

A 25-year study of breeding Greenshanks

Territory occupancy, breeding success and the effects of new woodland

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ABSTRACT Breeding Greenshanks *Tringa nebularia* have their British stronghold in Sutherland and Caithness, which hold 44% of the national population. In a 1,200-ha study area in north Sutherland, a 25-year study found a high density of breeding Greenshanks, with up to ten occupied territories each year. Based on 189 territory-years, territory occupancy averaged 52%, with strong variation between years (20–91%) and territories (24–78%). For 51 nests, the mean hatch rate was 59%. Predation accounted for 62% of known nest failures. Territory occupancy and breeding success were not linked to distance from a new, predominantly native, woodland scheme. However, the woodland is still young, and the work should be repeated at a later date.

Introduction

The lochs, pools and blanket bogs of Sutherland and Caithness – the ‘Flow Country’ – are renowned for their breeding birds (Stroud *et al.* 1987). One of the most characteristic of these is the Greenshank *Tringa nebularia*, whose far-carrying calls can be heard on almost any spring

visit to the area. Many ornithologists first became familiar with the Sutherland haunts of the Greenshank through the evocative books of Desmond and Mairi Nethersole-Thompson (1979, 1986), who based their pioneering long-term Greenshank study on the area.

The ornithological importance of Sutherland

and Caithness led to the designation of 146,000 ha of the two counties as a Special Protection Area (SPA) under the European Birds Directive, in 1999. This is one of the largest such areas, comprising 10% of SPA-designated land in the UK (Stroud *et al.* 2001). Although the Greenshank is included among the key bird species of the SPA, substantial numbers also breed outside it. The SPA was estimated to hold 256 pairs of Greenshanks in 1994–95 (Stroud *et al.* 2001), compared with 480 pairs (44% of the UK population) in the whole of Sutherland and Caithness in 1995 (Hancock *et al.* 1997). Thus nearly half the breeding Greenshanks of these two counties do not benefit from protection under SPA legislation.

In 1983, one of us (NC) first began observing breeding Greenshanks during visits to a study area of approximately 1,200 ha near the north coast of Sutherland (plates 112 & 114). With the support of members of the local community, these annual visits were maintained and, gradually, territory boundaries and nesting areas were discovered. Ultimately, 12 Greenshank territories were located. In peak years, when as many as 10 of the 12 were occupied, this represented a density six times higher than the mean for Sutherland and Caithness (Hancock *et al.* 1997), though about half the highest known densities in Scotland (Thompson 2007).

This study area lies outside the SPA, and when a 103-ha woodland scheme was proposed for the area in 2001, concerns were raised that this might affect breeding Greenshanks. This was in spite of the fact that environmental objectives were important in the design of the

scheme, with much of the area being assigned to open ground, and most of the tree planting being of native broadleaved species. Thus it was quite different from the kind of blanket conifer afforestation that caused so much controversy in Sutherland and Caithness during the 1970s and 1980s (Warren 2000). Such blanket conifer afforestation led to the loss of an estimated 295 pairs of Greenshanks in the region, but it is also true that elsewhere in Scotland some types of open, boggy woodland have been used regularly by breeding Greenshanks (Thompson 2007). Consequently, the impact of the proposed woodland scheme on breeding Greenshanks was uncertain. Ultimately, the scheme was approved, after some alteration of the planting plan to account for concerns over known breeding Greenshank territories. The ground was prepared by digging small mounds (rather than ploughing deep furrows, as was the case with the 1970s and 1980s plantations) and planting and fencing took place in winter 2002/03. Only 4% of the ground was assigned to non-native conifers, the remainder being native broadleaves (54%) and open ground (42%). The long-term Greenshank study was continued, with one of the aims now being to assess any impacts of the new woodland scheme, at least in the short term. Here, we present some key results of the long-term study, and use these data to assess the impact of the woodland scheme in its first five years.

