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Results of the national Red Grouse Survey 2006-2008

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Results of the national Red Grouse Survey 2006-2008

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Cover photo: Adult Male Red Grouse (© Mike Brown)

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EXECUTIVE SUMMARY

A baseline population estimate of Red Grouse *Lagopus lagopus* in the Republic of Ireland was determined by a national survey, carried out between 2006 and 2008. A supposed 70% decline in the species range over the past 40 years prompted its addition onto the *Irish Red List of Birds of Conservation Concern* in 1999 and the subsequent targeted action of a national survey.

Aim The priority of the national Red Grouse Survey is to produce an estimate of the national population and to provide a baseline for future surveys so as to enable long-term monitoring of the species. The intention is that this survey will demonstrate a link between habitat condition and presence of Red Grouse, where they occur. In this way, Red Grouse can be used as a bio-indicator of the favourable conservation status of their preferred habitats.

Methods Records of Red Grouse occupancy derived from innovative tape-playback methods, counts using dogs and a casual sightings database of incidental records, were used to determine the species range in the Republic of Ireland. The primary focus of the national survey was counts of territorial males in winter and early spring, determined using tape-playback transect methodologies in a selection of random 1km squares. Potential sites were stratified according to region and broad habitat class (CORINE Land Cover Data) and chosen survey sites with more than 60% habitat suitability for Red Grouse were randomly selected within these strata.

Results Densities of grouse were low (average 1.1/km^2 surveyed) with much variation across habitats and regions. The contraction in species range in the Republic of Ireland in the last 40 years was determined as 50%. The Irish population of Red Grouse was estimated at just over 4,200 birds (95% confidence limits (nearest 100) 3,800 – 4,700), using the best available data from sites surveyed and suitability of areas not surveyed. Regional population estimates are given along with estimates of population sizes across five broad scale habitat classes: mountain blanket bog, upland blanket bog, lowland blanket bog, raised bog and moors & heath.

Conclusion Red Grouse will remain on the Irish Red List as they have lost 50% of their former historical breeding range. The national population estimate is within the limits expected from most recent literature but highlights the decline in range, particularly in some regions. Regional estimates will be critical in guiding future conservation efforts by highlighting areas in steepest decline. Further analyses assessing relationships between occupancy of grouse with measures of habitat quality, including grazing damage assessments, are also given.

Recommendations are included in this report which will hopefully form the basis for a targeted Red Grouse Species Action Plan. These include continued monitoring of populations in key areas, making necessary improvements in habitat quality in former and existing grouse areas and future research on grouse ecology in Ireland. In particular current information on life history traits such as breeding success, juvenile recruitment, natal dispersal and over-winter survival is needed to decipher whether these factors have influenced the 50% contraction in Red Grouse historical breeding range in the Republic of Ireland and to ascertain how likely the current population is to expand, if habitat conditions are improved.

ABBREVIATIONS & COMMON TERMS USED

a.s.l.	above sea level
Blanket bog*	blanket peat that accumulates under conditions of high rainfall and humidity, it is typified by black bog rush (*Schoenus nigricans*), white-beaked sedge (*Rhyncospora alba*), bog cotton (*Eriophorum vaginatum*) and sundew (*Drosera rotundifolia*)
BWI	BirdWatch Ireland
Commonage	represents land held under common property that incorporates a system of local cooperative arrangements and rules to conserve and manage the Irish uplands
CFPs	Commonage Framework Plans
EHLG	Department of the Environment, Heritage and Local Government
EU	European Union
GPS	Global Positioning System
Grouse	Red Grouse *Lagopus lagopus scoticus*
Heath†	open areas with minimum cover of 25% dwarf shrubs and usually over peaty soils <50cm in depth in the case of '**wet heath**' and typically over poor mineral soils in the case of '**dry heath**'. Heath is usually characterised by ling heather (*Calluna vulgaris*), cross-leaved heath (*Erica tetralix*) and purple heather (*Erica cinerea*)
IKC	Irish Kennel Club
Moorland	or **moor** is a type of habitat found in upland areas, characterised by low growing vegetation on acidic soils. Moorland nowadays generally means uncultivated hill land
moors & heath	Definition of Land Cover Class using CORINE (2000). Any reference in the main body of this report to 'moors & heath' refers to this CORINE Land Cover class 3.2.2.
NARGC	National Association of Regional Game Councils
New Atlas	*The New Atlas of Breeding Birds in Britain and Ireland: 1988-91*
NPWS	National Parks and Wildlife Service
Old Atlas	*The Atlas of Breeding Birds in Britain and Ireland* (1968-1972)
Peat†	an organic soil made of partly decomposed and compacted remains of plants such as Sphagnum mosses and bog cotton*

