



BTO Research Report No. 473

**Extensive monitoring of arctic-alpine
birds in Scotland:
A pilot survey to test the potential
for using volunteer surveyors.**

Authors

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November 2007

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EXECUTIVE SUMMARY

1. Birds that are found in arctic-alpine areas of Scotland have been inadequately monitored to date, a result of their general remoteness from volunteer bird surveyors and practical problems associated with access (topography and weather). This report describes a project that assessed the efficacy of enlarging the potential volunteer base for bird surveying by recruiting and training new volunteers (often not specialist birdwatchers) that otherwise regularly spend time in the high mountains of Scotland.
2. The project focussed principally on the Rock Ptarmigan *Lagopus mutus*, as Scotland's most widespread and numerous and only year-round resident arctic-alpine specialist bird. A hierarchical recording approach permitted and encouraged additional recording of other species.
3. Between April and August 2006, 140 volunteer surveyors surveyed a total of 3,212 km of transects in arctic-alpine habitats in Scotland (self-selected by the volunteers), recording numbers of Rock Ptarmigan and other evidence of their presence (mostly faecal piles).
4. Mean encounter rates of 0.25 ptarmigan and 0.34 'sites' per km ('sites' being defined as encounters that included faecal piles as evidence of Ptarmigan presence) did not differ significantly from those by experienced ornithologists undertaking concurrent calibration surveys. Encounter rates varied between geographic regions and were highest in the Cairngorms (95% CLs 0.34 – 0.55 birds km⁻¹ and 0.49 – 0.94 sites km⁻¹) and lowest in the Western Isles and Western Seaboard (none encountered).
5. Although encounter rates strongly support the ability of the volunteers to collect quantitative data suitable for monitoring of Rock Ptarmigan, negative returns (no birds or signs seen) were reported significantly less frequently (54% of all survey returns) than during repeated calibration transects (77% of transects). This suggested that a proportion of surveys where no birds were seen were not reported and that the encounter rates reported by volunteers may thus be artificially high. The encounter rates of Ptarmigan 'sites' by volunteers were highest in April and inversely related to the proportional snow cover along transect routes. No such relationships were apparent for the detection rates of birds, nor for either birds or 'sites' in the systematically repeated calibration surveys. The differences between the volunteer surveys and the repeated transects are likely to be the result of biases associated with both surveyors and birds selecting snow-free patches.
6. In addition to Rock Ptarmigan, 41 other species were also reported by volunteer surveyors, suggesting a potential for monitoring a broader suite of species in the arctic-alpine areas of Scotland in addition to those considered as specialists of those habitats.
7. The pilot study in 2006 indicated an interest, enthusiasm and ability of volunteers to participate in the monitoring of Rock Ptarmigan, and potentially other species, in the mountains of Scotland. The use of such approaches to improve the monitoring of the birds of arctic-alpine habitats in Scotland would need to ensure that negative returns are reported and biases associated with snow cover (and potentially other influences of weather) are addressed. An appropriate balance between statistically rigorous sampling and pragmatism will also need to be achieved, to accommodate extensive fieldwork in areas with challenging topography and weather. The design and resourcing of any future monitoring programme specifically for the uplands will require further development. However, a new pool of volunteers willing to contribute to bird recording has been identified and some future training could be focussed on this group, to further encourage their participation in existing bird monitoring projects that cover the Scottish mountains.

1. INTRODUCTION

1.1 Arctic-alpine birds in Britain

Arctic-alpine habitats, that are those occurring above the natural tree line, occupy approximately 3% of Britain's land surface with the majority found in the Scottish Highlands (Thompson & Brown 1992). In Britain, there are only four species of bird that can be considered as arctic-alpine zone 'specialists': Rock Ptarmigan *Lagopus mutus*; Eurasian Dotterel *Charadrius morinellus*; Purple Sandpiper *Calidris maritima*; and Snow Bunting *Plectrophenax nivalis* (Thompson *et al.* 2003). Purple Sandpiper and Snow Bunting are rare breeding birds in Britain with normally less than five pairs and *ca.* 70 – 100 pairs respectively attempting to nest annually in recent years within restricted areas of the Scottish Highlands (e.g. Ogilvie *et al.* 2003, Smith 1993). The restricted populations and distributions of these two species, especially those of Purple Sandpiper, do not readily lend themselves as subjects for extensive monitoring. Eurasian Dotterels are more numerous, with an estimated 630 breeding males in Britain in 1999 (Whitfield 2002a), however they are migratory, moving mostly to north Africa outside of the breeding season and are also unusually itinerant on the breeding grounds (Whitfield 2002b). Therefore, their breeding populations could potentially be influenced by factors outside of the breeding areas within Britain. Rock Ptarmigan, on the other hand, are resident in their mountain environment throughout the year and remain relatively numerous and widespread through the Highlands, with a fluctuating population that is thought to exceed 10,000 breeding pairs (Watson & Rae 1993, McGowan *et al.* 2003). As such, the monitoring of rock ptarmigan distribution and abundance in Scotland could form an appropriate indicator of environmental change in arctic-alpine habitats in the Highlands.

Other bird species also breed extensively in arctic-alpine habitats in Britain that are also found, often more abundantly, in other habitats, for example, Golden Plover *Pluvialis apricaria* Meadow Pipit *Anthus pratensis*, Skylark *Alauda arvensis* and some raptors. Although not specialists of arctic-alpine environments, knowledge of any changes in their abundance on Britain's high ground could arguably provide as valid an indicator of the condition of arctic-alpine habitats as those of species that are specialists of such areas.

1.2 Monitoring of Rock Ptarmigan in Britain to date

The Rock Ptarmigan has a circumpolar distribution across northern Eurasia and North America. In Europe, there are isolated southern populations in the mountain ranges of the Pyrenees and the Alps and also in Scotland (Cramp and Simmons 1983). The insular population in Scotland is represented by the endemic subspecies *L. m. millaisi* (McGowan *et al.* 2003). This is a widespread resident across the Highlands, and some islands (Figure 1), where combinations of altitude and exposure maintain arctic-alpine habitats suitable for the species (Gibbons *et al.* 1993, Thompson *et al.* 2003).

Monitoring the trends in populations of widespread birds in Britain is primarily undertaken by volunteer birdwatchers but upland areas, including the entire range of the rock ptarmigan, have been severely under-represented. For example, the Breeding Bird Survey (e.g. Raven & Noble 2006) includes few surveyed 1-km squares within the species' range (Figure 1) and amongst those, few will include suitable habitat for Rock Ptarmigan; between 1994 and 2006, they were recorded in just 0-3 survey squares annually. Trends for breeding bird populations are generally derived from the Breeding Bird Survey (BBS) for species that are recorded in at least 30 randomly selected 1-km survey squares within composite countries or regions of the UK in each year (Raven & Noble 2006). The current encounter rates of Rock Ptarmigan during BBS fieldwork clearly falls far short of this threshold. Although a long-term study of Rock Ptarmigan populations has been made within some core areas of its distribution in Scotland (the Cairngorms and the Mounth; e.g. Watson 1965, Watson *et al.* 1998, Watson *et al.* 2000), there is little information on population levels, or trends from the

majority of its range within Scotland and notably none from the southern peripheral parts of its range (e.g. Bryant *et al.* 1993).

Although populations of Rock Ptarmigan have not been monitored effectively across Scotland, there is evidence of some long-term decline. The species bred formerly in south-west Scotland, becoming extinct there during the 19th century, and populations on the islands of Harris, Rum and Hoy were thought to have similarly gone extinct in the early 20th century (Thom 1986). In 1989-91, extensive fieldwork for a national atlas of breeding birds recorded rock ptarmigan in 173 10-km squares, some 11% fewer than during similarly extensive fieldwork in 1968-72 (Gibbons *et al.* 1993), suggesting a continued contraction of their range. The later atlas period recorded the apparent reappearance of the species on the islands of Arran and Jura, however, implying either some recolonisation (Thom 1986) or potentially documenting the fact that the species could have been missed in any of the atlas periods, highlighting a difficulty with their survey and monitoring. Although Rock Ptarmigan will have formerly occurred in England, information on the species' status in historical times is scant (Brown & Grice 2005).

1.3 Aims of the project

Long-term contraction in the range of Rock Ptarmigan in Britain may be related to post-glacial climate amelioration exacerbated by the resulting fragmentation of suitable habitat. More recent causes of change have been associated with higher grazing intensities by domestic and wild herbivores leading to the loss of ericaceous food plants (Watson and Rae 1993), and to human disturbance and an associated increase in predation (Watson and Moss 2004). Climate and weather patterns are predicted to change as a result of anthropogenic influences (e.g. Hulme *et al.* 2001) leading to changes in bird distribution, demography and phenology (e.g. Winkler *et al.* 2002, Crick 2004, Sæther *et al.* 2004). Population level responses to variation in climate have been shown for the ecologically similar White-tailed Ptarmigan *Lagopus leucurus* in Colorado (Wang *et al.* 2002) and weather has been shown to be a likely contributory factor influencing the population dynamics of Rock Ptarmigan populations in restricted study areas in Scotland (Watson *et al.* 1998) and also in the Swiss alps (Bossert 1995). With changes in climate, weather patterns and grazing regimes predicted or likely, we suggest that changes in the abundance and distribution of some bird species could be appropriate indicators for the condition of arctic-alpine environments in Scotland. For reasons described above, we suggest that the Rock Ptarmigan may be the most appropriate bird species for this purpose.

Given that bird populations in arctic-alpine areas of Britain and specifically those of Rock Ptarmigan have not been effectively monitored across their ranges by specialist ornithologists, this project principally aimed to test the efficacy of using volunteers that were not necessarily specialists to collect reliable quantitative data on birds in arctic-alpine areas of the Scottish Highlands. The ultimate aim of the work reported here is to develop a cost-effective long-term monitoring programme for mountain birds in Scotland that will inform assessments of the condition of arctic-alpine habitats. In summary, the project aims were:

- To test the efficacy of encouraging and training volunteers that were not specialist birdwatchers to collect reliable quantitative data on a limited number of bird species in the mountains of Scotland;
- To recruit new volunteers to participate in a range of bird monitoring programmes and surveys that include the Scottish mountains;
- To assess the possibilities for an extensive volunteer-based monitoring programme specifically for birds in arctic-alpine areas of Scotland.

2. METHODS

2.1 Development of field methods, volunteer recruitment and training

Following discussions with hill walkers (the most numerous potential volunteers for any fieldwork monitoring mountain birds) and an initial pilot study to assess field methods in 2006 (Calladine 2005), it was decided to record birds using linear transects. Alternative approaches such as random selection of survey sites and block surveys (e.g. searches of 1-km squares) were deemed unattractive by potential volunteers and incompatible with their principal aims (to climb mountains). As many potential volunteers were likely to have a limited knowledge of birds, it was also decided that the project should specialise on a single species. The Rock Ptarmigan was not only the most appropriate species (Section 1) but was also familiar to many hill walkers and could be relatively easily described to those for which it was not.

In the months leading up to the survey period (April to August inclusive, 2007), articles were written for mountaineering and other 'outdoor' magazines, club newsletters and websites and for the more general press to publicise the project with the aim of recruiting potential volunteers. At least 22 newspapers, magazines or newsletters published articles to publicise the project, including a number of national titles (Appendix 1), three talks were given to outdoor clubs (Cairngorms Club, Paisley Hill Walking Club and Glasgow HF Outdoor Club) in advance of the project and a feature was broadcast on Radio Scotland's 'Out of Doors' programme. A number of outdoor group web sites also carried promotional material for the project. Approaches were also made to Scottish Gamekeepers Association and also to the Scottish Rural Business and Property Association with the aim of encouraging sporting estates and their employees to participate in the project. Responses from these two organisations were not forthcoming following our initial approaches to them. As requests for information from mountaineering and other 'outdoor' groups utilised all of the allocated resources for project promotion, unfortunately contacts with sporting estates were not able to be pursued further.

Information sheets (Appendix 2) were supplied to volunteers that described transect selection and recording protocols, how to identify Rock Ptarmigan and their faecal piles and also background information about Rock Ptarmigan and the aims of the project. They were also given information on how to differentiate Red Grouse (*Lagopus lagopus scoticus*), the only potential confusion species.

2.2 Transect selection and recording

Survey routes were self-selected by the volunteers from within the known range of Rock Ptarmigan in Scotland (after Gibbons *et al.* 1993) and surveyed between April and August 2006, inclusive. Following the guidelines that were provided, these mostly started higher than 750 metres above mean sea level, the lower altitude for Rock Ptarmigan over much of their range in Scotland (Watson and Rae 1993). In the event that any Rock Ptarmigan were encountered at lower altitudes of the route taken, surveyors were asked to start their recording transects at that point. Such a design accommodated some areas (e.g. in the north-west Highlands) where exposure permits rock ptarmigan to inhabit considerably lower altitudes. Surveyors were asked to supply two-letter six-figure grid references (giving locational precision to within 100 m) for the start point and end points of their recording transects and also of any major turning points on their route. The overall length of transect surveyed was also recorded, and a random sample of these was compared against the given grid references to assess accuracy of details supplied. Also recorded were: the date of each survey; the start and end times for the walk along the survey route; the proportion of the survey transect that was covered with snow (five categories: none; <5%; 5-20%; 20-40%; >40%); and an indication of whether the surveyor thought that weather conditions were sufficiently adverse to affect their ability to detect birds (two categories: yes or no).

2.3 Bird recording protocols

Volunteer surveyors were given a series of options for recording:

- i) The minimum required was details of the transects surveyed (Section 2.2), the number of Rock Ptarmigan seen, the number of faecal piles seen and the number of Red Grouse seen;
- ii) The numbers or presence of six named species seen from the survey transects (Golden Plover, Meadow Pipit, Raven *Corvus corax*, Hooded Crow *Corvus cornix*, Wheatear *Oenanthe oenanthe* and Ring Ouzel *Turdus torquatus*);
- iii) The presence of cast feathers from Rock Ptarmigan;
- iv) Timed (10 minute) point counts where the surveyors would remain stationary and record all birds seen and heard;
- v) Counts of all other species that were recorded along the survey transect;
- vi) Any additional information that the surveyor wished to supply.

