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A Pilot Study to Test the Efficacy of Field Methods for Wide Scale Monitoring of Ptarmigan in Scotland

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CONTENTS

Page No.

LIST OF TABLES

Page No.

LIST OF FIGURES

Page No.

Summary

1. The Ptarmigan is the only resident montane specialist bird that is widespread through the Highlands of Scotland. As such, it is predicted to be a key species for monitoring the environmental condition of those montane areas.

2. This report describes a pilot study to test the efficacy of simple methods for assessing temporal and spatial variation in the abundance of Ptarmigan in Scotland. The methods aimed to be suitable for general hill users, who do not necessarily have specialist bird knowledge or previous experience of quantitative ornithological surveys.

3. In 2005, a total of 125.2 km of transects were walked at over 750 m a.s.l. across areas of the central and southern Highlands. Encounter rates of Ptarmigan were low, with a mean 0.5 birds per km of transect. An index of abundance was developed that included dropping piles as indicators of the presence of Ptarmigan gave a mean of 0.7 'sites' per km of transect. Significant differences in the abundance index were found between groups of survey sites based on fragmentation of available habitat. Ptarmigan were most abundant where extensive suitable habitat occurred and least abundant where habitat was more fragmented and at the southern periphery of their distribution. We conclude that temporal trends are likely to be detectable using the same or similar survey methods over a number of years but the analytical approach may need to be modified dependent on the distribution of any long-term data set collected.

4. A wider project in 2006 will encourage volunteers to collect data from numerous locations in the Highlands to test the efficacy of using the general hill-using public to collect long-term data on montane birds, notably Ptarmigan.

1. INTRODUCTION

1.1 Montane Birds in Scotland

Lying above the natural tree line, montane habitats in Britain form an isolated outlier of the European arctic-alpine zone that occupies approximately 3% of Britain's land surface (Thompson & Brown 1992). By far the greatest expanse of this habitat in Britain is found in the Scottish Highlands. In Britain, there are only four species of bird that are arctic-alpine zone 'specialists': Ptarmigan *Lagopus mutus*; Dotterel *Charadrius morinellus*; Purple Sandpiper *Calidris maritime*; 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). Dotterels are more numerous, with an estimated 630 breeding males in Britain in 1999 (Whitfield 2002a). Dotterels 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. Ptarmigan, on the other hand, are resident in their montane 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 Ptarmigan distribution and abundance in Scotland could form an appropriate indicator of environmental change in montane habitats.

1.2 Ptarmigan – Their Distribution and Historical Change in Britain

The Ptarmigan has a circumpolar distribution across northern Eurasia and North America. In Europe, there are isolated southern populations in the Pyrenees, the Alps and in Scotland. The endemic subspecies *P. m. millaisi* occurs in Scotland (Cramp & Simmons 1983, McGowan *et al.* 2003). In Scotland, Ptarmigan are found widely in the Highlands and also on some islands of the Hebrides and Clyde (Gibbons *et al.* 1993; Figure 1). Although populations have not been monitored effectively across Scotland, there is evidence of some long-term decline. The species formerly bred in south-west Scotland becoming extinct there during the 19th Century (Thom 1986). Isolated populations on Harris, Rum and Hoy were thought to have similarly gone extinct in the early 20th century. Although Ptarmigan will have formerly occurred in England, information on the species' status in historical time is scant (Brown & Grice 2005).

Between 1968-72, during extensive fieldwork for the first national ornithological atlas, Ptarmigans were recorded in 195 10-km squares (Sharrock 1976). During a repeat atlas covering 1989-91, this total was reduced by 11% to 173 (Figure 1, Gibbons *et al.* 1993) suggesting a continued contraction of range. The reappearance of birds on Arran and on Jura during the latter atlas, does suggest either that some recolonisation may have occurred (Thom 1986), or that they were missed there during the first atlas. An attempt at reintroduction into the Southern Uplands during the 1970s was apparently unsuccessful in that there was no resultant sustainable population (Thom 1986).