Peatland Φ	is an area where peat has accumulated in sites
PSG	Project Steering Group
Raised bog‡	accumulations of deep acid peat (3-12m in depth)
RGS	Red Grouse Survey
RGHS	Red Grouse Habitat Survey (Crushell & O'Callaghan, 2008)
SAC	Special Area of Conservation - areas considered of international importance whose legal basis is the EU Habitats Directive (92/43/EEC), transposed into Irish law through the European Union (Natural Habitats) Regulations, 1997
SPA	Special Protection Area - sites of international conservation importance for birds whose legal basis is the EU Birds Directive (79/409/EE)
Willow Grouse	*Lagopus lagopus (*although more recent nomenclature uses *Lagopus lagopus scotica*, David & Gosselin 2002*)*
1km square	$1km^2$

* taken from *A manual for the production of grazing impact assessments in upland and peatland habitats*: Version 1.2. NPWS and Department of Agriculture and Food (unpublished).

† taken from *An Illustrated Guide to British Upland Vegetation* (2004) Averis, A., Averis, B., Birks, J., Horsefield, D., Thompson, D. & Yeo, M. (Eds.) Joint Nature Conservation Committee.

‡ taken from *A Guide to Habitats in Ireland* (2000) Fossitt, J. A., The Heritage Council, Kilkenny.

Φ taken from *Strategy and Action Plan for Mire and Peatland Conservation in Central Europe*. Bragg, O. & Lindsay, R. (Eds.) (2003) Wetlands International, Wageningen, The Netherlands.

PARTNERSHIP

This project was funded by the National Parks and Wildlife Service of the Department of the Environment, Heritage and Local Government. NPWS contracted (by way of open tender) BirdWatch Ireland to project manage the survey, which was undertaken by professional fieldworkers [botanists included], NPWS staff and voluntary input from members of BWI, IKC and NARGC. In addition, anecdotal records were received from a wide range of sources. Together with the NPWS and BWI Partners, other representatives from stakeholder organisations, including the IKC and NARGC formed the Project Steering Group (PSG): Kenny Bucke, Sue Callaghan, Peter Carvill, Damian Clarke, Barry Coad, Des Crofton, Sinéad Cummins, James Dalton, Christy Davitt, James Dunne, Leonard Floyd, Martin Gavin, Caroline Hurley, Catherine Keena, Jim Kelly, Helen Lawless, Liam Lysaght, Frank Macken, Sara Malone, Ben McCabe, Jack Meath, John Muldowney, Tony Murray, Stephen Newton, Cliona O'Brien, John O'Halloran and John Wilson (for further details see Appendix 1).

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1.0 INTRODUCTION

Globally, grouse populations are represented by 18 recognised species and around 130 subspecies (Watson & Moss, 2008). In Ireland and Britain, the Red Grouse *Lagopus lagopus scoticus* (a sub-species of the Willow Grouse *Lagopus lagopus*) is endemic and it is closely associated with peatland habitats with reasonable heather cover (Lance, 1972, Watson, 1979b). Their range has been affected by many land use changes, particularly in the last 100 years (Allen *et al.,* 2005, Davies, 2005). These changes have caused much fragmentation of grouse habitats and fractured populations that were once extensive over much of Ireland's bogs and heaths (Sharrock, 1976). Given the estimated decline in Red Grouse extent in the Republic of Ireland (Gibbons *et al.*, 1993), it is of concern that important areas of grouse habitat continue to be lost or damaged by activities such as peat extraction, afforestation, drainage, conversion to grassland through blanket burning, overgrazing (particularly by sheep), and development pressures associated with the erection of wind turbines, communications masts and associated infrastructures. The patchiness of much of the remaining grouse habitat in Ireland is unlikely to benefit populations and may lead to lower average densities of grouse (Watson & Moss, 2008).