Options (i) and (ii) above were the minimum asked of volunteer surveyors. Option (i) was the core information on Rock Ptarmigan (see below) and option (ii) aimed to provide some assessment of the wider ornithological knowledge of the volunteers in general. Options (iii) to (vi) were opportunities for the surveyors to provide additional information if they so wished.

In option (i) above, the total number of individual Rock Ptarmigan that were seen along survey transects of known length and location was recorded. In addition, faecal piles were also recorded as an indicator of the presence of Rock Ptarmigan. Analyses considered both the numbers of Rock Ptarmigan actually seen on each survey transect and also the number of 'ptarmigan sites' encountered. 'Ptarmigan sites' were spatial clusters of birds and/or their faecal piles. A single faecal pile or a cluster of piles represented a single site. Similarly, a single ptarmigan or a flock represented just one site as did bird(s) seen in the same area as pile(s). Based on the distribution of birds and faecal piles found during the initial assessment of field methods in 2005 (Calladine 2005), a minimum separating distance of 20 m between birds or faecal piles was assigned to identify separate 'sites'. In the event that such 'sites' extended for more than 20 m, surveyors were asked to call each 20 m section a separate 'site'. We are not aware that the latter was ever required, however. The faeces of Rock Ptarmigan are inseparable in the field from those of Red Grouse and the two species occur close together in some areas of Scotland. Surveyors were asked to record the number of Red Grouse seen along their survey transects and the ratios of Rock Ptarmigan to Red Grouse counted were used to assign the proportion of faecal piles to species for cases when the birds themselves were not seen (Section 2.5.1).

Cast feathers are an indication of the presence of Rock Ptarmigan, assuming they are identified correctly. During tests of field methods in 2006, however, they were never found to be sufficiently abundant to generate a quantitative index of abundance and they were never found where no birds or faecal piles were also recorded (Calladine 2005). Furthermore, cast feathers can readily blow in the wind and therefore the locations where they are found need not necessarily reflect the location where birds occurred. Volunteers were also asked to collect and submit any cast feathers of Rock Ptarmigan that they found while surveying. The response was very good, with a total of 222 samples obtained, from 7 NHZs. These are to be used in a future analysis of the genetic structure of the species in Scotland.

2.4 Systematic calibration transects

Concurrent with the volunteer based survey, a series of transects were surveyed by experienced professional ornithologists. The aim was to repeat a series of 35 transects, each between 2 – 4 km in length (total combined length 78.8 km), that were clustered at 10 sites in the Scottish Highlands (Fig. 2), in each of the five months April to August inclusive. The recording of Rock Ptarmigan, Red

Grouse and signs of their presence was identical to that undertaken by volunteer surveyors (Section 2). The aims of these transects were: (i) to try and quantify any seasonal variation in the detection rates of Rock Ptarmigan; and (ii) to compare detection rates between volunteer (often inexperienced) surveyors and those of experienced professional ornithologists.

All birds (of all species) and faecal piles of ptarmigan or grouse were plotted onto large scale maps. Birds were also recorded in one of three distance bands from the transect (0-25 m, 25-100m and 100m+). The distance bands are the shortest perpendicular distance that a bird was first detected from the survey transect. In addition, the numbers of people, sheep and deer seen within 100 m of each transect when surveyed were also recorded. During July and August simple habitat measures were recorded for each 200 m length of transect surveyed. Analyses of the relationships between bird presence or abundance and habitat variables are planned and will be reported separately. This analysis could inform some likely impacts of changes in the mountain environment on bird populations.

2.5 Analyses

2.5.1 Assigning faecal piles to species

Based on topography, geology and land use, 21 Natural Heritage Zones (NHZs) or biogeographic regions have been described in Scotland (Scottish Natural Heritage undated). The known breeding distribution of the Rock Ptarmigan includes 11 of these NHZs (Figs. 1 & 2) and it is possible that a number of Ptarmigan persist, or recolonisation is conceivable, in a twelfth (the Western Isles: Stuart Rae pers. comm.). Within each NHZ, the total number of Rock Ptarmigan seen by volunteers was expressed as a proportion of the combined total number of Rock Ptarmigan and Red Grouse that were seen. These proportions were used to assign a proportional number of faecal piles to Rock Ptarmigan. When no counts of Red Grouse (but excluding zero counts) were given on the returned survey forms, the counts for Rock Ptarmigan were similarly treated as missing data and omitted from the calculations to estimate the proportions of either species. For the repeated calibration transects, the proportions of faecal piles that were attributed to Rock Ptarmigan were similarly estimated by using the sum totals of Rock Ptarmigan and Red Grouse through the 5 month survey season to produce a correction factor for each of the ten sites.

2.5.2 Determining influences on encounter rates

Generalised linear models (GLMs) were used to assess the influences of geographical region, season (month, $N = 5$), snow cover ($N = 5$ classes) and poor weather ($N = 2$ classes) on encounter rates by volunteer surveyors as follows:

$$\text{Count} = \text{Region} + \text{Month} + \text{Snow Cover} + \text{Poor Weather} + \text{constant}$$

Two separate models were run, where 'count' was either the number of actual birds seen or the number of 'ptarmigan sites' encountered on a transect, the latter after the number faecal piles had been corrected for the estimated proportions attributable to Rock Ptarmigan. The logarithm of the lengths of transect surveyed (in km) was introduced into the model as an offset and the models assumed a negative binomial distribution and a Log link function. In order to achieve model convergence, it was necessary to combine some neighbouring NHZs with sparse data to form eight biogeographic regions (Table 1). Similarly models attempted to control for possible observer bias by including the individual surveyor as an influencing factor on detection rates failed to converge. Although most volunteers (78%) supplied survey data from just one region (potentially confounding true regional variation with observer variation), there were at least 20 individuals (maximum 73) providing data from any one region. Therefore, we suggest that any biases associated with the detection rates of individual surveyors were likely to have been minimal and would have resulted in additional noise within the models rather than any systematic bias.

For the repeated calibration transects surveyed by professional ornithologists, the influences of season (Month, $N = 5$) and snow cover ($N = 5$ classes) were examined using the GLM:

$$\text{Count} = \text{Month} + \text{Snow Cover} + \text{constant}$$

Transect ($N = 35$) was included as a repeated measure and the logarithm of the lengths of the transect (km) was introduced as an offset. The models again assumed a negative binomial distribution and a Log link function. Note that the calibration surveys were not undertaken in conditions when poor weather was considered to have hindered the ability of the surveyors to detect birds.

Mean encounter rates, and their precision (standard error and confidence intervals), were estimated by back transformation of the adjusted (least squares) means from the above models.

2.6 Comparison of distribution with 1988-91 *Atlas* data

As part of an extensive ornithological atlas covering all breeding birds in Britain and Ireland, Rock Ptarmigan were recorded in 173 10-km squares in Scotland (Gibbons *et al.* 1993). A simple direct comparison with data collected by volunteers in 2006 was made by summarising the recorded presence of Rock Ptarmigan by volunteers in 2006 by 10-km squares. This comparison included data that were submitted from outwith the main survey period in January, February, September and October 2006, and also included the recording of cast feathers, as well as faecal piles) as positive evidence for the presence of Rock Ptarmigan.

3. RESULTS

3.1 Volunteer surveys

A total of 614 transect surveys were completed by 140 individual volunteers during the period April to August 2006, inclusive (Table 1, Fig. 3). A total of 3,212 km of transects were surveyed (mean 24.9 km per person, range 1 – 156 km per person) and totals of 1,027 Rock Ptarmigan and 288 Red Grouse were reported. After correcting for the proportion of faecal piles that were likely to have been attributable to Rock Ptarmigan (Table 2), 1,672 'Ptarmigan sites' were reported. Encounter rates of 'sites' tended to be greater than for birds (Fig. 4), with across all areas, a mean of 0.25 birds seen per km (95% confidence limits: 0.18 – 0.36) and 0.34 sites encountered per km (95% confidence limits: 0.25 – 0.46).

Encounter rates differed significantly between some regions (Table 3, Fig. 4). The highest encounter rates (of both birds and 'sites') were in the Cairngorms (95% confidence limits: for birds, 0.34 – 0.55 per km; for 'sites' 0.49 - 0.94 per km), and the lowest in the combined areas of Argyll, the Trossachs and Breadalbane (95% confidence limits: for birds, 0.05 – 0.14 per km; for 'sites' 0.09 - 0.22 per km) and the Western Isles and Western Seaboard (none) (Fig. 4).

Although having no effect on the detection rate of birds, there were significant influences of both season and snow cover on the detection of 'sites' (Table 3). Encounter rates of 'ptarmigan sites' were inversely related to the proportion of the survey transect that was covered by snow (Fig. 5) and were also greatest in April, although there was little variation between the other four months of the survey (May, June, July and August; Fig. 6). Although poor weather was reported by the volunteers as likely have affected 24% of the surveys completed, no statistically significant influence was detected (Table 3).

196 of the returned survey forms (32%) gave results for timed point counts. Of these, the vast majority (184) did not record any birds. The 12 reports of timed point counts recording Rock Ptarmigan were received from 9 surveyors within 4 months and 4 NHZs. Records of birds from point counts were of 6 of singles, 4 of 2s, and single reports each of 4 and 6 birds.

3.2 Systematic surveys

Complete coverage of all the 35 systematic calibration transects (totalling 78.8 km) was achieved only in August. Poor weather prevented completion in each of the other four months with 23 transect sections (51.6 km) surveyed in April, 33 (73.4 km) in May, 27 (56.8 km) in June and 32 (67.8 km) in July. In common with the surveys undertaken by volunteers, no statistically significant influences of season or snow cover were apparent on the detection rates of Rock Ptarmigan (Table 4). In contrast to the data collected by volunteers, however, no statistically significant influences of snow cover along each transect or of season on the encounter rates of 'ptarmigan sites' were detected (Table 4). Although the mean encounter rate of 'sites' was least when there was greatest snow cover, the difference was not statistically significant and there was no apparent trend with increasing snow cover (Fig. 7). Detection remained reasonably constant in each of the five months of the study (Fig. 8).

The majority (73%) of Rock Ptarmigan were seen within the 0-25 m distance band from the survey transect. 22% were recorded within the 25-100 m and 5% in the 100 m plus distance bands.

3.3 Comparison of detection rates between volunteer and systematic surveys

Systematic calibration surveys were undertaken in just four of the 12 NHZs in which surveys were also made by volunteers. The influences of region, season, snow cover and poor weather on the encounter rates of both birds and of 'sites' within a sub-sample of the volunteer data from those four

NHZs only were very similar to those for the full volunteer data set, however (Table 5). Similarly, the detection rates of birds (mean 0.28 per km, 95% confidence limits 0.18 – 0.43) and encounter rates of ‘sites’ (mean 0.37 per km, 95% confidence limits 0.25 – 0.54) by volunteer surveyors within those 4 NHZs did not differ significantly from the complete data set (Section 3.1). In the absence of any differences, comparisons of systematic repeated surveys are made with the full data set submitted by volunteers.

The mean detection rate of Rock Ptarmigan by volunteer surveyors was 56% greater than by professionals undertaking systematic repeated surveys, while in contrast, the mean encounter rate of ‘sites’ by volunteers was 40% less; the differences were not statistically significant, however (Table 6). Amongst the volunteer surveys, 54% (out of 615) of the survey returns reported no birds, significantly less than the 77% (out of 149) of the systematic professionally surveyed transects ($\chi^2_1 = 6.41$, $P = 0.03$). There was no significant difference in the proportions of nil returns for ‘sites’ reported by volunteers (36%, $N = 550$) and by professionals (40%, $N = 149$) ($\chi^2_1 = 0.42$, $P = 0.95$), but note that 65 volunteer survey returns (11%) did not include details of any counts of faeces piles, nil or otherwise.

Fourteen of the 187 survey returns (i.e. 7%) from volunteers reported zero counts for both Rock Ptarmigan and for ‘ptarmigan sites’ but reported the presence of cast feathers from Rock Ptarmigan. These were from six NHZs, the Cairngorms ($n=5$), Central Highlands ($n=1$), East Lochaber ($n=2$), North-west Seaboard ($n=1$), the Trossachs and Breadalbane ($n=3$) and the Western Highlands ($n=2$). With their wide geographic spread, the inclusion of these reports as ‘nil returns’ will have a negligible effect on the analyses and interpretation of the quantitative data collected by volunteers.

3.4 Comparison of distribution with 1988-91 Atlas data

Including data that were submitted outwith the main survey period of April to August, a total of 646 survey forms were returned. These surveys were undertaken in 157 10-km squares, including 121 of the 173 squares (i.e. 70%) in which Rock Ptarmigan were recorded during 1988-91 (Figure 9). Rock Ptarmigan were recorded as present during 2006 in 79 (65%) of the squares where they were seen during 1988-91 (Figure 9). Amongst the 36 squares additional to those where Rock Ptarmigan were recorded in 1988-91, birds were found in 19 (53%) in 2006 (Figure 9). Although squares in which birds were seen in 1988-91 but for where no signs were reported in 2006 were distributed throughout their range in Scotland, clusters of apparent negative returns were found within the Trossachs and Breadalbane and the Western and North-western Seaboards (Figure 9). All 10-km squares in which birds, or their signs, were reported in 2006 are adjacent to squares known to have been occupied in 1988-91 (Figure 9). Of the 19 squares in which Rock Ptarmigan were reported in 2006 but not during the 1988-91 atlas, 13 were squares where they had been recorded during an earlier atlas of breeding birds covering 1968-72 (Sharrock 1976).

It should be noted that survey effort was generally greater for the 10-km squares where Rock Ptarmigan were recorded with a mean of 4.98 (SE = 0.47) survey transects completed compared to 2.75 (SE = 0.30) for squares where no Rock Ptarmigan, or their signs were reported ($t_{155} = 3.50$, $P < 0.001$). The respective sums of transect lengths surveyed within each 10-km square was greater in those where Rock Ptarmigan were recorded (mean 8.54 km, SE 0.79km) than in those where they were not (mean 5.60 km, SE 0.50 km) ($t_{155} = 2.77$, $P = 0.006$). It should also be noted that these measures of survey effort per 10-km square are likely to be confounded with the extent of arctic-alpine habitat present and therefore the numbers of Rock Ptarmigan actually present within them. Therefore the absence of Rock Ptarmigan reported by volunteers within any square will not necessarily be a sole function of their survey effort.