Long-term declines may be related to climate amelioration exacerbated by the resulting fragmentation of suitable habitat. More recent causes of change have been associated with higher grazing intensities leading to the loss of ericaceous food plants (Watson & Rae 1993), and human disturbance and the associated increased predation (Watson & Moss 2004). Numbers of Ptarmigan are also known to cycle, or at least vary, naturally in some but not necessarily all, parts of the Highlands (Watson *et al.* 1998, Watson *et al.* 2000). Although a long-term study of Ptarmigan populations has been made within some core areas of its Scottish distribution (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 elsewhere. Notably, there is none from peripheral parts of the range (e.g. Bryant *et al.* 1993) where changes might be expected to be most noticeable.

Although Britain as a whole is relatively well served by programmes that monitor bird populations (e.g. Baillie *et al.* 2005), upland areas have traditionally been inadequately covered, and specifically for Ptarmigan, there are no rigorous data, apart from those described above, on trends. Climate is 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). Increased human disturbance is also widely expected. Despite some local reductions in grazing pressure, both from sheep and Red Deer, levels that could further deteriorate Ptarmigan habitats in Scotland are likely to continue over a wide area for the foreseeable future. Indeed, reduced snow cover could further exacerbate winter grazing pressure within areas occupied by Ptarmigan through increasing the period that montane vegetation is available to general herbivores. 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 dynamics of Ptarmigan populations in restricted study areas in Scotland (Watson *et al.* 1998).

1.3 Aims of the Project

The ultimate aim of the work reported here is to develop a cost-effective long-term monitoring programme for Ptarmigan, and potentially other montane birds, in Scotland. This would be used as an indicator of the condition of montane environments and inform land management and policy issues that influence them.

Specifically, this report describes an initial pilot study in 2005 to test the efficacy of using simple field methods that could be employed by hillwalkers and other hill-users, to collect quantitative data on the distribution and abundance of Ptarmigan in the Scottish Highlands. This aims to include people without specialist knowledge or experience of birds or birdwatching. The results will be used in the development of a wider scale project starting in 2006 that will trial using general hill users to collect quantitative information principally on Ptarmigan (although also including other birds) in montane areas of Scotland.

2 METHODS

2.1 Survey Methods

Field methods to be used in a non-professional extensive survey need to be simple and be particularly suited to the terrain and topography in which the birds occur. The only published studies of Ptarmigan from Scotland (e.g. Watson 1965, Watson *et al.* 1998, Thompson *et al.* 2003) have used intensive methods that would be unsuitable for individuals without specialist bird-surveying experience and with limited time available. In addition, these methods were designed to intensively survey extensive plateaux and relatively gentle slopes where those studies have been undertaken (see Section 4.2). To be practical within the range of mountain topography found throughout the Highlands, and also to be compatible with the general habits of hillwalkers, a survey along linear routes or 'transects' was adopted for this pilot study. The transects were pre-determined from 1:25,000 topographical maps and each aimed to include 4-8 km at altitudes greater than 750 m above mean sea level. Routes were planned to avoid crags or other dangerous features. Within these constraints, each transect consisted of a series of relatively straight lines. This aimed to sample representative areas of montane habitat and also minimise potential biases associated with 'choosing' the 'easiest' routes and also by 'overuse' of standard hill-walking routes (for example those listed in Bennet 1999) with their associated potential disturbance factors. All birds seen along transects were plotted on field maps using standard BTO two-letter species and activity codes (e.g. Marchant 1983). In addition, piles of Ptarmigan droppings, or Ptarmigan feathers were also plotted onto maps. The locations of all Ptarmigan, and their signs were checked using hand-held Global Positioning Systems (GPS).

2.2 Site Selection

The selection of survey sites aimed to encounter a range of Ptarmigan densities. In the near-absence of extensive data on relative abundance of Ptarmigan through the Highlands (see Section 1), sites were selected to be within one of three general areas based on topography and the known distribution of Ptarmigan (Figure 1):

1. Areas with extensive plateaux within a core area of Ptarmigan distribution in which suitable habitat for Ptarmigan is likely to be reasonably continuous.
2. Areas where ptarmigan habitat is likely to be relatively fragmented, although within the 'core area' of their distribution.
3. Areas on the southern periphery of Ptarmigan distribution in the Highlands, where suitable habitat is also fragmented.