1.1 Decline in numbers and range

As our only native species of grouse, the Red Grouse has suffered from a serious decline in range (purported to be as high as 70% in the Republic) in the past 40 years and as a result it was added to the Irish Red List of *Birds of Conservation Concern* in 1999 (Newton *et al.,* 1999), where it remains (Lynas *et al.,* 2007). While British bags have shown long term declines in most regions (Hudson, 1992, Redpath & Thirgood, 1997), Irish bags have shown even bigger declines (Watson *et al.*, 1993). A population of 1,000 to 5,000 breeding pairs was previously given as an all Ireland estimate (Gibbons *et al.,* 1993). A similar study in Northern Ireland in 2004, highlighted the extent of the decline there, with a national population estimate of just 202 breeding pairs (Allen *et al.,* 2004, Allen *et al.,* 2005).

In Britain, where grouse numbers on some moors often exceed 100 birds/km^2, the relationship between predators, such as Hen Harriers *Circus cyaneus*, on local grouse populations has been studied in depth (Redpath, 1991, Redpath & Thirgood, 1997, Thirgood *et al.,* 2000a, Thirgood *et al.*, 2000b). Less is known about the effects of predators on low density populations, as in the Irish context and whether diseases such as *Strongylosis* (Hudson, 1986, Hudson *et al.,* 1992) and *Louping ill* (Timoney, 1972) affect Irish populations to any great extent (Allen *et al.,* 2005).

1.2 EU Judgment

In June 2002, the European Court of Justice ruled (Case: EC, C-117/00) against the Irish government for its failure to fulfil its obligations under Article 3 of *Council Directive 79/409/EEC* of 2 April 1979 on the conservation of wild birds and Article 6(2) of *Council Directive 92/43/EEC* of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. The court ruling stated that 'Ireland has thus failed to fulfil its duty to safeguard a sufficient diversity and area of habitats for the Red Grouse' and in particular 'Ireland has failed to take the necessary measures to prevent the blanket bog of the Owenduff-Nephin Beg Complex SPA from being damaged by overgrazing'. On January 29th 2009, the case was closed by the European Commission, who were satisfied that the Irish government had taken significant steps to address the overgrazing issue with general destocking taking place across 440,000 hectares of commonage. In key areas where recovery was not being delivered, additional restrictions were implemented through agreements with farmers, which included offwintering and further destocking of sheep.

1.3 Climate change

The potential effects of climate change on Willow Grouse populations in Europe (including the sub-species *scoticus* endemic to Britain and Ireland) have been examined with a predicted north westwards shift in their breeding range by the end of this century, resulting largely in their disappearance from Ireland with populations in Britain restricted to the most northerly parts of Scotland (Huntley *et al.*, 2007).

1.4 Taxonomic status

The taxonomic status of the Red Grouse in Ireland has been the subject of much debate. In the past, genetic analysis of specimens from Ireland, Britain and Scandinavia found no clear evidence to support the classification of the Irish population as *hibernicus*, a distinct subspecies from its British counterpart *scoticus* (Freeland *et al.*, 2006). Indeed, the findings of this genetic research suggest that frequent introductions of birds into Ireland from Britain in the past 100 years (Watson & O'Hare, 1979b) were unlikely to have affected the conclusion of that study. However, a more recent study* (unpubl.) indicates that the Irish population *hibernicus* is indeed genetically distinct from *scoticus* and that a significant percentage of the population in Ireland is genetically bottlenecked, and in serious risk of extinction.

*The study was funded by the Native Species Conservation Committee of Dublin Zoo and Fota Wildlife Park and was carried out by the Irish Grey Partridge Conservation Trust, University College Dublin and the University of Uppsala, Sweden. Results of this study are due for publication in 2010.