3.5 Other species

Of the seven species for which information was specifically requested, Meadow Pipit had the highest reporting rate (recorded on 35% of transects for which information on the species was supplied), with Red Grouse, Wheatear, Golden Plover, Raven, Ring Ouzel and Hooded Crow all being reported from less than 20% of the survey transects (Table 7). Despite details of Red Grouse being included as an 'obligatory' part of the survey, including that of nil returns, 11% of the returned forms did not include any counts for Red Grouse (Table 7). On only 7% of the returned survey forms did the volunteers state they were not able to identify the six additional species. The reporting rates for these six species and Red Grouse were lower than the comparable reporting rates by experienced ornithologists undertaking the repeated calibration surveys (Table 7; $\chi^2_6 = 135$, $P < 0.01$). A further 34 species were reported by volunteers, including two arctic-alpine specialists Dotterel and Snow Bunting (Table 8, Figures 10 & 11).

4. DISCUSSION

4.1 Survey uptake and detection rates

This project demonstrated a keen interest in the voluntary monitoring of birds in the mountain areas of Scotland by hill walkers. Although we do not have precise details of surveyors' backgrounds, from communications with the volunteers it is clear that the 2006 survey attracted many participants who were not specialist birdwatchers and had not been involved previously in biological or environmental monitoring programmes. Furthermore, the differences in the relative abundance of Rock Ptarmigan detected by the volunteers between regions indicate a level of reliability in the quantitative data collected: the highest densities (of birds and signs) were recorded in the Cairngorms, the region of Scotland with the most extensive continuous areas of habitat suitable for Rock Ptarmigan (Shaw *et al.* 2006), and the lowest densities were recorded in the south of their range, where arctic-alpine habitats are highly fragmented and where anecdotal reports suggest that ptarmigan densities are low.

In general the detection rates of Rock Ptarmigan by both volunteers and experienced professional ornithologists were low. This perhaps was inevitable but it does lead to a low statistical power to detect spatial or temporal differences in abundance (i.e. to reliably measure change). Based on the detection rates and their variation reported by volunteers in 2006, a pair-wise difference in abundance of less than 60% might not be reliably detected (assuming a t-test to detect differences between pairs of transect data). Encounter rates were greater if faecal piles were also recorded and a similar test of the power to detect pair-wise differences suggested that a 40% difference could be detected reliably. Whilst a time series of data (e.g. data collected annually) could give enhanced power to detect significant trends, greater statistical power would still be expected if data on faecal piles were collected in addition to sightings of birds. Therefore any long-term extensive monitoring of Rock Ptarmigan that includes encounter rates of faecal piles to supplement observations of the birds themselves would have a greater ability to measure changes in their abundance.

The apparent detection rates of Rock Ptarmigan by volunteer surveyors tended to be greater than those by professional ornithologists although the difference was not statistically significant. This contrasted with the lower detection rates for seven other species for which comparisons could be made (Section 3.5). The survey instructions and promotional material had a clear emphasis on Rock Ptarmigan, indeed the project was promoted as 'Project Ptarmigan', and guidance on identification was only provided for Rock Ptarmigan and Red Grouse. Therefore, it is likely that more effort would have been spent looking for Rock Ptarmigan than for other species. There is evidence that reporting rates by volunteers may also have been artificially high however (Section 4.2).

4.2 Influences on detection rates

No influence of season or of snow cover on encounter rates was apparent in the systematic calibration surveys undertaken by experienced ornithologists. For encounter rates of faecal piles (but not for sightings of birds) this contrasted with the data collected by volunteers, which indicated a higher encounter rate in April and an inverse relationship with snow cover on the transects. Although we did not formally test the power to detect such differences amongst the systematic data, examination of Figures 7 and 8 shows no suggestion for a similar relationship from the repeated transects surveyed by professionals. The difference most probably resulted from the processes used to select routes by volunteers compared to the systematically repeated transects. The repeated transects surveyed by professionals were principally to investigate seasonal differences in detection rates, so that the data collected by volunteers could be corrected for these if necessary. The protocol adopted by the professionals required that the same transect routes were surveyed regardless of snow conditions on the ground. If conditions were impassable, then that transect (or section of it) was omitted. To ensure that the volunteer surveys were compatible with the aim of hill walkers to climb mountains and with no requirement for repeat surveys, the volunteers were able to select their own transect routes. This

meant that they could choose to avoid areas covered with snow. Similarly, Rock Ptarmigan probably select snow free areas in which to feed, hence their faeces piles might be concentrated in these areas. Therefore the high encounter rates of faecal piles by volunteers in April (the month in which the greatest snow cover was recorded) could potentially be an artefact of both the birds and surveyors being concentrated within snow-free areas.

Given the potential biases associated with the quantitative data provided by volunteer surveyors under some conditions, an alternative approach might be to use simple presence and absence data from defined areas (e.g. mountain groups or 10-km squares based on the Ordnance Survey's national grid) to measure temporal changes in distribution and abundance. With sufficient data, such an approach could have the advantage of including estimations of detection rates, and how they vary, in models to measure changes in occupancy rates (e.g. Olsen *et al.* 2005). However, the proportion of nil returns provided by volunteer surveyors was lower than expected when compared to the systematic repeated transects (Section 3.3). Although the survey instructions, recording forms and other materials associated with the project all emphasised the importance of reporting an absence (as well as a presence) of Rock Ptarmigan, it appears that some volunteers who completed surveys but did not see any birds failed to submit their records. This tendency would clearly limit any intention to monitor the species using simple presence and absence data, and also suggests that the detection rate of birds reported by volunteers might be artificially high.

4.3 Comparison with atlas data

Volunteers in 2006 did not find Rock Ptarmigan or their signs in 35% of the 10-km squares in which they were reported during fieldwork for the atlas of breeding birds during 1988-91. Initially, this may suggest either (i) a marked contraction in their range, or (ii) a lower efficiency in the detecting of birds by the surveyors in 2006. It should be noted, however that the atlas was a summation of four seasons of fieldwork and survey effort per 10-km square could have been greater than in 2006; a possible influence of survey effort is evident in the 2006 data alone (Section 3.4). It must also be noted that the 2006 volunteers located Rock Ptarmigan in a number of 10-km squares where they were not reported in 1988-91. Given that some of the latter included records of Rock Ptarmigan during the first atlas period (1968-72) and that some individuals submitted casual records of Rock Ptarmigan they had seen in recent years that included some areas for which there were no positive signs of birds reported in 2006 (e.g. on Skye; David Rogers & Richard Blindell *pers comm.*), in all likelihood, these differences may well be an indication of the intrinsic difficulties of surveying the species rather than a measure of any distributional change or measure of the efficiency of different cohorts of surveyors.

4.4 Monitoring of Rock Ptarmigan and other birds in arctic-alpine areas of Scotland

Some of the practical problems associated with monitoring birds in arctic-alpine habitats in Scotland were demonstrated by the inability of the professional surveyors to complete all of the calibration transect surveys in 2006. Even when resources (man-power and time) were available, poor weather prevented nearly 20% of the survey transects from being completed within the 5 month study period. Therefore, the extensive long-term monitoring of Rock Ptarmigan, and potentially other mountain birds in Scotland, is likely to rely on a major contribution by volunteer surveyors. This study confirmed an enthusiasm amongst hill walkers to contribute towards biological surveys of Scotland's higher ground and an adequate level of skill to contribute valid quantitative data, at least for a restricted number of species which pose relatively few identification problems. Further development of a monitoring programme for arctic-alpine birds in Scotland would benefit from a more systematic approach by volunteer surveyors, however. This would aim to reduce the potential biases associated with observer (and bird) distribution and snow cover and also to increase the reliability with which surveyors report having seen no birds. These refined survey approaches need to be developed in conjunction with the volunteers themselves, however, to ensure that they remain both enjoyable and compatible with their main purposes for being in the mountains. They must also be appropriate to produce the specific outputs from any survey, which might include: national and regional population

estimates for Rock Ptarmigan; monitoring of long-term trends; assessment of the status of the species itself; and indicators for the condition of the mountain environment (Section 1.1).

An up-to-date and robust estimate of the national breeding population of Rock Ptarmigan in Scotland (and therefore also the UK) would be valuable but the national population is thought to fluctuate (Watson & Rae 1993). Numbers of Rock Ptarmigan have been shown to be cyclical with a periodicity of usually around 10 years (but sometimes 6 years) at long-term monitoring sites in the Cairngorms and the Mounth, with those fluctuations not necessarily synchronous between study sites (Watson *et al.* 1998). We are not aware of any data that support cyclical population fluctuations elsewhere in Scotland but unpublished data (e.g. Holt & Whitfield 1996a & b) and anecdotes suggest marked fluctuation in local populations. Therefore even if a robust population estimate was established for a single year, the relationship between that estimate and population size in years of average, high or low abundance could be unclear. Contextual information would be obtained from an extensive and long-term monitoring programme that measured relative abundance. As well as informing relative changes in the abundance of Rock Ptarmigan, such a programme could potentially permit the interpretation of any single year survey that aimed to establish a national population estimate with appropriate confidence limits.

A future monitoring programme for Rock Ptarmigan and potentially other birds of arctic-alpine areas in Scotland must address the issues associated with the non-systematic selection of survey sites in 2006. The use of fixed survey routes, as in the calibration transects surveyed in 2006, may prove unpopular with many hill-walking volunteers and also be impractical given the vagaries of mountain weather and variable snow cover. Issuing of specific survey areas to named volunteers would reduce the risk of low submission rates of nil returns in that individuals can be contacted to ask if they had completed any surveys. Again, this was identified as undesirable by some potential volunteers before the 2006 field season. Any loss of volunteers through such an approach might be compensated for by increased reliability and value of submitted data, however.

Ideally any bespoke monitoring programme for birds of arctic-alpine habitats in Scotland would be compatible or integrated with other extensive programmes. Current extensive monitoring programmes for terrestrial birds in the UK, notably the Breeding Bird Survey (BBS), could potentially monitor arctic-alpine areas if there was sufficient uptake of appropriate survey squares; however current coverage is inadequate (Section 1.2). Although the current project has potentially encouraged new participants for that survey (at least 35 volunteers for Project Ptarmigan expressed an interest in taking part in the BBS for 2007; Mike Raven pers. comm.), the survey design of the BBS is arguably inappropriate and too inflexible to accommodate the topography and variable weather of the higher mountains of Scotland (see below). The design of a volunteer-based monitoring programme for birds in arctic-alpine areas of Scotland will need to consider a number of issues, including:

- a) *The size of area to be surveyed* – If a survey area is too large, for example a range of hills, then any data collected could be too imprecise to identify spatially. If a survey area was too small, then options for volunteer surveyors may be limited during unsettled weather. A suitable compromise could be to survey tetrads (2-km by 2-km squares) or 10-km squares. These would have the additional advantage of being compatible with data collected for ornithological atlases, which have resulted in the only extensive surveying of the species in Scotland to date.
- b) *The systematic selection of survey areas* – Assuming that comprehensive coverage could not be achieved, a random selection of survey areas, potentially stratified according to geographic region and likely coverage, would be the ideal, to reduce potential biases associated with completely free self-selection by volunteers. A more pragmatic approach to such a selection procedure may be necessary, however, both to encourage maximum participation by volunteers and also to permit flexibility for surveyors to accommodate variable weather conditions.

- c) *The frequency of surveys within a long-term monitoring programme* – This is likely to be a compromise between an annual survey that maintains a core of volunteers (potentially fewer than achieved in 2006) or periodic surveys at say 5-10 years, with associated publicity drives (as in 2006). With a species like Rock Ptarmigan where the population size may cycle or at least vary markedly in relation to weather, surveys that are infrequent may prove difficult to interpret. The ideal would be annual monitoring at a representative sample of sites across the range of the species in Scotland, the results of which would inform any population estimates derived for a given year (or years) from more intensive survey work.
- d) *Which species are to be surveyed?* – In addition to Rock Ptarmigan, and potentially other arctic-alpine specialist birds, the monitoring of non-specialist bird species that are also found in arctic-alpine habitats could also inform of any changes in the condition of those habitats. Many volunteers who contributed to the pilot study in 2006 were able to identify a range of bird species. With appropriate training and provision of materials, the general skill levels could likely be increased to reliably include at least some other species, for example: Dotterel, Golden Plover, Meadow Pipit, Ring Ouzel, Snow Bunting and Wheatear.
- e) *Training needs* – Training events and materials could be designed specifically for providing to potential volunteers that are not currently experienced birdwatchers (including hillwalkers, estate staff) and marketed specifically to these groups. Whether or not funding were available for a dedicated mountain bird monitoring scheme, the training of this pool of additional bird survey volunteers in mountain bird identification and simple surveying could result in further valuable casual recording of montane species for projects like the BTO/BirdWatch Ireland /SOC Bird Atlas 2007-11 and the BTO/RSPB/BirdWatch Ireland BirdTrack (collecting data that often form the basis for the design of specific surveys of population size), and the further encouragement of such volunteers to gain skills for more systematic bird survey work.
- f) *Weather recording* – Given the significant influence of snow cover on the data collected by volunteers in 2006, more information on weather conditions and how these influenced the survey and survey routes would be informative and should be collected (e.g. using the simple BTO/JNCC/RSPB BBS coding system in addition to snow cover).
- g) *Seasonal coverage* – In 2006, the survey period (April to August inclusive) was constrained by project funding; it also aimed to coincide with the main breeding season for birds and periods when most hill walkers would be active but also avoid periods when access may be restricted because of deer stalking. An annual monitoring programme could potentially make use of data submitted at any time of year, as long as the potential complication of variation in detection rates in relation to snow cover is addressed. Indeed, detection rates could be increased if Ptarmigan were recorded during the winter (when their plumage is white) but when snow cover is low (as suggested previously by Watson 1965) but further calibration fieldwork would be required to assess to what extent detection rates could be increased in this way.