Fifteen transects in six general areas were surveyed between 13 April – 10 May, termed the 'early period' (Table 1, Figure 2). Nine of the transects were repeated between 21 – 26 July, termed the 'late period', as an initial investigation of any evidence for seasonal differences in detection rates (Table 1). Weather constraints prevented some transects from being surveyed in full on some visits.

2.3 Recording Protocol and Analyses

All birds and Ptarmigan dropping piles were plotted onto 1:10,000 field maps using standard BTO species and activity codes (Marchant 1983). No maximum distance limit away from transects was set for the recording of birds with the initial idea of using distance sampling analyses (Buckland *et al.* 2001). During the survey, too few birds were encountered and very few were located at distances greater than 20 m from the transects for this approach, however (see Section 3.1).

Analyses considered both the numbers of Ptarmigan actually seen on each transect survey and also the number of 'Ptarmigan sites' encountered. 'Ptarmigan sites' are spatial clusters of birds and/or their signs. Thus a single Ptarmigan or a flock represented just one site. Similarly one pile of droppings or a cluster of many piles also represent a single site as did bird(s) seen in the same area as pile(s) of droppings. Based on the distribution of birds and their signs found during this survey, an arbitrary

separating distance of 20 m between birds and/or signs defined separate Ptarmigan sites. Although feathers were recorded, these were not included in analyses as nearly all that were found were small and could have easily blown considerable distances before being found. There were no instances where only feathers were found in any transect.

Variation in numbers (birds or sites) was examined using Generalised Linear Models (GLMs) with transect (n = 15), area (n = 3, nested with the transect variable) and survey period (n = 2) as the independent variables. The distance of each transect surveyed was included as an offset. The models used a log link function and assumed a Poisson error distribution.

3. RESULTS

3.1 Ptarmigan

During the early period (13 April – 10 May), a total of 73.8 km of transects were walked (a mean of 4.6 km per transect) at an altitude greater than 750 m. During the late period, a total of 51.4 km of transects were walked (mean 5.7 km per transect) (Table 1). A total of 32 Ptarmigan were seen during the early visits and 26 during late visits (Table 2). After including the additional signs of birds, the total number of Ptarmigan sites encountered was 59 during early visits and 23 during late visits (Table 2). All birds seen were initially recorded within 20 m of the transects apart from two separate individuals that were located at approximately 50 m from the transect.

There was a significant difference in encounter rates of Ptarmigan sites between selection areas (F_2 = 5.26, P = 0.01, when the non-significant independent factors are removed), but not between early and late visits (Table 3). No significant differences were detected between any variables for the number of individual Ptarmigan seen on survey transects (Table 3). Mean encounter rates of Ptarmigan sites, at 0.99 per km in areas with extensive plateau, was about twice that in areas where habitat suitable for Ptarmigan is more fragmented and the lowest encounter rate, at 0.21 sites per km, was recorded on transects in areas in the southern periphery of their range (Table 4). Although not statistically significant, the numbers of Ptarmigan seen in the different selection areas showed the same trend.

3.2 Other Species

Sixteen species, in addition to Ptarmigan, were recorded during the transect surveys, 12 during the early visits and nine during late visits (Table 5). Amongst these were two other montane specialists (see Section 1): Dotterel and Snow Bunting (on three survey transects each).

4. DISCUSSION

4.1 Efficacy of Field Methods

The detection rates of Ptarmigan were relatively low but the inclusion of other evidence of their presence (droppings) gave indices of abundance that were significantly different between general areas where differences had been expected *a priori*: Ptarmigan were most abundant where there is extensive continuous suitable habitat and least abundant at the southern periphery of their range and where habitat is more fragmented. This result suggests that data collected using similar field protocols suitable for detecting temporal changes in abundance.

