RESEARCH NOTE

The lengths of fences in Highland woods: the measure of a collision hazard to woodland birds

R. W. SUMMERS

Royal Society for the Protection of Birds, Etive House, Beechwood Park, Inverness, IV2 3BW, Scotland

Introduction

Birds die due to collisions with many static man-made objects, particularly wires (powerlines, ski-tows and fences) (Avery, 1978; Faanes, 1987; Bevanger, 1990; Alonso *et al.*, 1994). Although these events are common, the effect that fatal collisions have on bird populations has rarely been studied. Catt *et al.* (1994a) found that capercaillie (*Tetrao urogallus* L.) living in native pinewoods in Scotland collided at a rate of 3 collisions km^{-1} a^{-1} against 1.8 m high deer fences. This led to an annual mortality of 32 per cent, higher than all other causes of mortality combined. Further work showed that collisions against deer fences, particularly by gamebirds, were widespread in the Highlands of Scotland. In one year, 115 red grouse *Lagopus lagopus* (L.), 25 black grouse *Tetrao tetrix* L. and 31 capercaillie collided with 134.8 km of fences in and around woods, primarily conifer plantations. Smaller numbers of owls, pigeons and passerines also died (Petty, 1995; Baines and Summers, 1997). These mortalities are of conservation concern, particularly because capercaillie and black grouse are two of 23 species which have declined by over 50 per cent in numbers in the past 25 years (Gibbons *et al.*, 1996).

Our understanding of the importance of fence collisions to gamebird populations depends partly on knowing the amount of fencing in their environment. This study set out to provide this information.

Study area and methods

The study was carried out during 1994 and 1995 as part of a study of woodland birds in the Highlands of Scotland. Woodlands in the Dee and Moray faunal areas (Harvie-Brown and Bartholomew, 1893) were stratified as to whether they were native pinewood or other woodlands, primarily conifer plantations (Figure 1). Approximately 2500 km^2 of woodland occurs in these areas (D. Catt in prep.) of which 124.5 km^2 is native pinewood (Forestry Commission, 1994).

A total of 53 1-km grid squares within native pinewoods were selected systematically, like all the white squares on a chess-board, if the 6-figure grid reference *xx8yy5* fell within native

pinewood, as mapped by Bain (1987, unpublished RSPB report). The distribution of other woodlands was obtained from Bartholomew maps and 101 6-figure grid reference numbers were randomly selected, around which 1-km squares were surveyed for fences (Figure 1). The alignments of the squares were random in this habitat.

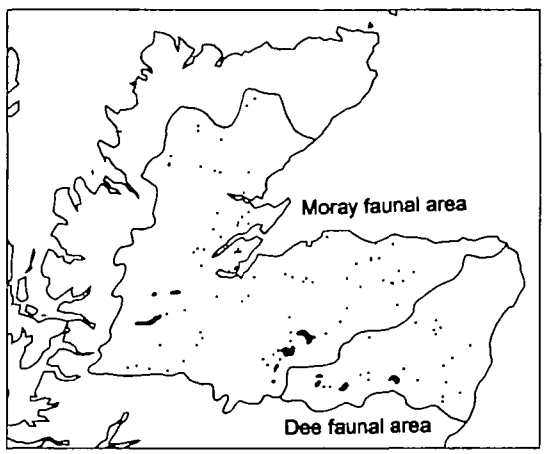

Figure 1. The study area in the Highlands of Scotland. Black areas show the locations of native pinewoods and dots show the locations of selected 1-km squares in other woodlands.

The following data were collected from each 1-km square: area of woodland, the lengths of associated stock fences (*c.* 1 m high) and deer fences (*c.* 2 m high), and their composition; line wire, hexagonal mesh or large rectangular mesh. The tops of deer fences were often different from the bottoms, and these differences were noted. Also, some line-wire fences had additional hexagonal mesh or rectangular mesh added. These fences were recorded as hexagonal mesh or rectangular mesh. Fences which did not occur around or through woodland were not recorded.

Mean lengths for fences were initially calculated for the 1-km squares associated with the two types of woodland. However, as some squares were not composed entirely of woodland, weighted means and s.e.s were obtained using GLIM (Aitkin *et al.*, 1989) to obtain means for woodland alone.

