeated visits to the same area. The method does to some extent take into account variation in the detectability of different species as a certain time of the season (June) and time of day (4–8 a.m.) is recommended for censusing. Changes in the detectability through the season probably do not occur gradually. They are rather abrupt phenomena as the birds enter different phases in the breeding cycle. The changes in detectability are to a large extent caused by different antipredator behaviours in the different breeding phases. Such changes may lead to considerable variation in detectability even within the recommended census period.

During studies of waders on Hardangervidda, southern Norway, we have noticed that such changes in behaviour and detectability indeed occur. In order to see how this affected the line transect results, we made line transects of 4 wader species several times during the breeding season. The results were compared with the results of the actual number present in the area, as determined from breeding biology studies.

2. Study area and methods

The study was conducted at Steinbuheii, Hardangervidda, southern Norway in 1981. The study area comprises 6.0 km² of a northfacing slope (1170–1350 m asl) in the middle alpine region. The vegetation is a mosaic of meadows and small bogs; the former characterized by grasses (*Anthoxanthum odoratum, Deschampsia flexuosa, Nardus stricta*), *Carex* spp., *Juncus trifidus, Empetrum hermaphorum* and lichens, and the latter by *Eriophorum* spp. The flat treeless area made it easy to survey the avifauna.

The actual densities of the waders within the study area were determined by searching for nests and broods through the breeding season, combined with colorringing and mapping of observed pairs.

In the study area four transects, each 2.0 km (Fig. 1), were censused at three different times of the breeding season (3 June, 5 July and 24 July). Apart from repeating the censuses, and extending them into July (to cover different breeding phases), the recommendations in the

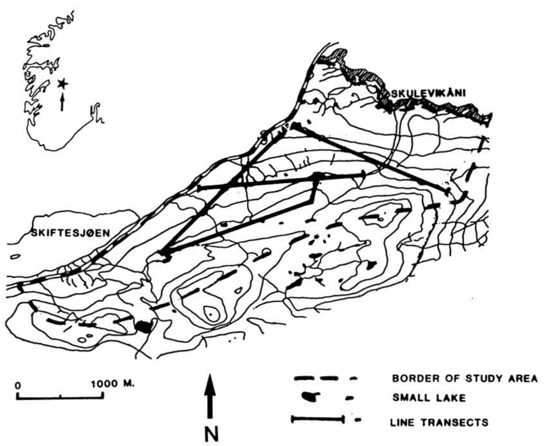

Fig. 1. Location of the line transects. Contour lines in 20 m intervals.

Finnish line transect method (Järvinen & Väisänen 1976) were followed. Densities were estimated according to Järvinen & Väisänen (1977), although, we pooled all sightings from our transect surveys within each period to determine single MB-ratios (1000k values) for the Golden Plover. For the other species this was not possible due to few sightings. As transect lines crossed each other, we have for some censuses a higher number of observations than breeding pairs in the study area.

To show differences in the detectability of the Golden Plover, we also used data from studies on Jaeren in 1972/73 in a 9 km² *Calluna* heath (Byrkjedal 1978).

3. Results and discussion

The densities estimated from our line transects were consistently higher than the actual densities, except for the Purple Sandpiper on 5 July (Table 1). One main reason for this could be that for 3 of the species we used the 1000k values of Järvinen & Väisänen (1977) instead of calculating a value of our own, due to few MB observations. The importance of testing the applicability of the Finnish 1000k values before they are used in a specific census is pointed out by Järvinen (1976). The reasons for deviations between estimated line transect densities and the actual densities differ for the species involved as shown below.

3.1. Golden Plover

By using our own 1000k values, the estimated densities were 1.4–3.3 times higher than the actual densities (Table 1); however 3.4–3.8 times higher if the 1000k value given for Golden Plover by Järvinen & Väisänen (1977) is used. In both cases the estimated densities grow through the season in relation to the actual densities, which may be explained by the difference in detectability at different stages of the breeding cycle. Before egglaying, pairs of Golden Plovers are easily seen on their territories. After egglaying, the incubating bird is either sitting tightly or behaving very inconspicuously, while the off-duty mate is spending the time outside of the territory (Byrkjedal, unpubl.). After hatching, the mates are again on the territory, and as part of their antipredator behaviour they make themselves very conspicuous and may even approach the observer. The detectability in the incubation and posthatching periods is shown in Fig. 2.

