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Effeciency of censusing Golden Plovers

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Two study sites were each surveyed once a week throughout the breeding seasons of 1987 and 1988, and sightings of Golden Plovers *Pluvialis apricaria* were later aggregated into probable territories. We make the assumption that the aggregate number of territories registered over the season is equivalent to the true population of each census plot. The proportion of territories registered on each visit was around 20% during incubation, but increased to 70% or more in weeks 2 to 7 after the earliest dates of hatching, before declining as birds left their breeding grounds. Out of 39 site visits in the post-hatching periods, only two recorded 100% of the apparent territories.

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INTRODUCTION

A great deal of effort has been expanded in recent years on extensive surveys of moorland breeding birds in Britain, by the RSPB *e.g.* Cadbury 1987), the NCC (*e.g* Stroud *et al.*1987) and individual researchers (*e.g.* Yalden 1974; Bell 1979; Jones 1983). Such surveys usually depend on one or two observers making only one or two visits to study areas during the breeding season. For comparisons between different moorlands, such methods are perfectly adequate. If, however, the requirement is to obtain an absolute value for the population, or to compare estimates of the breeding population derived from such censuses with, for example, direct counts of wintering flocks, then some idea of the censusing efficiency is essential. Reed & Langslow (1985) analysed a sequence of line transects across twelve sites in Caithness which were visited three or four times during the season. They emphasized that the most efficient censusing was achieved in June when the parents, guarding their chicks, "alarm" loudly at any intruder. However, they noted that breeding failures and variation in the timing of the breeding season from year to year because of weather fluctuations could affect censusing efficiency to an unknown degree, and that repeated censuses would be needed to resolve the extent of such affects.

During 1987 and 1988, we censused two study areas for Golden Plovers *Pluvialis apricaria* at weekly intervals throughout their breeding season, and can offer some empirical evidence on these aspects.

SITES AND METHODS

The two study sites, on Saddleworth Moors and the Snake Summit area, are described elsewhere (Yalden & Yalden 1988); both are areas of blanket bog dominated by *Eriophorum vaginatum*, in the Peak District of England. Approximately 4.6 km^2 and 5.2 km^2 respectively, were censused at each site; one observer, usually D.W.Y., covered each site along a roughly standard route which should have visited each territory, recording the positions of all Golden Plovers seen on 1:25,000 scale maps. Each site was visited once a week from early April to late July; it took about 7 hours to conduct each census. At the end of the season, clusters of records were interpreted as territories. There must be a degree of subjectivity about this interpretation but we paid particular attention to adults alarming to protect their chicks. Their alarming behaviour is most intense when the chicks are newly hatched and both parents are usually present at this stage. They become slightly less anxious, and less tied to the small area surrounding their chicks, as these get older (Byrkjedal 1985; Yalden & Yalden 1990).

The sex of alarming birds was recorded and although we did not colour-ring any adults, we did score the degree of black ventral colouration of each bird. In many cases, a particular 50 ha of moorland only held one pair, and we could reasonably presume that the same pair was present in that area on each census. In a few areas several pairs held territories very close together, and as their chicks grew older would join together to alarm near us. If such a group included, say, three males and a female, we presumed that three territories were present, and that the female was the mate of one of the males. Thus our final estimate of the number of territories in a season was the minimum number needed to account for all the alarming birds of one or the other sex on any one (the "best") occasion, plus the number of territories that were "late" (either replacement clutches, or possibly serial occupants of the same territory) or were judged to have failed within the first week or so past hatching.

Territories which were apparently registered for four (or more) successive weeks were presumed to have successfully fledged at least one chicks. Records were analysed in relation to the week in which the first nests hatched *i.e.* when the first alarming parents were recorded), and the proportion of territories recorded in each week of the breeding season calculated from these. In 1986, we only censused during the post-hatching period, so cannot evaluate detectability throughout the season, but some of our information from that year is also relevant.

RESULTS

Our interpretation of the clusters of registrations suggested to us that there were 21 territories at Snake Summit and 23 at Saddleworth Moors in 1987, 29 and 27 respectively in 1988 (Table 1). Thus, in aggregate, we sampled 100 territories during each week of the breeding season (except for some irregularities in the sampling at the beginning and end of the season). Retrospectively interpreting our censusing efficiency in each week of the season relative to this subsequent estimate of 100 territories, we recorded, between 35% and 57% of the territories at the beginning of the season, at 4-7 weeks before the earliest hatchings. This is a period when the pairs are establishing territories and spend much time just standing in their haunts (Yalden & Yalden 1990). During incubation, detectability falls to around 20%; on one extreme occasion only one territory, out of 27 (4%), was detected.

Detectability improved rapidly over the two-three weeks following the first hatchings, this spread presumably reflecting

Table 1. The number of Golden Plover *Pluvialis apricaria* territories registered in weekly censuses, relative to the week in which the first nests hatched (H) (=13-16 May). Two sites, Snake Summit (SS) and Saddleworth Moors (SM), were censused weekly in both 1987 and 1988 throughout the breeding seasons.