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TABLES

Table 1. The number of transects surveyed by volunteers (and the sum length of transect surveyed (km) in parentheses) in each Natural Heritage Zone (NHZ) in each month, April to August inclusive, 2006.

	April	May	June	July	August	TOTAL
Argyll	0	1 (3)	3 (20)	0	0	4 (23)
Cairngorms	29 (181)	37 (246)	48 (298)	39 (285)	20 (156)	174 (1168)
Central						
Highlands	6 (20)	11 (57)	10 (36)	5 (25)	3 (6)	35 (144)
East Lochaber	16 (69)	23 (79)	31 (165)	21 (117)	11 (44)	102 (473)
North-west						
Seaboard	7 (35)	15 (53)	6 (64)	12 (39)	2 (2)	42 (193)
North-east						
Glens	5 (9)	0	0	0	0	5 (9)
Northern						
Highlands	19 (78)	20 (186)	23 (128)	19 (132)	6 (19)	87 (542)
Peatlands of						
Sutherland	1 (1)	2 (5.5)	4 (8)	4 (145)	0	11 (28)
Trossachs and						
Breadalbane	17 (112)	6 (32)	18 (54)	15 (64)	16 (68)	72 (330)
Western						
Highlands	4 (15)	15 (54)	14 (96)	22 (55)	11 (45)	66 (264)
Western						
Seaboard	2 (5)	5 (9)	4 (6)	1 (3)	1 (3)	13 (26)
Western Isles	0	0	0	2 (5)	1 (8)	3 (13)
TOTAL	106 (523)	135 (724)	161 (875)	140 (739)	71 (350)	614 (3112)

Note: To permit analytical models to converge, the following NHZs were combined:

- Argyll with Trossachs and Breadalbane;
- Cairngorms with North-east Glens;
- North-west Seaboard with Peatlands of Sutherland;
- Western Seaboard with Western Isles.

Table 2. The numbers of Rock Ptarmigan counted by volunteer surveyors expressed as a proportion of the sum of all Rock Ptarmigan and Red Grouse seen within each Natural Heritage Zone (NHZ). These proportions were used to estimate the number of groups of faecal piles that were attributable to Rock Ptarmigan within each NHZ.

Natural Heritage Zone	Rock Ptarmigan as a proportion of all grouse species seen
Argyll	0.64
Cairngorms	0.73
Central Highlands	0.81
East Lochaber	0.97
North-west Seaboard	0.93
North-east Glens	0.75
Northern Highlands	0.94
Peatlands of Sutherland	1.00
Trossachs and Breadalbane	0.93
Western Highlands	1.00
Western Seaboard	1.00
Western Isles	1.00

Table 3. The relationships from generalised linear models assessing the influences of region, season, snow cover and poor weather on the detection rates of Rock Ptarmigan and 'ptarmigan sites' (a measure of abundance that includes faecal piles) by volunteer surveyors in Scotland, April to August 2006.

	BIRDS			SITES		
	χ^2	df	<i>P</i>	χ^2	df	<i>P</i>
Region	34.5	6	<0.001	59.0	6	<0.001
Month	2.1	4	0.72	19.1	4	0.001
Snow cover	3.7	4	0.46	12.3	4	0.02
Poor weather	0.1	1	0.75	0.02	1	0.90

Table 4. The relationships from generalised linear models assessing the influences of season and snow cover on the detection rates of Rock Ptarmigan and 'ptarmigan sites' (a measure of abundance that includes faecal piles) on systematically repeated survey transects carried out by professional ornithologists in Scotland, April to August 2006.

	BIRDS			SITES		
	χ^2	df	<i>P</i>	χ^2	df	<i>P</i>
Month	4.6	4	0.33	2.5	4	0.64
Snow cover	1.8	3	0.62	4.0	3	0.26

Table 5. The relationships from generalised linear models assessing the influences of region, season, snow cover and poor weather on the detection rates of Rock Ptarmigan and ‘ptarmigan sites’ (a measure of abundance that includes faecal piles) by volunteer surveyors within the four Natural Heritage Zones that also included repeated calibration transects surveyed by professional ornithologists, April to August 2006. A comparison with Table 3 shows similar influences to the full data set from all areas.

	BIRDS			SITES		
	χ^2	df	<i>P</i>	χ^2	df	<i>P</i>
Region	33.3	3	<0.001	49.9	3	<0.001
Month	4.4	4	0.35	18.6	4	0.001
Snow cover	3.5	4	0.48	9.8	4	0.04
Poor weather	1.9	1	0.17	0.0	1	0.95

Table 6. The mean detection rates of Rock Ptarmigan and encounter rates of ‘ptarmigan sites’ by volunteer surveyors with self-selected transects and by professional ornithologists with systematic repeated transects.

		Mean per km	95% confidence limits
Birds	Professional	0.16	0.08 – 0.33
	Volunteer.	0.25	0.18 – 0.36
Sites	Professional	0.57	0.36 – 0.91
	Volunteer	0.34	0.25 – 0.46

Table 7. The reporting rates of seven additional species for which volunteers were specifically asked to report.

SPECIES	No. of transects ¹	Reporting rate ² (%)	Reporting rates by professionals ³ (%)
Red Grouse	96 out of 547	18	32
Golden Plover	77 out of 489	16	48
Meadow Pipit	156 out of 442	35	89
Ring Ouzel	28 out of 480	6	18
Wheatear	84 out of 491	17	66
Raven	62 out of 483	13	45
Hooded Crow	7 out of 507	1	10

¹ The number of transects where a species was seen out of the total number of transects for which reports (positive or negative) for that species were given by volunteer surveyors.

² The percentage of transects where a species was seen as a proportion of the total number of transects for which reports (positive or negative) for that species were given by volunteer surveyors.

³ Data from transects within each of the 10 sites where systematically repeated transects were surveyed (Figure 2) are combined. Each species is recorded as either seen or not seen within each site in each month, representing a site visit. The total number of site visits in which a species was seen is expressed as a proportion of the total number of site visits made (n=44).

Table 8. Species additional to Rock Ptarmigan and those listed in Table 7 for which volunteers submitted reports.

SPECIES	No. of transects	SPECIES	No. of transects
Red-throated Diver	1	Herring Gull	2
Grey Heron	1	Common Gull	7
Sand Martin	1	Cuckoo	4
Grey-lag Goose	1	House Martin	1
Mallard	1	Swallow	1
Golden Eagle	25	Pied Wagtail	1
Buzzard	9	Grey Wagtail	2
Red Kite	2	Dipper	1
Kestrel	5	Stonechat	1
Merlin	2	Wren	1
Peregrine	7	Black-headed Gull	2
Dotterel	29	Swift	1
Lapwing	1	Skylark	8
Curlew	4	Twite	1
Greenshank	1	Snow Bunting	20
Snipe	2	Dunlin	13
Common Sandpiper	3	Black Grouse	4

FIGURES

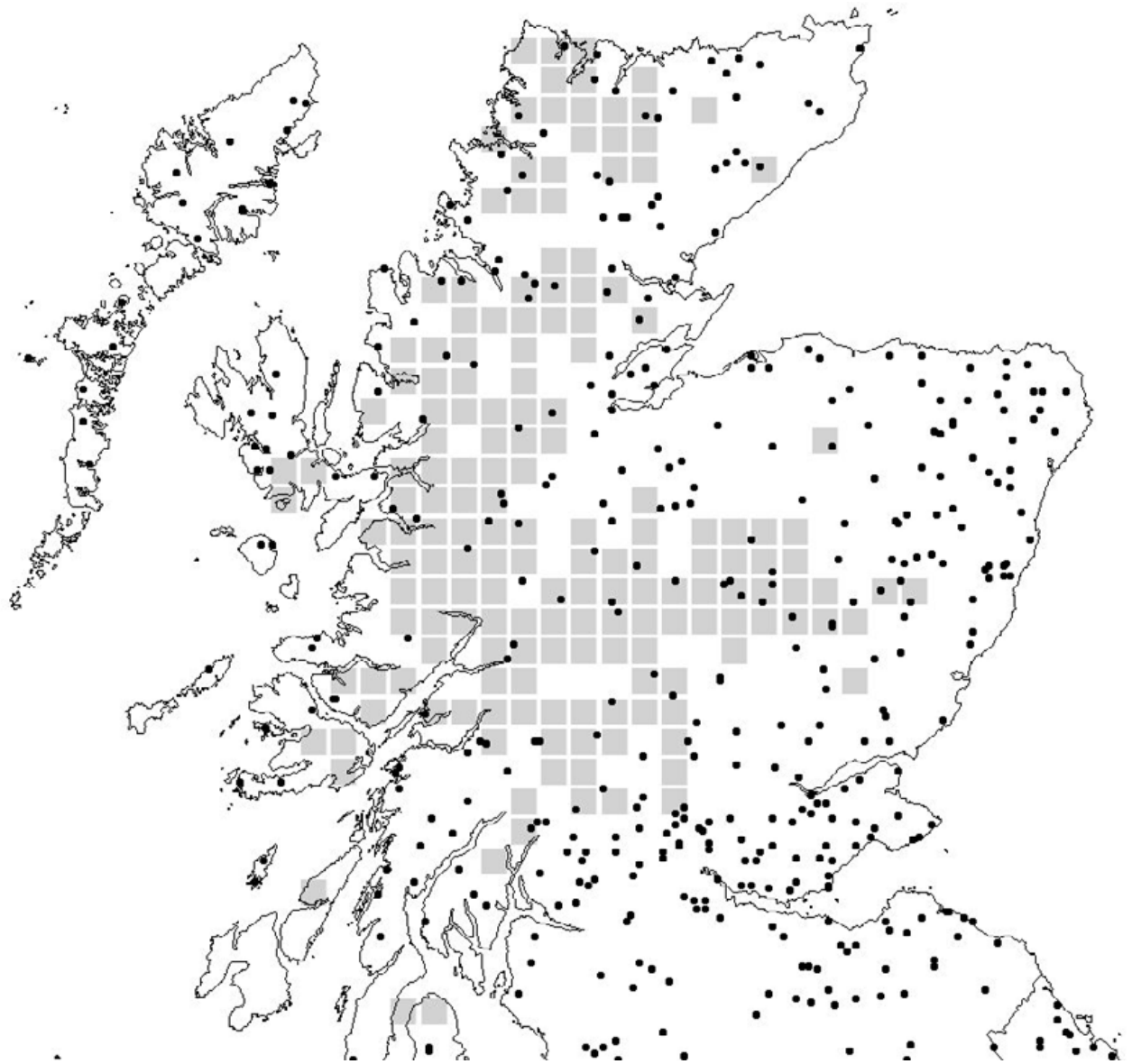


Figure 1. The distribution of 1-km squares included in the Breeding Bird Survey between 1994 and 2004 (black dots) and the distribution of Rock Ptarmigan in Scotland as reported during a national atlas of breeding birds in 1988-91 (grey squares representing the 10-km squares in Rock Ptarmigan were recorded; after Gibbons *et al.* 1993).



Figure 2. The locations of 10 sites (dots on the map) where calibration transects surveyed systematically in each of five months (April – August) by experienced professional ornithologists and the boundaries of Natural Heritage Zones in which Rock Ptarmigan are known to occur in Scotland.

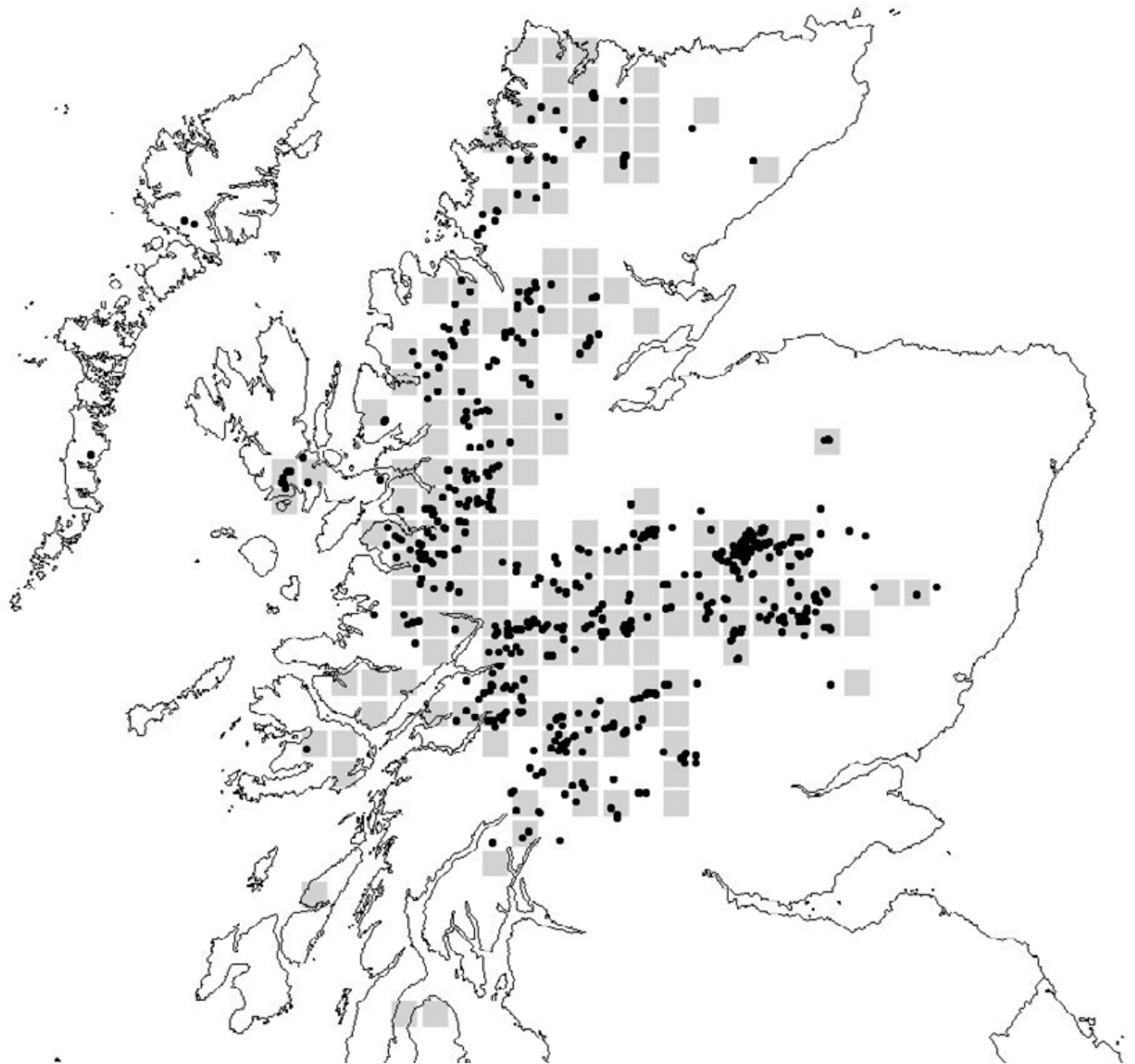


Figure 3. The distribution of survey returns from volunteers (black round dots representing the central points of survey transects; returns with and without records of Ptarmigan) and the distribution of Rock Ptarmigan in Scotland as reported during a national atlas of breeding birds in 1988-91 (grey squares representing the 10-km squares in Rock Ptarmigan were recorded; after Gibbons *et al.* 1993).