Our line transect estimates give an increased 1000k value with the season, indicating a decrease in detectability. This apparently contradicts the notion of a high posthatching detectability, but the reason may be that some Golden Plovers have approached the observer unnoticed, and being first discovered in the main belt, they have contributed to an increase in the main belt observations and in the 1000k values.

When estimating breeding density, flocks of non-breeders may complicate the line-transect estimates. In Golden Plover the off-duty mates are also likely to be found in flocks outside the

Table 1. Line transect results and actual densities (pairs/km²) for Golden Plover, Dotterel, Purple Sandpiper and Dunlin. Pl = prelaying, Inc = incubating, Ph = posthatching, L = actual density, T = transect density, MB and SB denote numbers observed on the main belt and survey belt, respectively.

	Number of pairs			L	T	MB/SB	T/L
	Pl	Inc	Ph				
Plover							
3 June	20	4	0	4.0	5.4	2/30	1.4
5 July	0	15	10	4.2	7.7	3/31	1.8
24 July	0	2	22	4.0	13.0	5/33	3.3
Dotterel							
3 June	9	5	0	2.3	11.8	2/7	5.1
5 July	2	20	5	4.5	10.1	2/6	2.2
24 July	0	5	15	3.3	5.0	2/3	1.5
Sandpiper							
3 June	4	5	0	1.5	5.0	2/5	3.3
5 July	0	3	4	1.2	1.0	0/1	0.8
24 July	0	0	5	0.8	2.0	0/2	2.5
Dunlin							
3 June	7	0	0	1.2	8.8	1/10	7.3
5 July	0	0	5	0.8	4.4	0/5	5.5
24 July	0	0	?	?	3.5	1/4	?

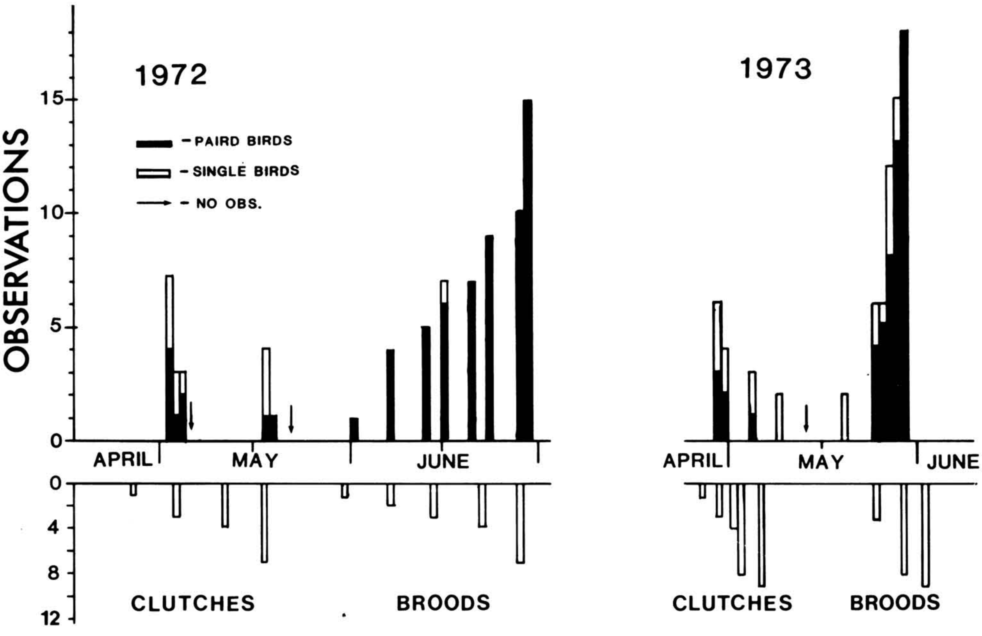

Fig. 2. Number of Golden Plovers observed on censuses of a 9 km² heather moor on Jaeren 1972–73, SW Norway, during different stages of the breeding period.

territories. In most of the day-time this will be the females (Byrkjedal, unpubl.). In estimating breeding density, such flocks have no value.