The wider project starting in 2006 will collect data from a larger number of sites (transects) and therefore the power to detect changes should be enhanced. A number of additional factors will need to be considered in more detail however:

a) Timing of surveys – Although no statistically significant difference was detected between detection rates in the early and late visits during the pilot study in 2005, the early visits were before the main incubation period and the late visits afterwards. It is possible that detection rates may differ (likely to be lower) while Ptarmigan are incubating. We also had a reduced number of transects that were covered during late visits and therefore statistical power to detect differences was probably low. A larger-scale project, even if targeting the summer months, will need to assess more rigorously any seasonal variation in detection rates with a view to calibrating the data collected.

b) Variation in detection ability between observers – This pilot study mostly used experienced field ornithologists. The wider project will aim to collect data from a wide range of hill users, including those without specialist knowledge of birds and those without previous experience of ornithological fieldwork. As such the detection rates from this pilot work could be expected to be higher than will be the case during the wider project. Few of the fieldworkers that were involved in the pilot study were familiar with either Ptarmigan or with montane habitats, however. Furthermore, the collection of data on dropping piles was also novel to all but one surveyor. Therefore, given adequate guidance and training materials, there is no reason why individuals without specialist bird knowledge should not have comparable detection efficiencies to those individuals who took part in the 2005 pilot. There will probably be a need to include some form of calibration between 'experienced' and 'inexperienced' contributors to the wider project however.

c) Variation in detection ability within observers – The ability of any given observer to detect Ptarmigan is likely to vary with weather conditions and topography (the latter due to differences in the need to concentrate and in tiredness. Although the same issue will apply to most bird surveys, in montane areas their influence is potentially greater and therefore could be significant. With many observers contributing to the wider project, individual effects may be less important but the survey methodology should aim to minimise such effects nonetheless, perhaps by including a number of systematic 'stop and search' periods during each transect. Data from these will need to be identifiable from the walking parts of the transects.

d) Snow cover – Using piles of droppings as well as observations of the birds themselves will be key in establishing indices of abundance as detection rates of birds could be too low to be useful by themselves. Detection rates for signs will be influenced by the extent and age of snow cover. Therefore surveyors should be asked to record a measure of the proportion of each transect route that was obscured by lying snow.

e) Confusion species – With limited guidance, it is expected that most people able to walk a montane transect will be able to identify a Ptarmigan when seen. We are not aware, however,

of any method of distinguishing droppings of Ptarmigan and Red Grouse, although these two are distinctive from all other droppings likely to be encountered. Overlap in the altitudinal ranges of the two species does occur (as in Transects M and O in this study). This perhaps presents the greatest risk to data interpretation in the central and eastern Highlands where Red Grouse are more abundant and occur at higher altitudes. For the extensive project in 2006, surveyors should need to be made aware of this potential problem, and the numbers of Red Grouse seen should be recorded as well as Ptarmigan. Further work should investigate the ratios of Red Grouse to Ptarmigan seen during surveys for assigning counts of dropping piles to either species.

4.2 Population Estimates or Indices of Ptarmigan Abundance

Transect data can be used to estimate population densities using distance sampling techniques (e.g. Buckland *et al.* 2001). Distance sampling works on the principle that randomly distributed objects become more difficult to detect with increasing distance from a transect line. As a result, an increasing proportion of objects (in this case, Ptarmigan) that are present will go undetected with distance. For distance sampling to generate reliable estimates of population density, a minimum number of birds needs to be detected; a minimum of 40 is generally recognised as being needed for each area surveyed (Buckland *et al.* 2001). In addition to the low numbers of Ptarmigan that are likely to be detected, the restricted distances from the transects at which most birds were seen during this pilot study (all < 50 m, most considerably so) also suggest that the generation of rigorous population estimates from the transect surveys alone is not likely to be possible.

The use of droppings, as indicators of Ptarmigan presence, increases the number of records to deliver a potentially useful index of population density but how this index relates to actual bird densities can not be determined from the data collected in our study to date. Calibration of transect counts (of birds and signs) with detailed censuses across a range of sites would be required.