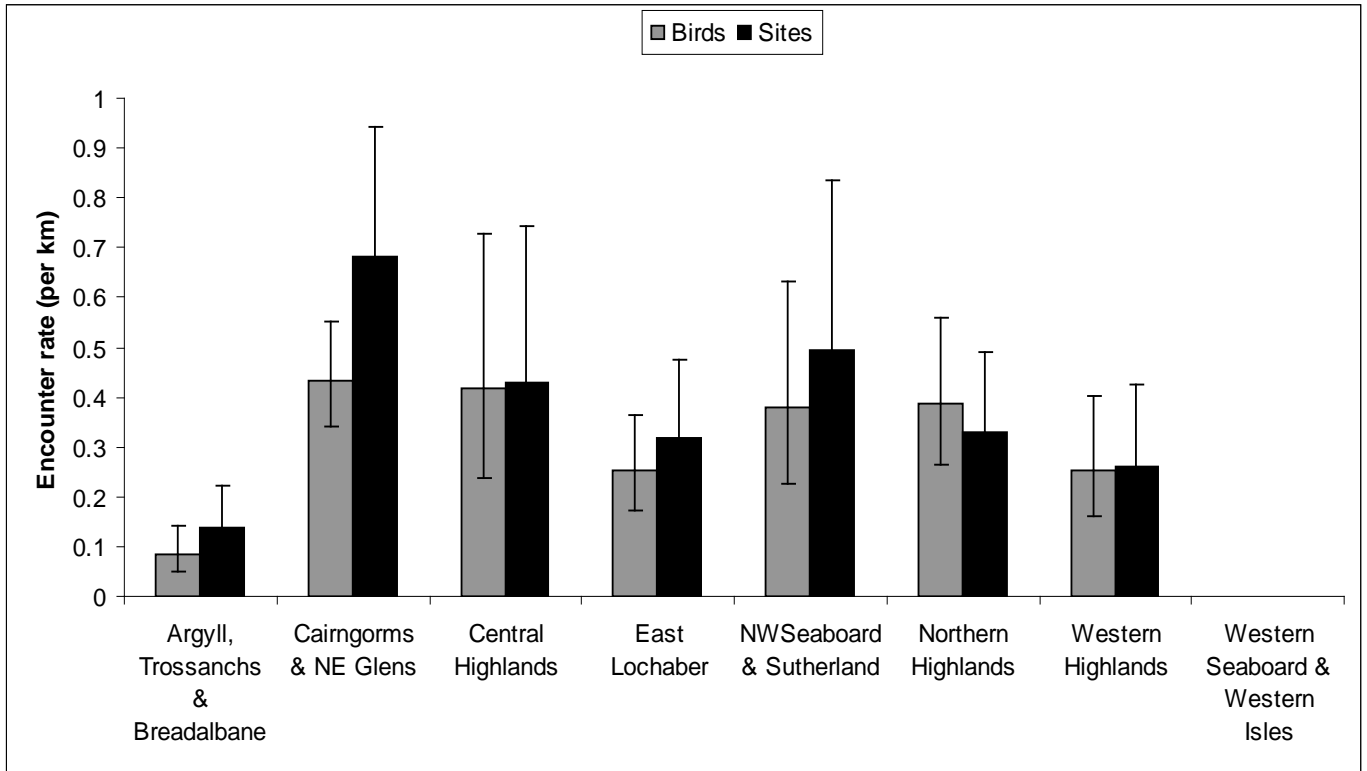


Figure 4. Encounter rates (means \pm 95% confidence limits) by volunteer surveyors of Rock Ptarmigan and 'ptarmigan sites' by volunteer surveyors within eight regions of Scotland during April to August 2006.

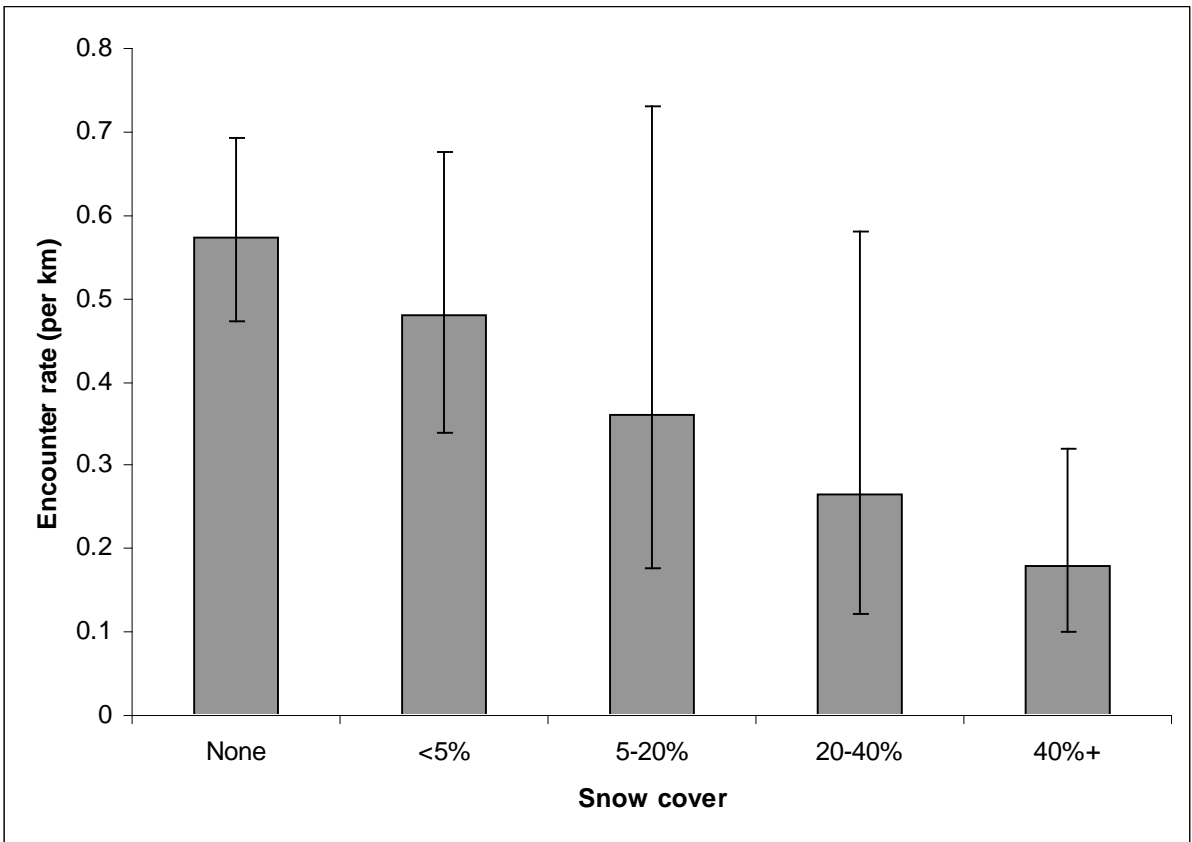


Figure 5. The encounter rates (mean \pm 95% confidence limits) of 'ptarmigan sites' by volunteer surveyors with different proportions of snow cover on the survey transects.

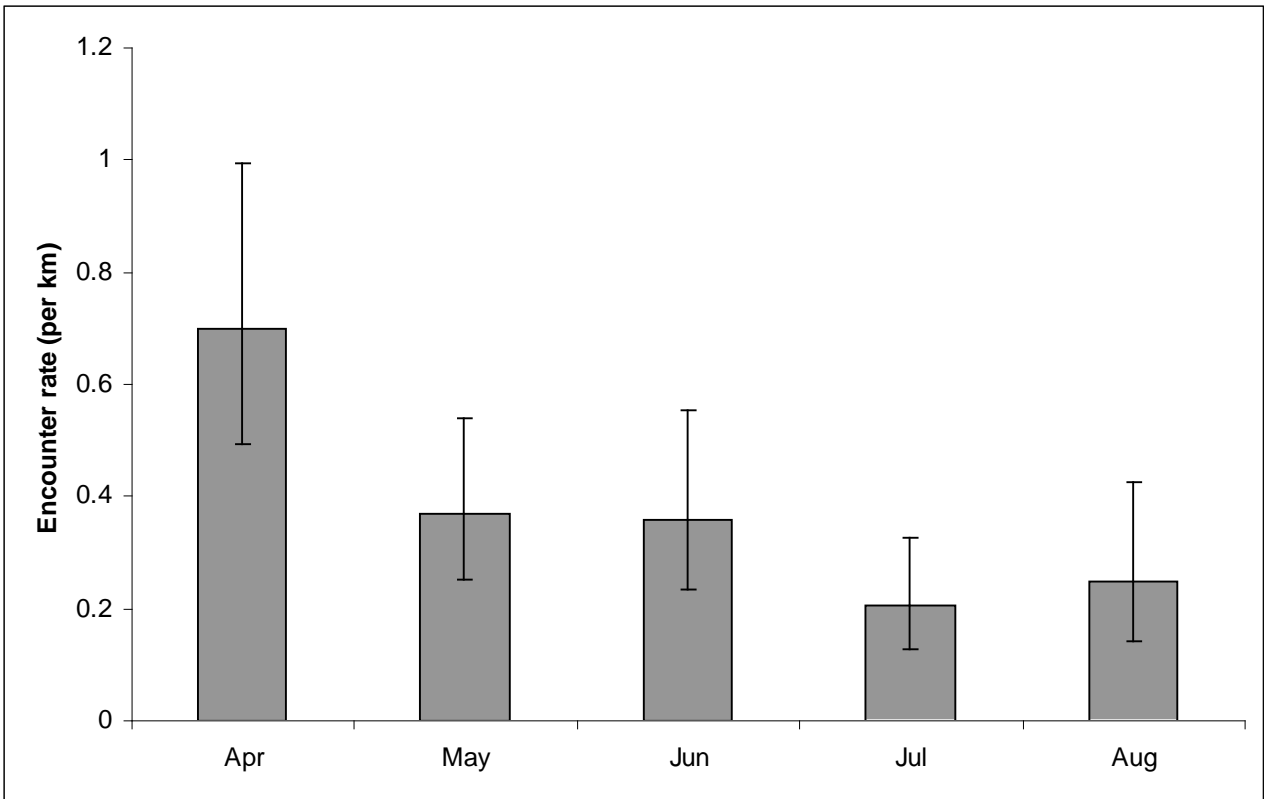


Figure 6. The encounter (mean \pm 95% confidence limits) rates of 'ptarmigan sites' by volunteer surveyors in each of the five months, April to August, 2006.

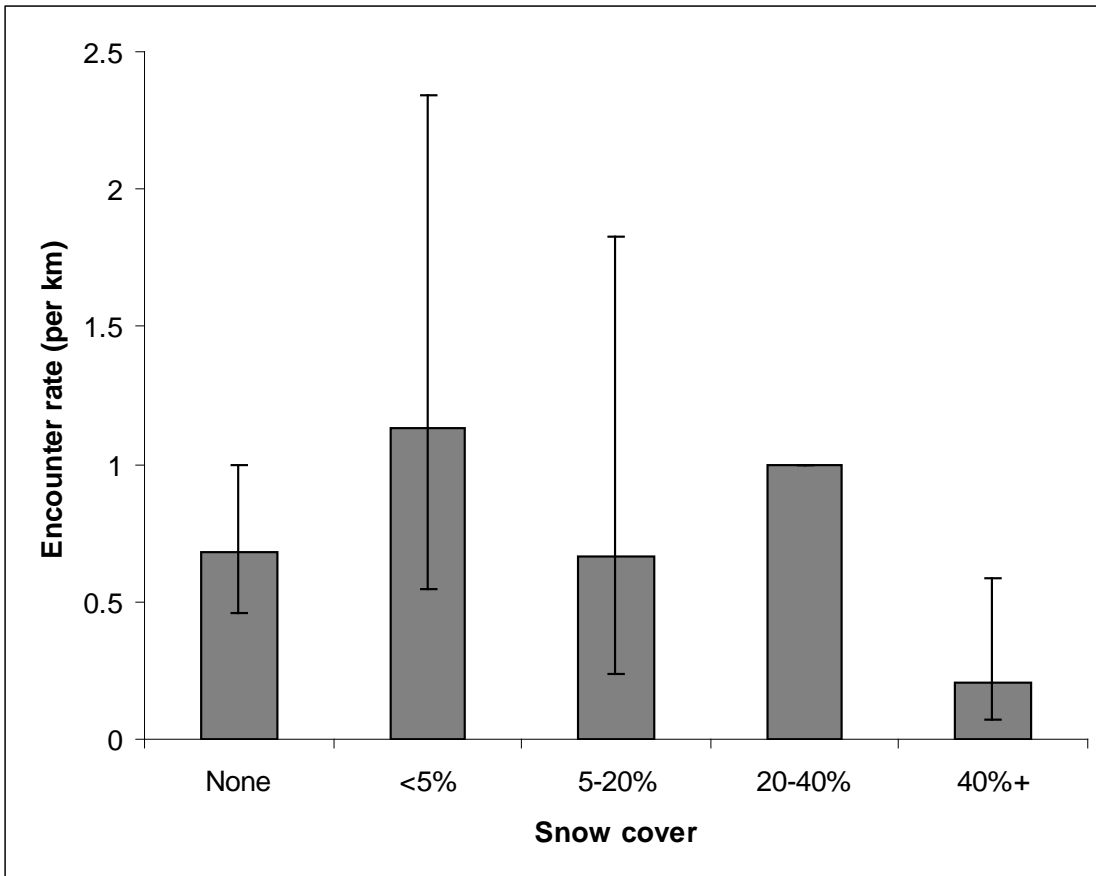


Figure 7. The encounter rates (mean \pm 95% confidence limits) of 'ptarmigan sites' during systematic calibration surveys with different proportions of snow cover on the survey transects.