The frequencies of birds in the different stages of the breeding cycle observed on a line transect depends on the breeding synchrony between the pairs. In the Golden Plover population studied on Hardangervidda, egg-laying takes place within a month (ca 1 June – 1 July), sometimes shorter, while in lowland populations, the period may cover 1 1/2 months (Byrkjedal 1978, unpubl.). Sequential breeding may also increase asynchronously as well as the total number breeding in an area during a summer (Parr 1979).

Accordingly, using line transects for censusing Golden Plover populations, pre-laying censuses should clearly give the most accurate estimates, due to many complicating factors later on. This is also consistent with our results.

3.2. Dotterel

Our transect observations do not include flight-displaying females. The 1000k value of Järvinen & Väisänen (1977) was used, due to :he few observations on our transects. This ɾalue gives density estimates 1.5–5.1 times too high (Table 1). In comparison with Golden Plover, the species has a low detectability throughout the season. The material shows that detectability is highest early in the season. At this time the pairs can be seen, and often also heard, at a distance. In the incubation period the Dotterel is hard to find, as the flushing distance of the sitting male is only 0–5 m (own obs.). The females are relatively conspicuously displaying in the air to attract new mates, in accordance with their polyandrous mating system (Kålås & Byrkjedal, unpubl.). These display filghts cover extensive distances, and colour ringing indicates a low within-season philopatry in the females (unpubl.). Accordingly, the displaying females are useless for estimating breeding densities. Just after hatching, the males are again more conspicuous, and they may perform distraction display when the observer is within 15–20 m of the chicks. Often Dotterel males with young stand motionless in the presence of an observer and may be passed unnoticed even at a short distance (20–30 m). Older chicks are often led away by the male when the observer is more than 100 m away (own obs.). We think that in the present material the low detectability in late July is due to some males having sneaked away undetected on our approach.

Due to polyandry egglaying is highly asynchronous within a Dotterel population. Different breeding stages are met during a large part of the season. In the studied population, egglaying takes place between 1 June and 15 July (Kålås & Byrkjedal, unpubl.). Moreover, the number of different nestings in an area may be far larger through an entire season than what is present on a single census date. This difference is, in particular, pronounced early and late in the season.

In conclusion, Dotterel is extremely difficult to census, and we do not consider line transects particularly useful for estimating the size of the breeding population in an area through a summer. However, early season censuses are most likely to deal with only one category of birds (i.e. prelaying pairs), and as an instantaneous sampling, line transects should give the best results at that time. The reason for this not being so in the present material is most likely the 1000k values, which could not be calculated specifically for these censuses.

3.3. Purple Sandpiper

The estimated densities deviate from the actual densities by 0.8-3.3 times, but the number of birds involved is very low (Table 1).

The seasonal pattern in the detectability of the Purple Sandpiper may resemble that of the Golden Plover: The pairs are fairly easily detected on the territories before egglaying.

During incubation the sitting bird will flush from the nest only at a distance of 0-2 m, and the off-duty mate may be far beyond the territory (Swanberg 1945, own obs. from colour-ringed birds). After hatching, the parent bird (usually the male unaided in charge of the brood) approaches the intruding observer, giving loud alarm calls. There is a better synchrony in egglaying than in the two plovers, (egglaying falls within 14 days in the studied population), but there may be replacement clutches following predation.

Provided that enough birds are observed for the calculation of new 1000k values we think line transects may give good population density estimates in the pre-laying period.

3.4. Dunlin

The 1000k value of Järvinen & Väisänen (1977) was used. The estimated densities are 5.5-7.3 times higher than the actual densities (Table 1). This indicates a higher detectability in our study area than in the Finnish line transects. There is a high degree of synchrony in egglaying (8-10 days), but this may be disrupted by replacements following predation. As in the other species, prelaying censuses are probably best.

3.5. Concluding remarks

In order to census populations of the four wader species in this study by means of the line transect method, only prelaying censuses are expected to yield useful results. Line transect censuses at other times of the season are expected to be affected by the simultaneous occurrence of birds at different stages in the breeding cycle with different detectability. Accordingly, the best time for censusing waders by the line transect method may not coincide with the best time for censusing e.g. passerines. In the polyandrous Dotterel line transects may be quite inaccurate in estimating breeding densities.

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