Methods of censusing Ptarmigan that have been used previously (Watson 1965, Watson *et al.* 1998, Watson & Moss 2004) include: (i) counting birds in winter on days when there is little or no snow cover, when their white plumage can make birds obvious at a distance; (ii) parallel transects walked at 20-30 m distance to achieve blanket coverage of an area, from August to March; and (iii) direct observations of territorial behaviour in spring. Further methods could include the use of pointer dogs to search areas or transects. Using parallel transects and pointer dogs will be impractical across many parts of the Highlands where steepness of slopes and roughness of terrain will make such comprehensive access difficult or impossible. Using such methods would be restricted to the more extensive plateaux (as monitored by e.g. Watson *et al.* 1998) and therefore any data collected and used to calibrate transect data against population densities by that method may not be representative of other types of terrain. The other two approaches (counting white birds on snow-free days in winter and counting territorial birds in spring) should be considered as part of a wider monitoring project.

Although the derivation of density estimates from extensive transect data would be useful, it is not essential for comparing indices of abundance both temporally and spatially. A range of analytical approaches will be considered dependent on the quantity and distribution of data that is collected from the wider project in 2006. One of the principal aims of the project in 2006 will be to test the efficacy of data collection with a view to developing a long-term monitoring programme. Within two study areas, in the Cairngorms and the Mounth, both extensive plateaux areas (selection criteria 1 areas, Section 2.1), the population dynamics of Ptarmigan over five decades were considered unstable, with some apparent cycling of roughly 10-year periodicity (Watson *et al.* 1998). The apparent cycles were probably influenced and modified by external factors, such as weather and geology, and the influences of these on breeding success, and the cycles were not synchronous between the two study areas (Watson *et al.* 1998). With unstable population dynamics and the potential for asynchronous variations between regions, the determination of trends across the Highlands is potentially problematic. However, the identification of weather, in this case June temperatures, as a factor influencing those

dynamics, does suggest that Ptarmigan would be an appropriate focal species for monitoring any influence of progressively changing climate on montane environments.

4.3 Other Species

Other montane specialist species (Dotterel and Snow Bunting) were recorded during the 2005 pilot study but were not encountered frequently enough to assess differences in relative abundance. The wider project in 2006 will encourage participation at multiple levels depending on the previous survey and identification experience of observers. Collection of data on the full suite of species found in montane areas during the wider project in 2006 will depend on the number of experienced ornithologists participating. Although not a priority in the current project, it would be important to assemble further information on trends in other bird species in montane areas. Reasons for this include: (i) trends in numbers of the other montane specialist species are not well known; and (ii) trends in other bird species are not well known for the part of the population that inhabit montane areas.

4.4 Habitat

Although not reported here, simple habitat data was collected for each 200 m section along the transects surveyed in 2005. Further sample data will be collected in 2006 for examination of correlates of Ptarmigan abundance and, in the longer term, of any recorded changes in status.

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Table 1. Ptarmigan transect survey dates, 2005.

Transect	Selection area*	Early visit		Late visit	
		Date	Length surveyed (km)	Date	Length surveyed (km)
A	3	4 May	5.4		
B	3	4 May	4.4	22 July	4.4
C	3	15 April	4.4	22 July	4.4
D	3	15 April	1.0		
E	3	15 April	3.4	22 July	6.0
F	2	25 April	4.4	21 July	4.4
G	2	13 April	5.0	21 July	5.0
H	2	25 April	3.8		
I	2	24 April	6.6		
J	2	24 April	5.8		
K	1	10 May	6.8	26 July	6.8
L	1	10 May	6.0	26 July	6.0
M	1	21 April	7.8	25 July	7.8
N	1	21 April	1.0		
O	1	21 April	6.6	25 July	6.5

* See Section 2.1 for details of area selection criteria.

Table 2. The number of Ptarmigan seen, and Ptarmigan sites* encountered during transect surveys in 2005.