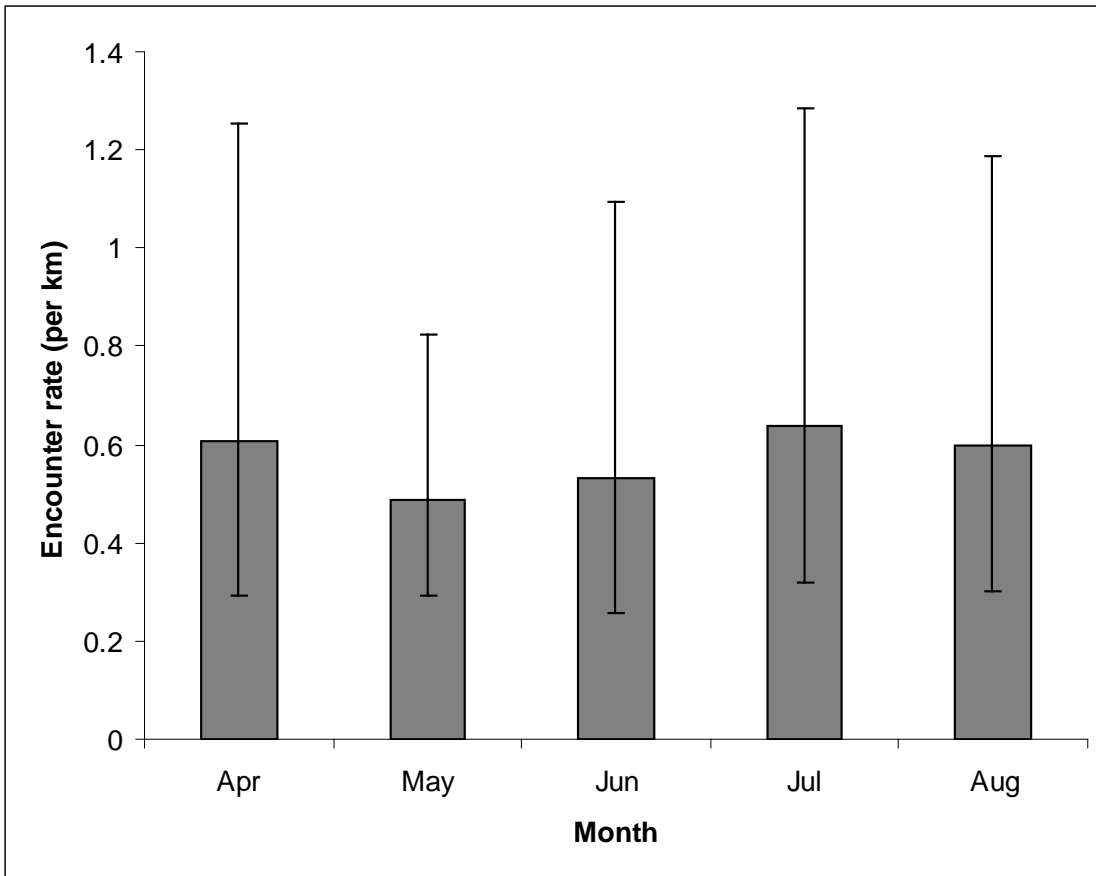


Figure 8. The encounter (mean \pm 95% confidence limits) rates of 'ptarmigan sites' during systematic calibration surveys in each of the five months, April to August, 2006.

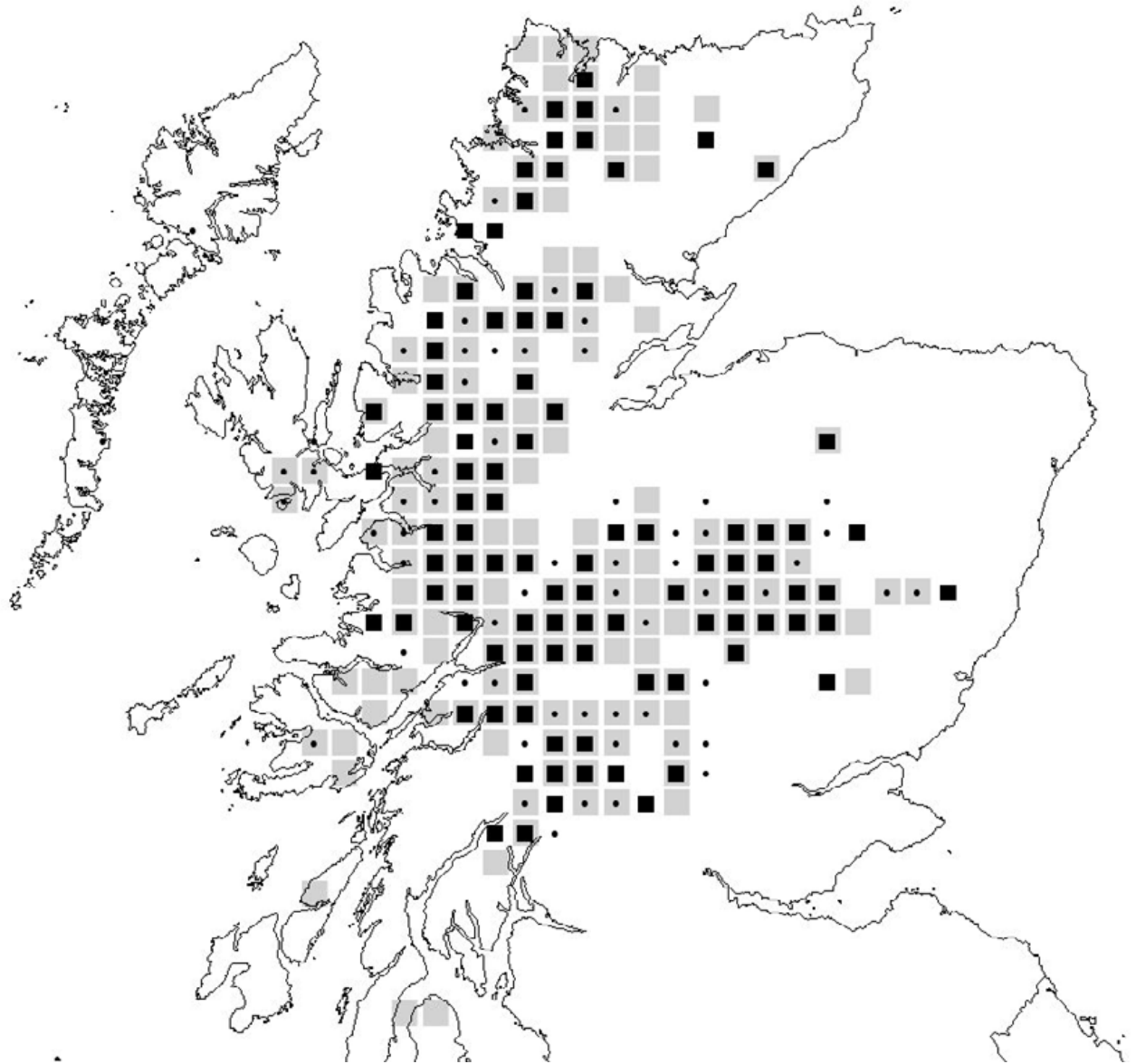


Figure 9. The distribution of survey returns from volunteers by 10-km square. The black squares represent 10-km squares in which volunteers saw Rock Ptarmigan or evidence of their presence (faecal piles or cast feathers) in 2006. The small black dots represent 10-km squares surveyed by volunteers in which no birds or their signs were detected. The distribution of Rock Ptarmigan in Scotland as reported during a national atlas of breeding birds in 1988-91 is shown by the larger grey squares (after Gibbons *et al.* 1993).

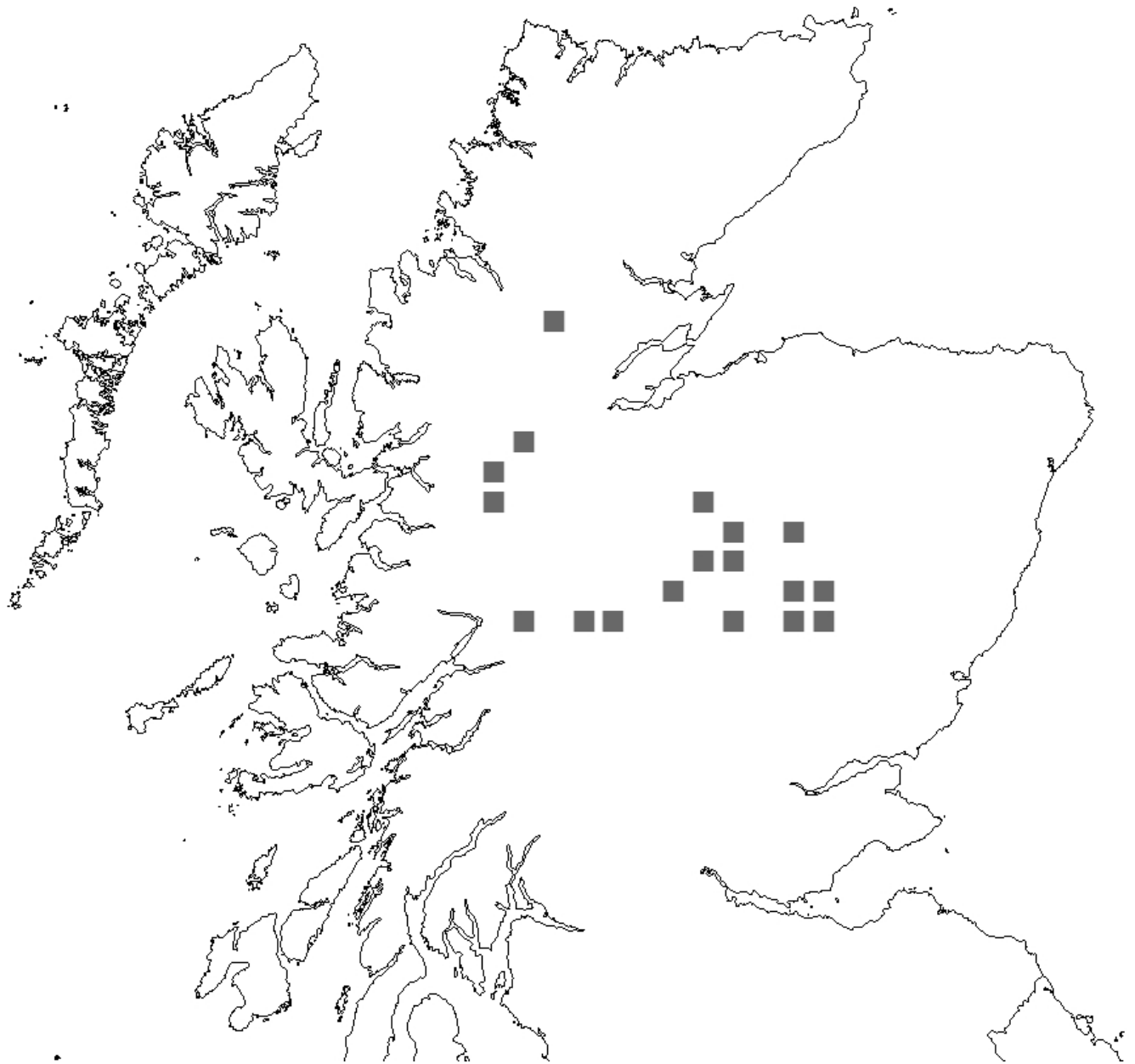


Figure 10. The distribution of 10-km squares where Dotterel were reported by volunteer surveyors, April – August 2006.