Week:																			
Site/Year	(n)	-7	-6	-5	-4	-3	-2	-1	H	1	2	3	4	5	6	7	8	9	10
SS 1987	(21)	-	-	8	10	4	6	4	3	8	15	16	14	20	21	17	14	10	3
SM 1987	(23)	-	-	10	5	6	3	3	2	8	17	22	16	20	22	19	13	4	4
SS 1988	(29)	-	17	3	8	11	7	10	13	16	21	23	23	25	22	15	5	1	-
SM 1988	(27)	11	15	15	12	3	6	1	5	6	14	16	17	22	21	28	18	6	2
Total	(100)	11	32	36	35	24	22	18	23	38	67	77	70	87	86	79	50	21	9
Out of n visited		27	56	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	71
% Recorded		41	57	36	35	24	22	18	23	38	67	77	70	87	86	79	50	21	13

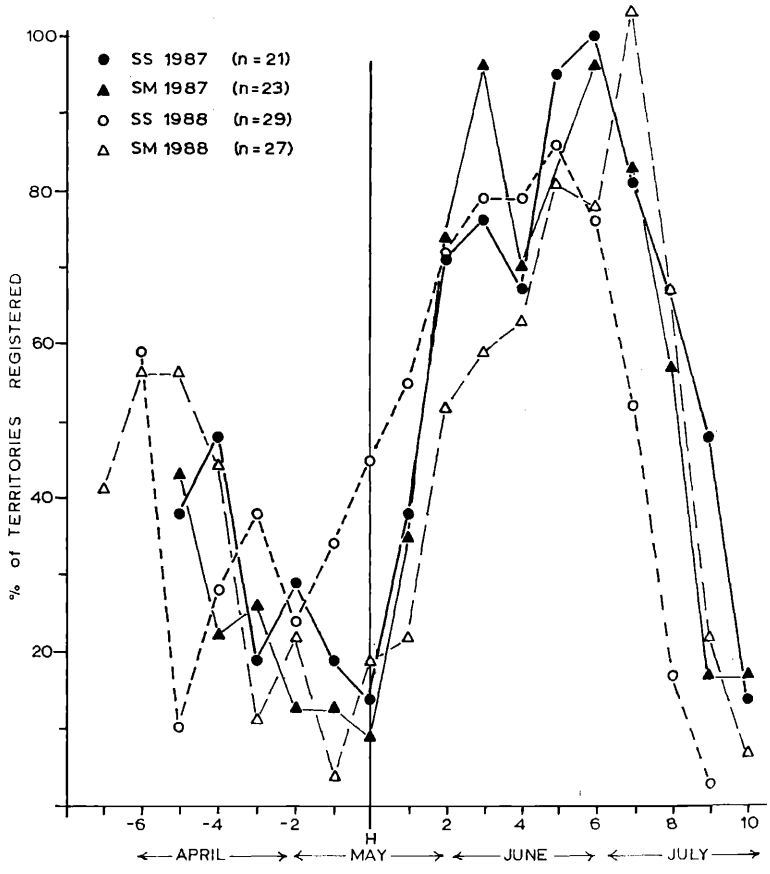

Figure 1. The percentage of Golden Plover territories recorded on successive weekly censuses through the breeding season of 1987 and 1988 at Snake Summit (SS) and Saddleworth Moors (SM).

the spread of laying/hatching dates in the population as a whole. Over weeks 3-7, censusing efficiency was consistently 70% or better; in fact, the best censusing was in weeks 5-6 post-hatching, when it reached 86-87% efficiency. Survey efficiency then fell over weeks 8-10 as the young reached full independence and birds left the moors for better feeding grounds on pastures elsewhere (Figure 1).

Over these two years and two sites, the breeding was remarkably constant, in that the first alarming adults were detected on 13, 14, 15 and 16 May. However, although the earliest nests at Saddleworth Moors in 1988 hatched at about the same time as those at Snake Summit, the majority of the nests were about 10 days later; this difference was also reflected in the end of the season. In 1986, we did not conduct weekly censuses in the incubation period but the earliest hatchings that year, after late snowfalls and a very cold period in March-April, were a full two weeks later than in 1987 or 1988 (actual dates were 30 May at Snake Summit and 3 June at Saddleworth Moors). Thus one could potentially expect about two weeks variation in the timing of peak detectability of Golden Plovers as a result of variations in weather during early spring (Yalden & Yalden 1989a).

DISCUSSION

These results raise a number of interesting questions. Firstly, it is surprising that the territories were occupied for so long; all the relevant sources (*e.g.*Cramp & Simmons 1983; Harrison 1975; Nethersole-Thompson & Nethersole-Thompson 1986) suggest that Golden Plover chicks should fledge in about 30 days. If one allows an extra week for the attainment of full independence, one might expect to record a particular territory for four or five weekly censuses from hatching. Yet it is clear that territories were usually occupied for seven weeks, and peak detectability for the population as a whole was in weeks 5 and 6. Development of Golden Plover chicks must be very slow compared with that of other waders (*cf.* Visser & Beintema 1987).