Transect	Early visit		Late visit	
	No. of Ptarmigan	No. of Ptarmigan sites* encountered	No. of Ptarmigan	No. of Ptarmigan sites* encountered
A	0	0	.	.
B	1	3	6	1
C	1	1	0	1
D	0	0	.	.
E	0	0	0	1
F	0	4	4	3
G	3	3	6	1
H	0	1	.	.
I	1	4	.	.
J	1	1	.	.
K	6	8	0	2
L	9	21	0	0
M	9	8	10	9
N	0	3	.	.
O	1	2	0	5

* Ptarmigan sites are locations where Ptarmigan and/or their signs were seen, regardless of numbers and are separated by a minimum distance of 20 m.

Table 3. Model (GLM) parameters of detection rates of Ptarmigan and of Ptarmigan sites.

Source of variation		Birds		Sites	
	df	**F**	**P**	**F**	**P**
Model	15	0.74	0.71	1.03	0.50
Selection area	2	0.66	0.54	4.70	0.04
Period	1	0.11	0.75	1.87	0.21
Transect*	12	0.76	0.68	0.48	0.88

* nested in the variable 'Selection area'

Table 4. Detection rates (per km) of Ptarmigan and Ptarmigan sites on survey transects within different selection areas in 2005. Means and standard errors are weighted by the length of transect surveyed.

Selection area*	Ptarmigan		Ptarmigan sites	
	mean	**SE**	**mean**	**SE**
1	0.66	0.20	0.99	0.35
2	0.43	0.17	0.49	0.10
3	0.24	0.17	0.21	0.07

* 1 Extensive plateaux.
2 Fragmented habitat within core distribution.
3 Fragmented habitat at southern periphery of distribution.

Table 5. Species, in addition to Ptarmigan, recorded during montane transect surveys in 2005.

a) Early visits

Species	Transect														
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Golden Eagle		2	1												
Peregrine				1									1		
Red Grouse													8		2
Golden Plover							4								
Dotterel									3		11	10			
Lesser Black-backed Gull	1														
Meadow Pipit	4	7	2		2	4	9		9	1	2	5	15		15
Wheatear	5								2			3	2		1
Ring Ouzel	1								2	1	1		1		
Raven		1	2			1			2	1					
Twite													2		
Snow Bunting			3						28	3					

b) Late visits

Species	Transect														
		B	**C**		**E**	**F**	**G**				**K**	**L**	**M**		**O**
Kestrel		1													
Merlin													1		
Red Grouse													3		
Golden Plover						7	1				3				
Meadow Pipit		18	1		4		1				2	25			21
Wren		1													
Wheatear						1	4				2				
Ring Ouzel			1												
Raven		2			1										