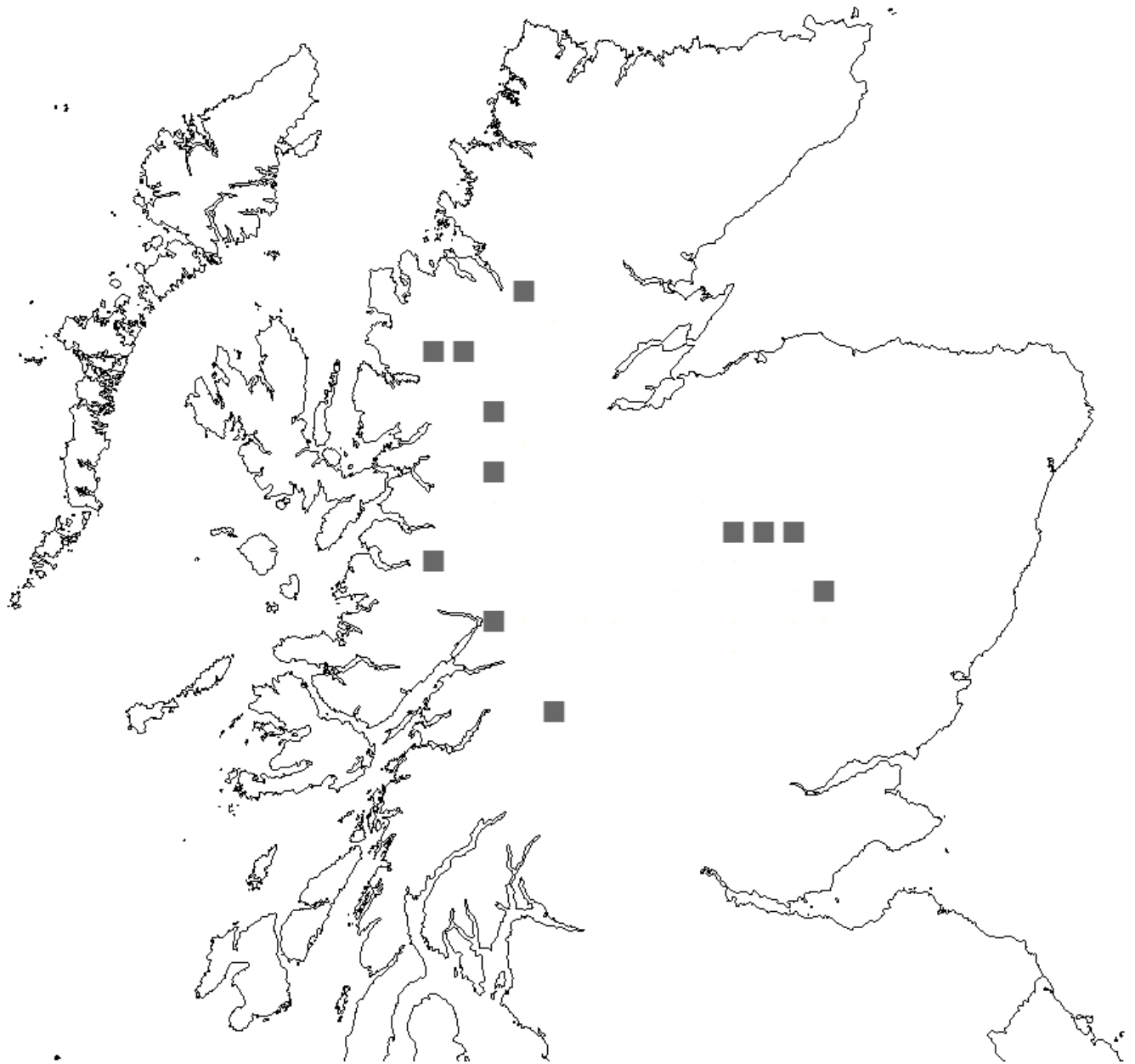


Figure 11. The distribution of 10-km squares where Snow Buntings were reported by volunteer surveyors, April – August 2006.

APPENDICES

Appendix 1. List of newspapers, magazines and newsletters that published articles to publicise Project Ptarmigan.

BTO News
Bird Clubs Partnership Newsletter
Birdwatching Magazine
Buchanan Voice
Daily Telegraph
East Locharside News
Evening Express
Glasgow Herald
Glasgow HF Outdoor Club Newsletter
Highland News
Lochaber News
Loch Lomond and Trossachs News
Ochils Mountaineering Club Newsletter
Ptarmigan Mountaineering Club Newsletter
Press and Journal
Scottish Biodiversity Forum
Scottish Bird News
Stirling Observer
TGO – The Great Outdoors
The Lennox
The Scottish Mountaineer
World Pheasant Association News

Appendix 2. The Information Sheet given to volunteer surveyors in 2006.

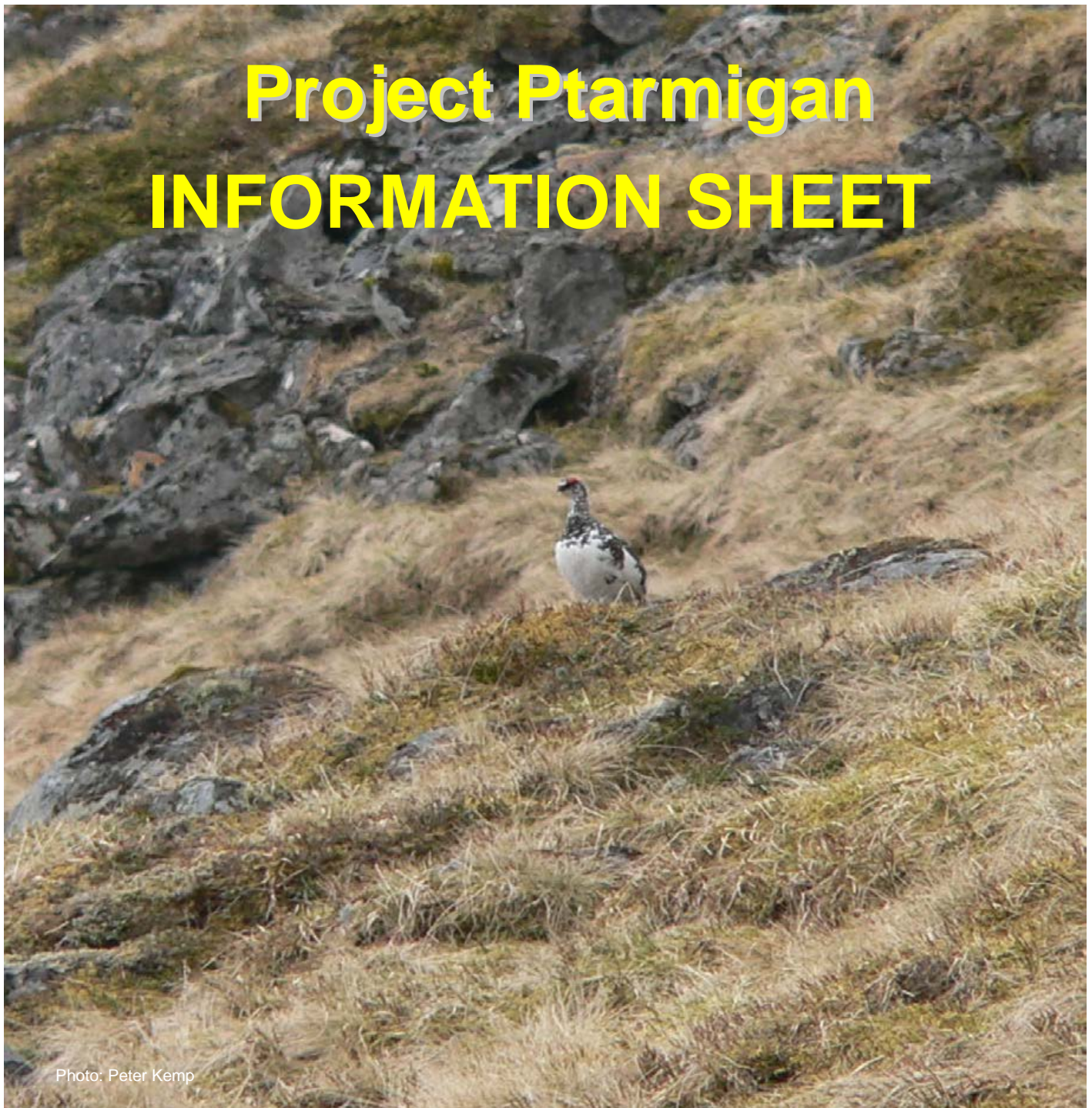
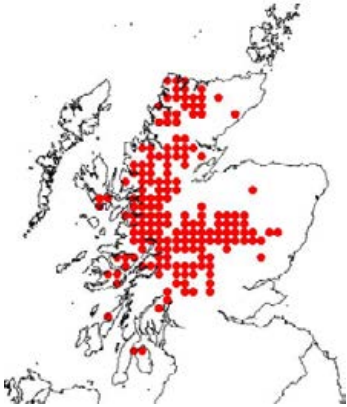


Photo: Peter Kemp

Thank you for volunteering to take part in Project Ptarmigan. This sheet gives some background to the project as well as information on how to identify Ptarmigan and recognise signs of their presence. Other sheets in the Project Ptarmigan pack are the 'Instructions for Participants', the 'Recording Form' and 'Health & Safety Advice'. It is the Recording Form that we would like returned with information on what you have seen in the hills.

BACKGROUND



predation.

Rock Ptarmigan are found right across the tundra zone of northern Eurasia and North America. In Scotland, it is represented by a subspecies found nowhere else, *Lagopus mutus millaisi*. They are found in the arctic-alpine zone, mostly on the higher hills, and are the only resident and reasonably widespread bird in Britain that can be described as a true montane specialist. Any changes in their numbers or distribution will be a useful indicator of change in the condition and quality of the mountain environment. Amongst the broad factors that are likely to influence these areas, and the birds that live in them, are changing climate and weather patterns, disturbance, grazing and

Ten-km squares in which Ptarmigan were recorded during the 1988-91 Breeding Bird Atlas

(see www.bto.org/atlasses)

WHERE DO YOU FIND PTARMIGAN?

As far as we know, Ptarmigan are currently found across the Highlands and on the islands of Skye, Mull, Jura and Arran. In general, they are found at over 750m above sea level but can be found at lower altitudes in exposed areas in the north-west, even as low as 200 m in north-west Sutherland. They are found on high summit heaths (shown on cover) and rock-strewn fell fields where the natural vegetation is general less than 15cm tall.

They mainly eat the shoots and leaves of ericaceous plants and dwarf willow, but berries can be important in autumn. In some especially favoured areas, as many as 50 adult Ptarmigan can be found in each square kilometre, but over much of their range, they are much scarcer.

A long-term study in the Cairngorms has shown that populations can cycle with highs and lows at roughly 10-year intervals. These fluctuations are probably influenced and modified by factors such as weather and geology. It is not known how Ptarmigan numbers vary across the majority of their range in the Highlands, however. Although Ptarmigan populations have not been monitored effectively across Scotland, there is evidence of some long-term decline. The species formerly bred in southwest





Scotland, becoming extinct there during the 19th Century. Populations on Harris, Rum and Hoy have similarly disappeared in the early 20th Century.

WHAT DO PTARMIGAN LOOK LIKE?

Ptarmigan are rather plump gamebirds that measure around 35 cm from bill to tail. They show marked seasonal variation in plumage. In winter they are mostly white. In spring they can be strikingly pied, white and grey.



Through the summer, the plumage becomes progressively greyer with some darker blotches and a fine scaled appearance, though the wings and underbody remain mostly white all year. This is one of the easiest characteristics from which to distinguish Ptarmigan from Red Grouse.

In spring and summer, female Ptarmigan have a more yellow ground colour to their grey plumage compared to the males. These different plumages provide good camouflage against the rocks and lichens in summer and snowy slopes in winter.



CONFUSION SPECIES



The only species that could be confused with Ptarmigan is the Red Grouse. Although Red Grouse tend to occur at lower altitudes (in areas with more extensive and taller heather cover) they can be found very close to each other in many areas. Red Grouse are slightly larger, though this may not be noticeable in the field. Their plumage is darker brown and they lack the distinctive white underbody and wings of Ptarmigan. The Red Grouse call is a loud, almost human-like cackle, commonly transcribed as 'go-back, go-back'. Red Grouse do not turn white in winter.

Red Grouse droppings look the same as those of Ptarmigan and therefore there is a risk that grouse droppings may be mistaken for those of Ptarmigan. This is why we would also like to know how many Red Grouse you see on each Ptarmigan Transect.

OTHER SIGNS OF PTARMIGAN



In addition to being well camouflaged, Ptarmigan are quite confident and it is quite normal to only become aware of their presence when within a few metres of them. Not infrequently, their presence is given away by their calling and also by their droppings or feathers. The most frequently heard call is a low-pitched rattling call, reminiscent of a drawn out human burp or the sound of pulling a stick across the slats of a picket fence. The call can be difficult to locate, especially in breezy conditions.



For *Project Ptarmigan* an index of Ptarmigan abundance will be developed. This will use both counts of birds seen, or heard, and by recording the distribution of their droppings. Ptarmigan droppings do not look like typical bird droppings, they are quite fibrous, almost looking like compacted sawdust.

Ptarmigan droppings can be found either singly, in small piles or in quite extensive clusters of piles. They are cylindrical, in the order of 5 to 20 mm long and about 2 to 5 mm in diameter, though this can vary depending how dry and shrunken or how wet and swollen they have become.

Characteristic white feathers can sometimes be found amongst the droppings (e.g. in the photo above).

COLLECTING PTARMIGAN FEATHERS



Photo: Peter Kemp

We are hoping to glean further information about Scottish Ptarmigan through analysis of the genetic material in their feathers. Although not a principal part of *Project Ptarmigan* we will be extremely grateful for any Ptarmigan feathers collected in Scotland. Feathers should be placed in small plastic bags or paper envelopes in the field and labelled with a six-figure reference, date and name of the hill, or nearest hill where it was found. The important part of the feather is the tip where it sticks into the skin. When handling feathers,

please avoid touching this part. Please keep feathers from different birds in separate bags or envelopes. Only put feathers together if you are absolutely certain they came from the same bird, for example if you found the remains of a kill on the hill.

Project Ptarmigan, BTO Scotland, School of Biological and
Environmental Sciences
Cottrell Building, University of Stirling, Stirling, FK9 4LA.
Telephone: 01786 466 560
Email: scot.info@bto.org
Web: www.bto.org



Project Ptarmigan

1st April – 31st August 2006



INSTRUCTIONS FOR PARTICIPANTS

BACKGROUND

The Ptarmigan is the only resident truly montane bird in Britain. It occurs in the Scottish Highlands and also on a few islands of the Hebrides and Clyde. In general, they are found at over 750 m above sea level (asl) but can be found at lower altitudes especially in exposed areas in the north-west. As a year-round resident of the high ground it makes an ideal indicator for environmental change in montane habitats. Ptarmigan are not currently monitored effectively across their range in Scotland. For more information on Ptarmigan, please refer to our *Ptarmigan Information Sheet*.

AIMS OF PROJECT PTARMIGAN

In 2006 we are inviting a broad range of hill users to contribute to the first extensive collection of information on Ptarmigan throughout Scotland. You do not need previous experience of bird surveys to help – anyone out in the montane areas of Scotland can provide useful information and we welcome your help. The long-term aim will be to measure any changes in Ptarmigan abundance and distribution as an indicator of the environmental condition, and the effects of management practices, of montane areas in Scotland.