Methods

The study area, including the woodland area prior to planting, comprises a fine-grained mosaic of blanket bog, transitional mire, rocky heather-dominated knolls, and numerous shallow, peaty water-bodies, ranging from under 1 m² to tens of hectares. The altitude range is 60–120 m, and agricultural use is limited to rough grazing by sheep and cattle, with occasional heather burning. Traditional peat-cutting has not taken



112. The study area, north Sutherland.

place in the area for a number of years and there is no organised predator control. Owing to one conviction following theft of a Greenshank clutch in the study area, and the continuing threat of egg-collecting, the precise location of the study area is not given.

Bird surveys in 2003–07 were limited to two spring visit periods, one

averaging seven days (range 5–11) centred around 5th May, and one averaging nine days (range 7–11) centred around 24th May. A similar pattern of visits took place in earlier years. Visits were timed to coincide with the main period of laying and hatching of first clutches. The initial method of discovering territories and nests was to observe 'off duty' birds feeding beside lochs and lochans. Nests were located when the feeding bird flew to the nest to swap incubation duties with its mate. Such changeovers occur most frequently in the morning and the evening, often accompanied by much calling, and with time, the areas of preferred nesting habitat were identified. This made it possible to locate part clutches or incubating birds by careful searching, though unusual nest locations could also occur in any year. Early in the season, much activity took place at the larger lochs, where birds might be observed courting and mating before flying off to prospect for nest-sites, usually 50–900 m from the courtship lochs. This helped both with determining the number of pairs present, and with



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113. Incubating female Greenshank *Tringa nebularia* in the north Sutherland study area. This photograph illustrates the species' excellent camouflage.

nest finding. Known nests were visited to determine whether or not they were successful. Where shell fragments were present, predation and hatching were distinguished as per Green *et al.* (1987). Owing to the known activity of egg-collectors in the area, the outcome of nests that failed at the egg stage but for which no shell fragments were found was recorded as 'eggs disappeared' rather than as predation.

To investigate whether territory occupancy and breeding success were affected by proximity to the new woodland scheme, we carried out two regression analyses. These involved comparing the probability firstly of occupancy and then of breeding success, for each territory, with distance from the scheme. If these



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114. The study area, north Sutherland. This photograph shows a Greenshank *Tringa nebularia* feeding loch and, in the middle distance, fencing for the woodland scheme discussed in the text.

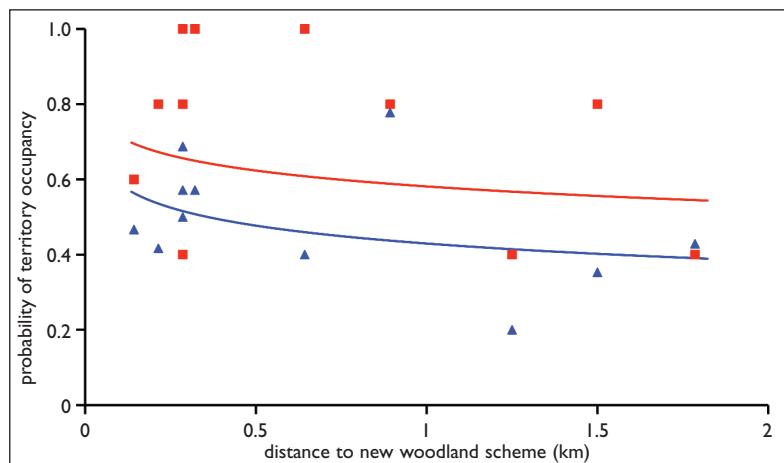


Fig. 1. Greenshank *Tringa nebularia* territory occupancy rates, and distance to the woodland scheme. Blue triangles: before the scheme was established (1983–2002); red squares: after the scheme was established (2003–07). The back-transformed fitted relationship is also shown for before the scheme (blue line) and after (red line).

probabilities changed significantly after the woodland was established, in territories closer to woodland relative to other territories, this would be evidence of an effect on breeding Greenshanks. More details of the analytical methods are given in Appendix 1.