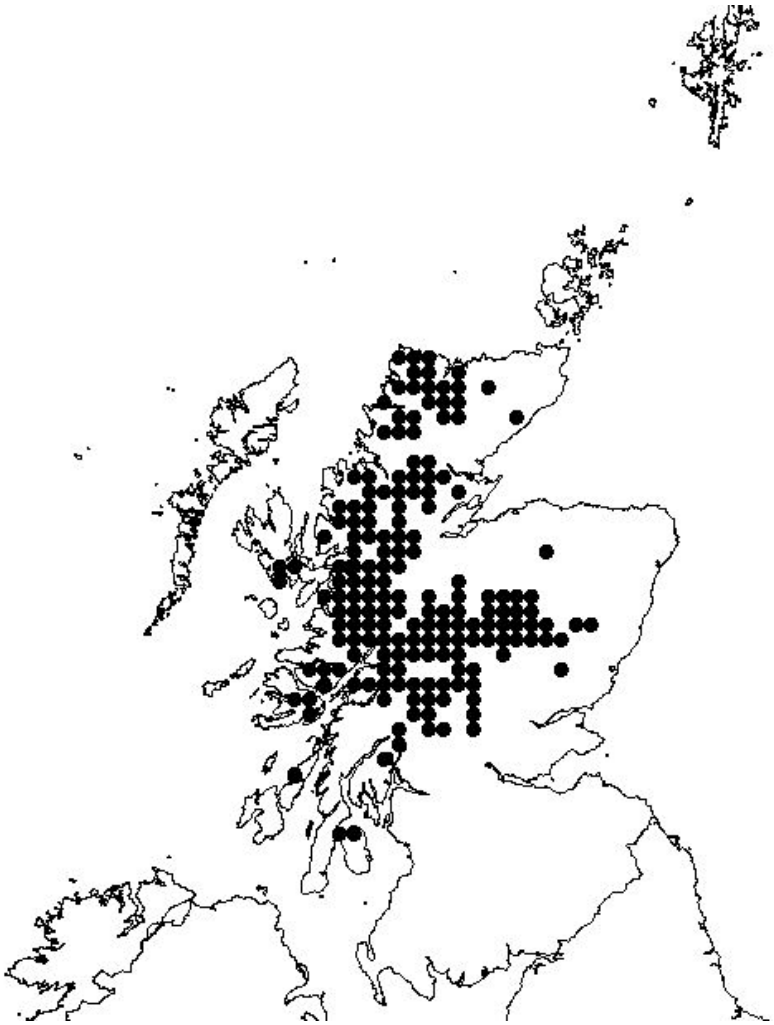

Figure 1. The distribution of 10-km squares in which Ptarmigan were recorded in Scotland during ornithological atlas fieldwork 1988-1991 (after Gibbons *et al.* 1993).

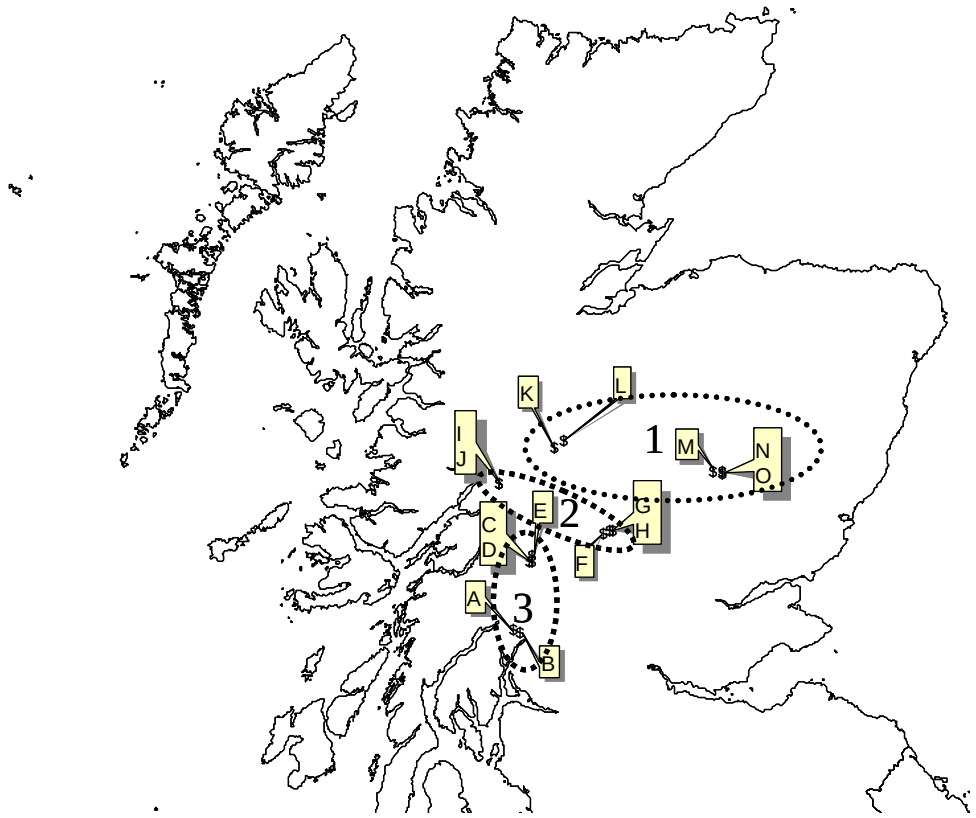

Figure 2. The distribution survey transects in 2005. The letters refer to individual transects (see Table 1) and the numbered regions refer to the broad selection criteria described in Section 2.1.