PROJECT METHODS

There are three options to collect information for *Project Ptarmigan*:

- i) Simply record the number of Ptarmigan seen and the number of 'sites' with evidence of their presence along a recorded route or 'Ptarmigan Transect'.
- ii) As above but additionally include an element of stop-and-searching.
- iii) As i) but additionally record the numbers of all bird species seen along the recorded routes.

Where to survey

We welcome information from anywhere in the range of Ptarmigan in Scotland (see the *Information Sheet*). Participants can choose which hills they wish to survey. If you are flexible, however, we would especially welcome information from (a) the Trossachs (the southern Highlands), (b) from Wester-Ross and Sutherland (the north-west Highlands) and (c) from the 'greater Cairngorms' area (that is between the hills above the Angus Glens in the east to those around Loch Laggan in the west). Birds in these different areas could show contrasting responses to environmental change.

When to survey

The main survey period will run from 1st April to 31st August 2006. We welcome information from anytime within that period. We would also be interested in reports from the same 'Ptarmigan Transect' at different times or from different transects on the same hill.

Planning a Ptarmigan Transect

Participants should select and plan their own Ptarmigan Transects, or survey routes, but it is important to record the transect on the *Record Form*. Aim to include at least 4 km at altitudes greater than 750 m (or about 2,500 feet) above sea level, though this may not always be possible. In some areas, Ptarmigan will be found at lower altitudes, especially in the north-west Highlands. If you see any Ptarmigan on the 'walk in' to higher ground, please start recording at that lower level.

Transects should be planned, using minimum scale 1:50,000 topographical maps (1:25,000 maps, e.g. the Ordnance Survey Explorer Series, are probably the ideal option if you have them). Plan your routes to avoid crags or other dangerous topography. Within these constraints, try and make your Ptarmigan Transect a series of straight(-ish) lines. This will aim to sample representative areas of montane habitat and minimise potential biases by choosing the most used routes to the summits. Of course, when walking in the hills, with steep slopes to ascend and descend, and rocks, snow patches and other features to avoid, walking an ideal straight line will be impractical. In effect, you will zig-zag or meander either side. It is expected that many people will necessarily have to wander up to 50 m either side of their 'ideal' transect. In addition Ptarmigan Transects will often need to be convoluted in order to achieve 4 km on some hills or to avoid crags and also to achieve a practical, and enjoyable, circular route. Where this is the case, try to keep more than 50 m away other sections of the route. On narrow ridges, for example, this may not be possible. An example of route, and how it is recorded is given on this sheet.

Rather than planning a Ptarmigan Transect in advance, you may wish to simply record a route you have walked, but try to follow the above guidelines while on the hill.

WHAT TO RECORD

Please use the *Recording Forms*. Feel free to contact the BTO Scotland office for more forms if you need them or to photocopy one of those provided. As well as the birds, please ensure you record the date of each survey walk you undertake and also the route.

a) *Your name and address.*

b) *Date and times of your Ptarmigan Transects* - The start and end times are those when you reach and leave 750 m asl, or otherwise start recording if you find Ptarmigan below that height.

c) *Details of your Ptarmigan Transect*

This can be done in one of two ways, or if you wish, use both:

- i) Write a series of six figure grid references for the start, end and for each turning point of your Ptarmigan Transect (see the example).

OR

- ii) Send a photocopy of a map with your route drawn on it – please ensure the start point has a 6-figure reference in order for us to locate where it is.

Please try and calculate the length of your Ptarmigan transect.

d) Recording birds and their signs – Count all the Ptarmigan you see or hear along your Transect. Also count the number of 'Ptarmigan Sites' you encounter along the route. If you encounter a brood of young Ptarmigans, please count each young bird as a separate individual. Additional information on how many birds were young, and brood sizes can be included in the *Additional Information Box* on the Recording Form (Part j).

A single *Ptarmigan Site* is either a single bird, a group of birds, one pile of droppings, many piles of droppings or any combination of these (see the *Information Sheet* for descriptions and photographs of birds and dropping piles). Piles of droppings can be found in clusters, and naturally can be close to birds. Where birds, or droppings, are scattered take a minimum gap of 20 m along your route where you do not see any as the separating distance between different *Ptarmigan Sites*. In the event such *sites* extend for more than 20 m please call each 20 m section a separate *Ptarmigan Site*.

Please record whether or not you saw any Ptarmigan feathers on your transect, but do not include just feathers as a counted *Ptarmigan Site*.

Please note that nil returns, that is, the reporting of a survey route on which you did not see any Ptarmigan or any other evidence of their presence, are just as important as positive reports. We are expecting quite a lot of nil returns. Even if you walked several Ptarmigan Transects and found no evidence of birds on any of them, this information is very important.

e) Weather and Snow cover – As the recording of Ptarmigan droppings are a key part of the surveying procedures, it is important to estimate the proportion of each survey route that was covered with snow and potentially obscuring any signs of their presence.

f) Red Grouse – Where these two species overlap, there is a real risk of confusing droppings of the two species (as far as we are aware, they are inseparable by sight). Therefore we ask that the number of Red Grouse seen along a survey route is also recorded – this will give some idea of the proportion of droppings and *Sites* that may actually refer to Red Grouse. How to identify Red Grouse is described in the *Information Sheet*.

g) Other species – The *Recording Form* lists an additional six species that you may encounter on a Ptarmigan Transect. Please tick these if you saw or heard any of these species **or leave blank** if you are not certain whether or not you saw any.

ADDITIONAL INFORMATION YOU MAY WISH TO RECORD

Sections (a) to (g), above, list the simplest and minimal information we would like to collect. If you are inclined, and have a broader knowledge of birds, please consider recording the following:

h) Stop and search recording (optional) – For each 1 km of survey route walked, choose a point where you can comfortably stand, or sit, with a reasonable view of your surroundings. For 10 minutes carefully scan the surrounding area with binoculars for Ptarmigan and listen for calling birds. Please record any birds that are *additional* to those seen while walking separately on the relevant part of the *Recording Form*.

i) Recording species other than Ptarmigan and Red Grouse (optional) – This is **not** an essential part of the project, but if you know your birds, we would welcome counts of all

species seen during your survey walk(s). Please include birds seen only in flight, as well as those on the ground, and at any distance from the transect.

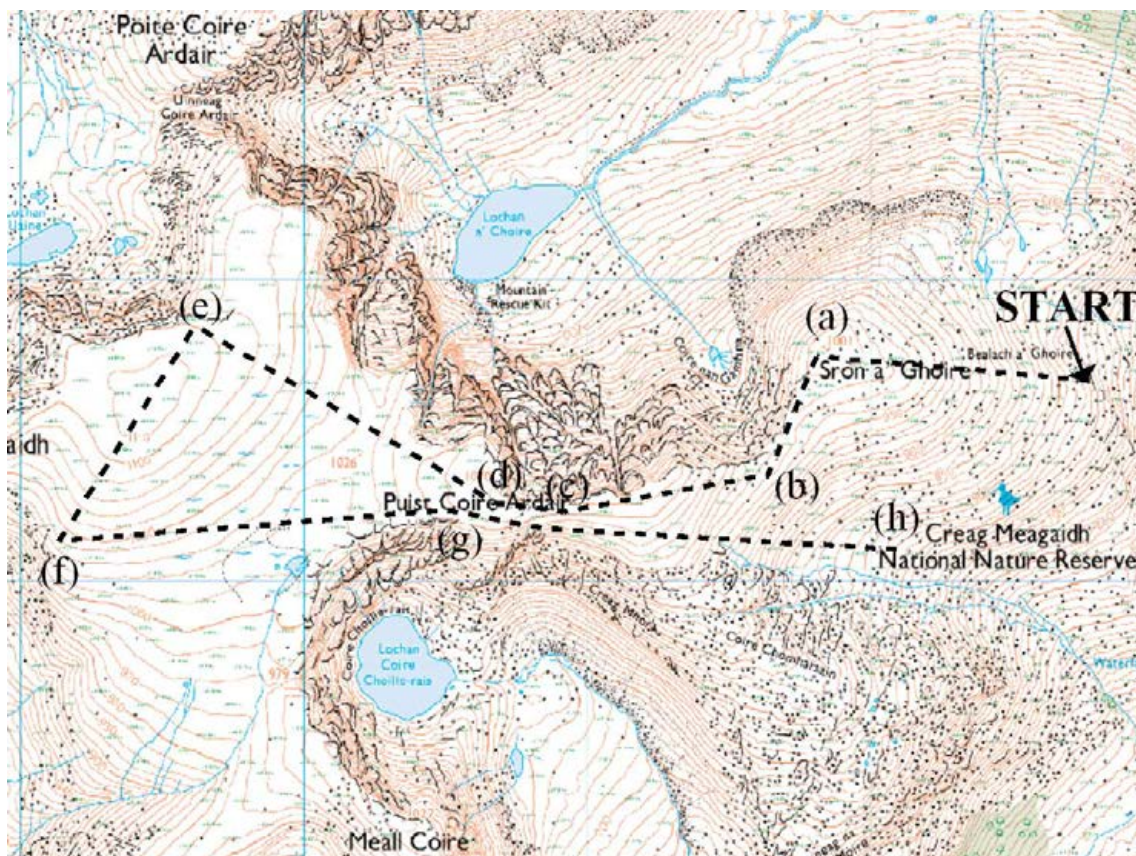
j) Other people (optional) – If possible, could you report a count, or estimate of the number of people you saw within 100 m of your Ptarmigan Transect.

k) Locations of birds and details of any nests and broods encountered (optional) – Please use the **Additional Information Box** to record any additional details of the birds you encounter. This can include their precise locations (6-figure grid references), the composition of flocks (e.g. the numbers of either sex and of young birds), brood sizes or nest contents where these are encountered.

SAFETY and COURTESY

For general advice, please refer to the BTO's 'General health and safety advice to volunteer fieldworkers' leaflet. Volunteer surveyors are also reminded to follow the Scottish Outdoor Access Code (www.outdooraccess-scotland.com).

EXAMPLE OF A SURVEY ROUTE:



c) PTARMIGAN TRANSECT DETAILS

Starting point of the Ptarmigan Transect (6-figure grid reference): NN458876

Length of survey route: ...6.8... km

List the grid references at all turning points* of your Ptarmigan Transect:

a) NN448877	h) NN451871 (Finish)	o)
b) NN447874	i)	p)
c) NN439873	j)	q)
d) NN437873	k)	r)
e) NN426879	l)	s)
f) NN421872	m)	t)
g) NN435872	n)	u)

Project Ptarmigan is run by BTO Scotland in partnership with the Scottish Ornithologists' Club and has been supported by the Scottish Executive's Biodiversity Action Grant Scheme, the AEB Trust and the Scottish Mountaineering Trust



SCOTTISH EXECUTIVE





Project Ptarmigan

1st April – 31st August 2006



RECORDING FORM

Thank you for taking part in *Project Ptarmigan*. Please read the accompanying instructions before completing this form. Please complete one form for each Ptarmigan Transect (each walk within Ptarmigan range, normally starting and ending at 750 metres).

If you would like more forms, either photocopy this one, download copies from the web site (www.bto.org/survey/special/ptarmigan/ptarmigan.htm) or from BTO Scotland (address at bottom of this page).

Please send ALL completed forms back, including those for transects where you did not see Ptarmigan. It is just as important that we know where Ptarmigan are absent as where they are present.

a) YOUR NAME & ADDRESS

Name: _____

Address: _____

Post Code: _____

b) TRANSECT DATE & TIME

Date of survey: _____ / _____ / 2006

Starting time*: _____ Finishing time*: _____

* Time (BST) at the start and end of the Survey Route – do not record your 'walk-in' times.

Please return your completed form to:
 Project Ptarmigan, BTO Scotland, SBES, University of Stirling, FK9 4LA.
 Telephone: 01786 466 560
 Email: scot.info@bto.org

c) PTARMIGAN TRANSECT DETAILS

Starting point of the Ptarmigan Transect* (6-figure grid reference):

* This is the point where you reach 750 metres above sea level or where you first see a Ptarmigan if lower than 750 m.

Length of survey route: _____ km

List the grid references at all turning points* of your Ptarmigan Transect:

a)	h)	o)
b)	i)	p)
c)	j)	q)
d)	k)	r)
e)	l)	s)
f)	m)	t)
g)	n)	u)

* Please only include 'major' turning points and not every meander or zig-zag. Continue in the Additional Information box if you wish. If you wish, attach a map of your Survey Route to this form. See 'Planning a Ptarmigan Transect' in the Instructions sheet.

d) RECORDS OF PTARMIGAN

Number of individual Ptarmigan on your transect: _____

Number of *Ptarmigan Sites encountered on your transect:** _____

* Please refer to survey instructions for definition of a *Ptarmigan Site* (under 'Recording birds and their signs')

If you did not see any Ptarmigan or any Ptarmigan droppings, did you see any Ptarmigan feathers?

(Please delete as appropriate)

YES / NO

OPTIONAL RECORDING

h) STOP AND SEARCH RECORDING

How many 'Stop and Search' points did you include on your transect?

How many *additional* Ptarmigan were seen during timed 'Stop and Searches' along the Ptarmigan Transect?

If you undertook this optional part of the survey, and did not record any extra Ptarmigan please write 'NONE' in the space.

i) COUNTS OF OTHER SPECIES

Please give numbers of all species of birds seen from the Ptarmigan Transect. If any numbers are estimated, please indicate by inserting 'c' before the number e.g. c. 30.

Species	Number	Species	Number

j) OTHER PEOPLE

How many other people did you see within 100 m of your Ptarmigan Transect?

k) ADDITIONAL INFORMATION

Please use the space below to include any additional details you feel are relevant.

Project Ptarmigan is run by BTO Scotland in partnership with the Scottish Ornithologists' Club and has been supported by the Scottish Executive's Biodiversity Action Grant Scheme, the AEB Trust and the Scottish Mountaineering Trust



SCOTTISH EXECUTIVE