Results

The occupancy rate of individual territories ranged from 78% (territory 4, checked in 23 years) to 24% (territory 5, checked in 25 years). On a year-by-year basis, excluding the first five years of the study, during which new territories were being discovered regularly, the territory

occupancy rate varied from 92% (2004) to 20% (1998). Overall mean occupancy was 52%, averaged across all territories and years.

At the end of the study, the trees in the woodland scheme were still small (0.5–1.5 m high). Plotting Greenshank territory occupancy rates against distance from the scheme

did not show a strong link between the two (fig. 1). In fact, occupancy rates appeared to be somewhat higher nearer the scheme, although this pattern effectively pre-dates the establishment of the scheme (in other words, the woodland was established near to territories with a relatively high occupancy rate).

Statistical analysis of the territory occupancy data, based on 189 territory-years during 1983–2007, confirmed that the relationship between territory occupancy and distance from the new woodland did not change in the first five years after the scheme was established (see Appendix 1).

Fifty-one nests were found during 1983–2007 for which the outcome was known. The most common outcome was the hatching of at least one egg (30 nests, 59%). Of 21 nest failures, most were due to predation (13 nests, 62%), principally by Common Raven *Corvus corax* and Hooded Crow *C. cornix*, which are well distributed throughout the study area. Remaining causes of failure were as follows: eggs disappeared (three nests); nest deserted (two nests); and nest swamped, trampled or adult predated at the nest (one nest each). The predated adult was



115. An unusual Greenshank *Tringa nebularia* clutch of six eggs, the product of two different females.

probably killed by a bird of prey (plate 116). This nest was unusually located, within a rock cleft (plate 117). Nests were more typically located on flat ground in short vegetation, often next to a rock or an exposed piece of bog pine. Nest locations were highly clumped within the study area, reflecting the patchy distribution of typical nesting habitat: low ridges with scattered rocks, thin peat soils and short vegetation. Only approximately 16% of the study area was within 100 m of a known nest (though 76% was within 500 m).

The mean distance of successful nests from the woodland scheme's perimeter fence in 2003–07 was 600 m, lower than the mean distance of failed nests (870 m). Distances varied considerably in both groups (standard deviation 350 m and 460 m, respectively), which suggested that a significant effect due to proximity of the woodland was unlikely. This was confirmed by regression analysis (see Appendix 1). One nest was found on open ground inside the forest fence of the woodland scheme (outcome unknown), while activity at another area of open ground inside the woodland scheme suggested a probable additional nesting attempt here.

Occupancy and success rates at individual territories were not correlated ($r=0.09$, $P=0.78$, $n=12$, based on territory parameters from the two regression analyses). This implied that territories that were more regularly occupied were no more likely to have successful nests than other territories.

Discussion

In general terms, the findings from this long-term study were similar to those from the well-known study by the Nethersole-Thompson (1986). For example, their study found an occupancy rate of 50% (52% in our study), although hatching rate was higher in their study (72%, compared with 59% in ours). One clutch of six eggs was the result of polygamy, which has occasionally been found before (Nethersole-Thompson & Nethersole-Thompson 1986), but the

five eggs in another nest were almost certainly laid by one female.

We found that the new woodland scheme had no measurable effect on territory occupancy or breeding success during the first five years after establishment, although we recognise the limitations of this study as a means of assessing the impact of woodland planting on breeding Greenshanks. The scheme is still only young, and considerable changes in the structure of the



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116 & 117. The remains of a nesting female Greenshank *Tringa nebularia* in 2006, probably taken by a raptor. The unusual nest-site where this dead bird was found is shown in plate 117 (the nest and abandoned eggs can be seen at the base of a cleft in the rock, in the centre of the photograph).