Results

Fifty-three, 1-km squares associated with native pinewoods were surveyed. These had mean lengths of 158 m of stock fence and 771 m of deer fence per square kilometre (Table 1). However, the 53 squares had only a total of 42.36 km^2 of woodland, so the mean values for woodland are higher; at 198 m (s.e. 108) and 965 m (s.e. 162) respectively. Therefore, the 124.5 km^2 of native pinewoods were estimated to have totals of 25 km (s.e. 9) of stock fences and 120 km (s.e. 13) of deer fences within and around them.

A total of 101 1-km squares associated with other woodlands were surveyed. These had mean lengths of 1087 m of stock fence and 537 m of deer fence km^{-2} (Table 1). The 101 squares had a total of 72.24 km^2 of woodland, so the mean lengths of fences for woodland alone were 1521 m (s.e. 236) of stock fence and 752 m (s.e. 144) of deer fence. Therefore, the 2400 km^2 of other woodlands were estimated to have 3650 km (s.e. 549) of stock fences and 1805 km (s.e. 335) of deer fences.

Stock fences tended to be either of line wire or hexagonal mesh. The commonest types of deer fence were of hexagonal mesh, rectangular mesh and line wire in native pinewoods, and hexagonal mesh, rectangular mesh and a combination of line wire and hexagonal mesh in other woodlands (Table 1).

Discussion

The above estimates of fence lengths could be used to estimate the total number of collisions by grouse, if estimates of collision rates were available. Unfortunately, current estimates of collision rates are based on a biased selection of deer fences, so extrapolated totals are only a rough indication of the total numbers of collisions against these. Within native pinewoods and mature plantations, rates of 1.8–3 collisions km^{-1} a^{-1} by capercaillie, 0.4 collisions km^{-1} a^{-1} by black grouse and 0.5 collisions km^{-1} a^{-1} by red grouse have been recorded against deer fences. Within and around pre-thicket plantations, 0.7 black grouse and 1.2 red grouse collisions km^{-1} a^{-1} have been estimated (Catt *et al.*,

Table 1: Mean lengths (m km^{-2}) of different types of fence and composition around and through woodland in the Dee and Moray faunal areas of Scotland. Mean 1 gives the values in the whole 1 km^2 regardless of habitat, while Mean 2 gives the weighted values for the woodland alone

	Native pinewood		Other woodland	
Fence type	Mean 1	Mean 2	Mean 1	Mean 2
Stock fence—line wire	67	84	452	633
Stock fence—hexagonal mesh	69	87	475	665
Stock fence—rectangular mesh	22	27	160	223
All stock fences	158	198	1087	1521
Deer fence—wire above and below	133	167	16	22
Deer fence—wire above, hexagonal mesh below	39	48	86	121
Deer fence—hexagonal mesh above and below	274	343	250	350
Deer fence—hexagonal mesh above, rectangular mesh below	35	44	2	2
Deer fence—rectangular mesh above, hexagonal mesh below	10	13	16	23
Deer fence—rectangular mesh above and below	265	331	151	211
Deer fence—wire above, rectangular mesh below	15	19	16	23
All deer fences	771	965	537	752

1994a; Petty, 1995; Baines and Summers, 1997). Therefore, total collisions against deer fences in the Highlands may amount to a few hundred by capercaillie and black grouse, and a few thousand by red grouse.

The population size of capercaillie in Scotland is 2200 (95 per cent confidence limits 1500–3200), of which about 400 live in the 124.5 km^2 pinewoods of the Highlands at a density of 3.6 birds km^{-2} (Catt *et al.*, 1994b; Forestry Commission, 1994). Even from the crude estimate of a few hundred collisions by capercaillie, it is clear that deer fences pose a severe threat to the population in the habitat where the density of capercaillie is highest.

The losses of several hundred black grouse from fence collisions are also of concern, as its British population was estimated at *c.* 25 000 displaying males based on work carried out during 1989–1993 (Baines and Hudson, 1995). However, a more recent national survey would suggest that the population is much lower (Hancock *et al.* in prep.). The effect of losses of red grouse, on the other hand, is likely to be small in relation to the *c.* 190 000 shot plus an unknown number that die from other reasons in the Highlands each year (Hudson, 1992).