The central question for this study must be, why does detectability never reach 100% ? It may be noted that our figures, in the range 70-87% for weeks 3 to 7, encompass the figure 78% suggested by Reed & Langslow (1985). There are three factors involved.

Firstly, there is the natural spread in laying, and therefore hatching, dates within the population. For first clutches, this is about 3 weeks both from our own observations and those summarized by Ratcliffe (1976); his Table III suggests that about 55% of clutches are laid in the 3 weeks of April 7-30. In addition to this, there is a further spread due to repeat clutches laid by pairs that have lost their first clutch or perhaps (as suggested by Parr 1979) by pairs that serially occupy the territories. The extent of this will depend upon, particularly, the level of predation on eggs; we believe, from our interpretation of territories, that only 6 territories (6%) had late broods.

Secondly, there are the territories that lose their chicks early on and therefore disappear from later censuses. In these two years, a high proportion (85%) of the territories we plotted were successful (*i.e.* survived, through at least four censuses post-hatching), and we think that only 11, possibly 12, territories failed in their first two weeks (*i.e.* 11 or 12%). In 1986, however, the success rate was much less (45%) and we would expect censusing efficiency to be commensurately poorer in such a breeding season.

Thirdly, even for the successful territories, we believe that parents were occasionally missing when we attempted to census them; that is, they were present, alarming, for two or three weeks, missing on the next weekly census, but then re-

appeared for the nest two or three weeks. It will be noted (Table 1) that census efficiency fell from 77% in week 3 to 70% in week 4, and then increased to 87% in week 5. Byrkjedal (1985) suggested that parental attentiveness fell after the chicks were two weeks old. Aggregating all our census visits during the post-hatching period, we think that absences of this sort only occurred 27 times out of 406 potential registrations during 39 site visits. Thus overall parental attendance was around 93% during this period and on any one visit such absences should only reduce censusing efficiency by about 5% (*i.e.* one "missing" territory out of 20-25 that ought to be present).

Our assessment of our census efficiency depends, of course, on our estimate of the number of territories. Given the overt anxiety behaviour which Golden Plover parents employ, the openness of the habitat, (Yalden & Yalden 1986), the density of the survey routes relative to that of the birds, and their faithfulness of attendance (Brykjedal 1985) we doubt that we missed any birds that were actually present. Broods which hatched and died almost immediately could have done so between our weekly censuses, in which case we have underestimated the population size and *over* estimated our censusing efficiency. Similarly, if one pair lost all their chicks in the same week that close neighbours hatched theirs, we might have scored this as one territory, not two; again, this would have led us to *over* estimate our censusing efficiency, though this would also require that we failed to notice the extreme anxiety of a pair with newly hatched chicks. We might have *over* estimated the population, and therefore *under* estimated our censusing efficiency, if we scored the males and females from one territory as two separate ones (which might account for the aberrant 104% censusing efficiency in week seven at Saddleworth Moors in 1988) or if we failed to detect a pair leading their brood well away from its natal area. We might have recorded such a situation as one territory which failed early and a new, later-hatching, one which was successful. In that case our overall assessment of breeding success would be pessimistic but we have already noted that we thought that 85% were in fact successful; thus there can be very little scope for errors of this sort and, of course, we were well aware of the possibility of this behaviour (Yalden & Yalden 1990).

Our overall conclusion then is that, in agreement with Reed & Langslow (1985), one would expect to detect about 80% of the breeding pairs of Golden Plovers by a single census visit during the peak of the post-hatching/chick guarding period. If one is attempting to extrapolate from such censuses to get some idea of the absolute population size, then an appropriate adjustment of 25% may be necessary (25% x 80% = 20%!). In a normal spring, the period from the last week of May to the first week of July would serve, in both the Pennines and in Caithness. After a notably severe spring, as in 1986, one would expect the peak season to be about two weeks later. A poor spring might be not only a late breeding season but also a poor one, with higher mortality and therefore a lower censusing efficiency; our 1986 figures suggest an average efficiency in weeks 1-5 of only 56% (range 36%-81%).

This conclusion seems to contradict Kålås & Byrkjedal (1984), who recommend censusing Golden Plovers in the pre-laying period. In part, their results confirm ours: they too found that Golden Plovers were most detectable in the post-hatching period. Their caution over using this period for censusing stemmed from their strict adherence to a transect method; they found themselves over-estimating the apparent density for the study area because the birds apparently approached their transects, to alarm at them, and therefore inflated the density on the limited area of the transect. This would be less of a problem if a mapping technique were used. Their advice to use the pre-laying period is less applicable to Britain where the fickle spring weather means that the birds' presence on the moors then may vary from day to day, and the proximity to lower feeding pastures a few kilometres away makes it easy for the birds to commute. The commencement of breeding in Norway is constrained by the time of snow-melt, and the extensive areas of montane habitat make it harder for the birds to leave or return at short notice.

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