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118. Female Greenshank *Tringa nebularia* removing hatched eggshell from a nest in the north Sutherland study area.

woodland and ground vegetation can be expected over the next few years. Greenshanks are highly site-faithful (Thompson *et al.* 1988) and females may remain faithful to particular territories for up to eight years (Nethersole-Thompson & Nethersole-Thompson 1986). Furthermore, birds may continue to nest in territories that have been subjected to major habitat alteration, such as deep ploughing for forestry (Nethersole-Thompson & Nethersole-Thompson 1986). The number of Greenshank records close to and within new forestry was found to be strongly negatively correlated with forest age, in new conifer forests of 1–11 years old (Hancock & Avery 1998). All these factors point to the possibility that, as the woodland within this study area matures, the use of nearby areas by breeding Greenshanks may decline.

Studies involving other wader species include that by Avery (1989), who measured the effects of forestry on three breeding wader species (European Golden Plover *Pluvialis apricaria*, Dunlin *Calidris alpina* and Eurasian Curlew *Numenius arquata*), including some near young forestry in the Flow Country. He found few effects of forest proximity on these species, once vegetation differences were accounted for, but stressed the need to repeat studies when the trees were older. More recently, Hancock *et al.* (in press) found evidence of negative impacts of

forestry on Dunlins, in areas that included some close to the same (now older) forests that were studied by Avery (1989). This illustrates the potential for factors to change over time, as forests mature, and emphasises the need for our results to be followed up in due course, perhaps during the five years leading up to the removal of the woodland perimeter fence.

The potential mechanisms by which forests could affect waders nesting nearby have been reviewed extensively (Stroud *et al.* 1987; Avery 1989; Hancock *et al.* in press). These include increased predator activity, indirect habitat impacts (such as cessation of heather burning near woodland, resulting in a change in vegetation structure), or behavioural avoidance by birds whose instincts or habits predispose them to nesting in open habitats. Set against these are the potential environmental benefits of establishing pockets of new, open woodland, comprising mainly native species, within landscapes that are only treeless because of previous human management. Scattered trees and open woodland, interspersed with open boggy ground, are, indeed, quite typical habitats of Greenshanks and other waders in Fennoscandia and Russia (Cramp & Simmons 1983).

One aspect in which such natural boreal woodland differs from new woodland plantings

in Scotland is that it is unfenced and thus open to low densities of native large herbivores. In Scotland, the absence of large herbivores within areas fenced for forestry has been shown to increase the numbers of voles *Microtus*, which respond to the increased vegetation biomass and cover (Evans *et al.* 2006). In turn, greater vole numbers can lead both to increased damage to young trees and to higher populations of generalist predators. The latter may affect ground-nesting birds and this led Evans *et al.* (2006) to suggest that low-density livestock grazing of new woodland would be advantageous in some circumstances. Similar suggestions, from forestry and livestock-production perspectives, were made by Hester *et al.* (2000) and Pollock *et al.* (2005). However, they also pointed out the need to better understand the grazing regime that allows both grazing and woodland development, before prescriptions can be recommended. Early fence removal could result in benefits to breeding birds (shorter vegetation, reduced populations of voles and associated generalist predators), together with potential gains in livestock production. The timing of fence removal would of course need to be carefully considered, owing to the risk of herbivores damaging the trees.

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Appendix I.

Within our regression analyses, we wished to account for variation in territory occupancy or breeding success that was not linked to forest distance. For example, breeding success might be lower in some years due to weather conditions, while occupancy might be higher in