The above estimates of collisions do not include birds which collide with fences not associated with woodland. Although the fences across open moor are not screened by trees, birds still collide with them. Additionally, collisions occur against stock fences, though by being smaller than deer fences, stock fences will have a lower but as yet unmeasured collision rate. However, given that the mean length of stock fence associated with other woodland is twice that of deer fence, then the bird mortality may be considerable. It has not yet been determined if it is possible to reduce collision rates by making fences more visible. At present, the removal of deer fences is the only sure way to prevent collisions by grouse (Petty, 1995). In many Highland forests, fences are a means of keeping out red deer *Cervus elaphus* L. If the deer density in Scotland were reduced, then plantations would not be at such risk and also natural regeneration of pine forests could take place (Staines, 1995). In this way, the need for expensive fencing and the consequent mortality of woodland birds would be reduced.

Acknowledgements

The following helped with field work: Dr I. Francis, Dr A.M. MacLennan, R.A. Mavor, R. Proctor and G. Rebecca. Prof. S.T. Buckland and Dr R.E. Green gave statistical advice. D. Catt of the Institute of Terrestrial Ecology assisted with the selection of survey sites. The draft was commented on by Drs M. Avery, I.P. Bainbridge, R.E. Green and S.J. Petty.

References

Aitkin, M., Anderson, D., Francis, B. and Hinde, J. 1989 *Statistical Modelling in GLIM*. Clarendon Press, Oxford.

Alonso, J.C., Alonso, J.A. and Muñoz-Pulido, R. 1994 Mitigation of bird collisions with transmission lines through groundwire marking. *Biol. Conserv.* 67, 129–134.

Avery, M.L. (ed.) 1978 Impacts of transmission lines on birds in flight. *Proceedings of a Conference, Oak Ridge Associated Universities*. Oak Ridge, Tennessee.

Baines, D. and Hudson, P.J. 1995 The decline of black grouse in Scotland and northern England. *Bird Study* 42, 122–131.

Baines, D. and Summers, R.W. 1997 Assessment of bird collisions with deer fences in Scottish forests. *J. Appl. Ecol.* 34, 941–948.

Bevanger, K. 1990 Topographic aspects of transmission wire collision hazards to game birds in the central Norwegian coniferous forest. *Fauna Norv. Ser. C, Cinclus* 13, 11–18.

Catt, D.C., Dugan, D., Green, R.E., Moncrieff, R., Moss, R., Picozzi, N. *et al.* 1994a Collisions against fences by woodland grouse in Scotland. *Forestry* 67, 105–118.

Catt, D.C., Baines, D., Moss, R., Leckie, F. and Picozzi, N. 1994b *Abundance and Distribution of Capercaillie in Scotland 1992–94*. Institute of Terrestrial Ecology and The Game Conservancy Trust report to Scottish Natural Heritage and the Royal Society for the Protection of Birds.

Faanes, C.A. 1987 Bird behavior and mortality in relation to power lines in prairie habitats. *US Fish and Wildlife Service, Fish Wildl. Tech. Rep.* 7, 1–24.

Forestry Commission 1994 *Caledonian Pinewood Inventory*. Public Information Division, Forestry Commission, Edinburgh.

Gibbons, D.W., Avery, M.I., Baillie, S.R., Gregory, R.D., Kirby, J., Porter, R.F. *et al.* 1996 Bird species of conservation concern in the United Kingdom, Channel Islands and Isle of Man: revising the Red Data List. *RSPB Conserv. Rev.* 10, 7–18.

Harvie-Brown, J.A. and Bartholomew, J.G. 1893 *Naturalist's Map of Scotland*. David Douglas, Edinburgh.

Hudson, P.J. 1992 *Grouse in Space and Time*. Game Conservancy, Fordingbridge.

Petty, S.J. 1995 Assessment of fence collisions by grouse species in Scotland. *Research Information Note* No 264. Forestry Commission, Edinburgh.

Staines, B.W. 1995 The impact of red deer on the regeneration of native pinewoods. In *Our Pinewood Heritage*. J. R. Aldhous (ed.). Farnham, Surrey, Forestry Commission, RSPB, Scottish Natural Heritage, 107–114.

Received 17 December 1996