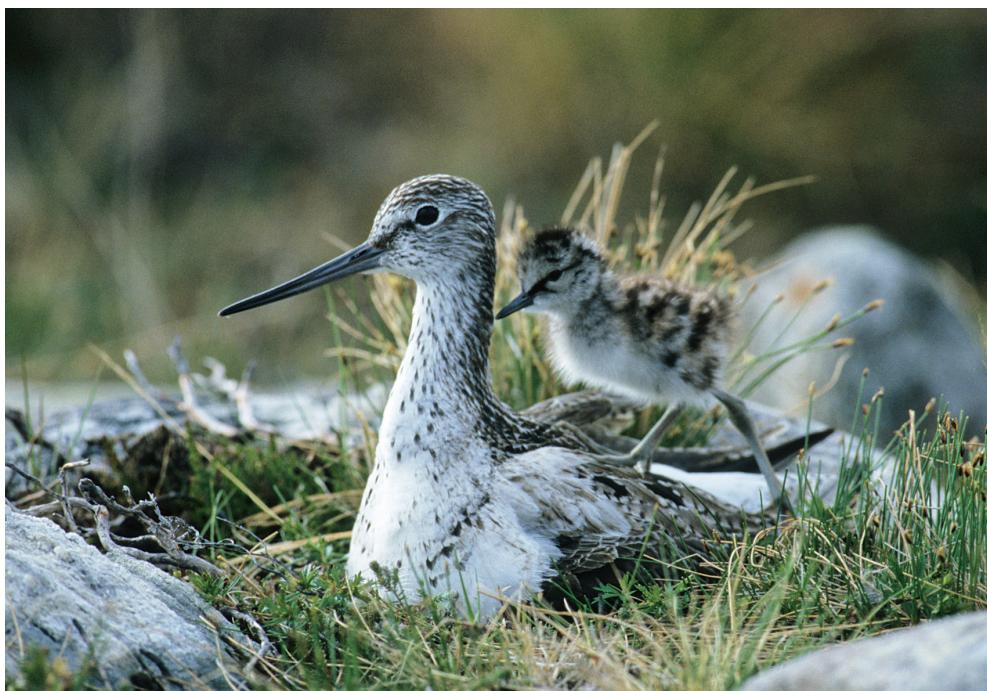
some territories because of habitat factors. We carried out regressions using a mixed model (Littell *et al.* 1996), with 'year' and 'territory number' fitted as random effects. This allowed us to make the best use of the data, which were not balanced (i.e. sample size varied between years and territories), provided that additional

assumptions were met (normality of year and territory effects). The dependent variable in each analysis (occupancy, success) was fitted in a logistic model with a binomial error distribution. Each row of data referred to one territory in one year (territory occupancy model) or one nest with a known outcome (breeding success model). It is possible that territories near the woodland scheme differed from other territories before the woodland was planted, in ways that affected occupancy and/or success, and thus were not related to the scheme. In order to account for this, we included data from before and after the scheme was established, and looked for change between these two periods. Nest visits were too infrequent to allow the use of the Mayfield methods in nest success analysis (Mayfield 1975). Thus we make the assumption that the number of 'exposure days' per nest, for failed nests in our sample, did not vary systematically with distance to the woodland scheme.

In the analysis of territory occupancy, the effect of distance to the woodland scheme was low [$F_{1,12}=0.86$, $P=0.37$], as was the effect of time period (before/after the scheme was established) [$F_{1,39}=1.54$, $P=0.22$]. The high P -value of the distance \times time interaction term [$F_{1,185}=0$, $P=0.96$] indicates that obtaining data under the null hypothesis, which states that there was no difference in the relationship between territory occupancy and distance to the woodland scheme before and after the scheme was established) was likely. The occupancy–distance relationship (fig. 1) shows a slight increase in the fitted occupancy rate in the later period, but this change did not differ according to distance from the woodland scheme, and was not significant in the model ($P=0.22$).

In the analysis of breeding success, the results were essentially similar. The results were as follows for distance [$F_{1,15}=0.28$, $P=0.61$], time [$F_{1,19}=1.67$, $P=0.21$] and time \times distance interaction [$F_{1,47}=1.22$, $P=0.27$].

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119. Female Greenshank *Tringa nebularia* brooding chicks in the study area.