1.5 Previous studies

Extensive research has been conducted on the Red Grouse in Britain where it is an economically viable gamebird (*Games and Wildlife Trust Review*, 2008). In Ireland, most studies were carried out back in the late 1960s and 1970s by Adam Watson, P.J. O'Hare and Art Lance working mainly out of Glenamoy Research station in north Co. Mayo (Watson & O'Hare, 1973, 1979a, 1979b, 1979c, Lance, 1976, 1978). It is widely accepted that grouse populations in Ireland are sparsely distributed, and largely confined to wet, nutrient-poor blanket bog (Watson & O'Hare, 1973). Densities in Britain can reach over 100 birds/km^2 (*Games and Wildlife Trust Review*, 2008, Hudson, *et al.* 2002). Populations there often experience delayed density-dependent boom-and-bust cycles (O'Hare, 1972, Hudson *et al.*, 2002) whereas Irish populations tend to remain more stable with low densities of 1-6 individuals per km^2 (Watson & O'Hare, 1979b, Murray & O'Halloran, 2003, Allen, *et al.* 2005).

1.6 Habitat preferences

The Red Grouse is associated with specific habitat types, namely heaths, blanket bogs and raised bogs (Cramp & Simmons, 1980). Its diet is almost exclusively ling heather (*Calluna vulgaris*) (Jenkins *et al.*, 1963, Lance & Mahon, 1974, Finnerty *et al.*, 2007) and therefore its distribution is restricted to peatland habitats that have heather. Historically, the Red Grouse was among the most characteristic birds of Ireland's bogs given its unique association with these habitats and heather where it spends its entire life cycle (Watson & O'Hare, 1979). A recent survey of peatland birds in Ireland confirmed this association. Blanket bog (atlantic and montane) was the first choice for Red Grouse with a weaker preference for areas with high densities of heather cover (Bracken *et al.*, 2008). Another recent study in Ireland found no birds on mountain blanket bog sites with less than 25% heather cover (O'Connell, 2008) mirroring previous studies (Lance, 1972). Grouse populations in Ireland occur at lower densities than in Britain, particularly on the more nutrient poor western blanket bogs (Watson & O'Hare, 1973), although national abundance data across regions or habitats has been lacking up to now.

1.7 Territory establishment and habitat management

Given their largely sedentary nature (Wernham *et al.*, 2002), rarely dispersing more than 4km from natal territories (Warren & Baines, 2007), grouse populations are susceptible to habitat losses and changes in quality (Lance, 1978a). Males establish territories in autumn (months before the breeding season) with territorial males calling at dawn and dusk, albeit less so in daytime particularly in the case of low density populations (Watson & Jenkins, 1963). Flat moorland supports lower densities of grouse than hillocks as males take larger territories where they can readily see each other (Lance, 1978b). Some studies suggest territory size in grouse largely depends on the availability of enough plant material of adequate nutritive value (richer in nitrogen), rather than the total amount of available heather (Savory, 1978).

1.8 Conservation value

Much of Ireland's peatland habitat suitable for conservation has been dramatically reduced in size, with less than a quarter remaining in relatively intact condition (Foss *et al.*, 2001). The loss of peatland habitats has been recognised internationally by the inclusion of blanket bog, raised bog, wet heath and dry heath on Annex I of the *EU Habitats Directive*, which affords peatlands (including fen) special conservation status. In Ireland, certain sites have been allocated special protection through their designation as Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Natural Heritage Areas (NHA).

AIMS:

- To determine the distribution and abundance of Red Grouse in the Republic of Ireland.
- To assess the relationships between Red Grouse and suitable 'grouse habitats' and habitat quality.
- To carry out a standardised national survey providing a reliable national population estimate of Red Grouse.
- To establish an effective methodological base from which future monitoring can be conducted.
- To provide up to date information for addressing national grouse management issues.

2.0 METHODS

2.1 Sampling Range

The historical species range of Red Grouse in Ireland, prior to their decline, was taken to be the distribution of Red Grouse as represented in the first breeding bird atlas in 1968-72 (Figure 1). This atlas showed that Red Grouse were closely associated with 'heather' habitats which were widespread in Ireland and more intact in their extent and condition in the past than now (Foss *et al.*, 2001). The historic species range was defined as all 10km squares in which the species had been recorded between 1968-1972. These 10km squares are referred to as the '**defined historical breeding range**'.

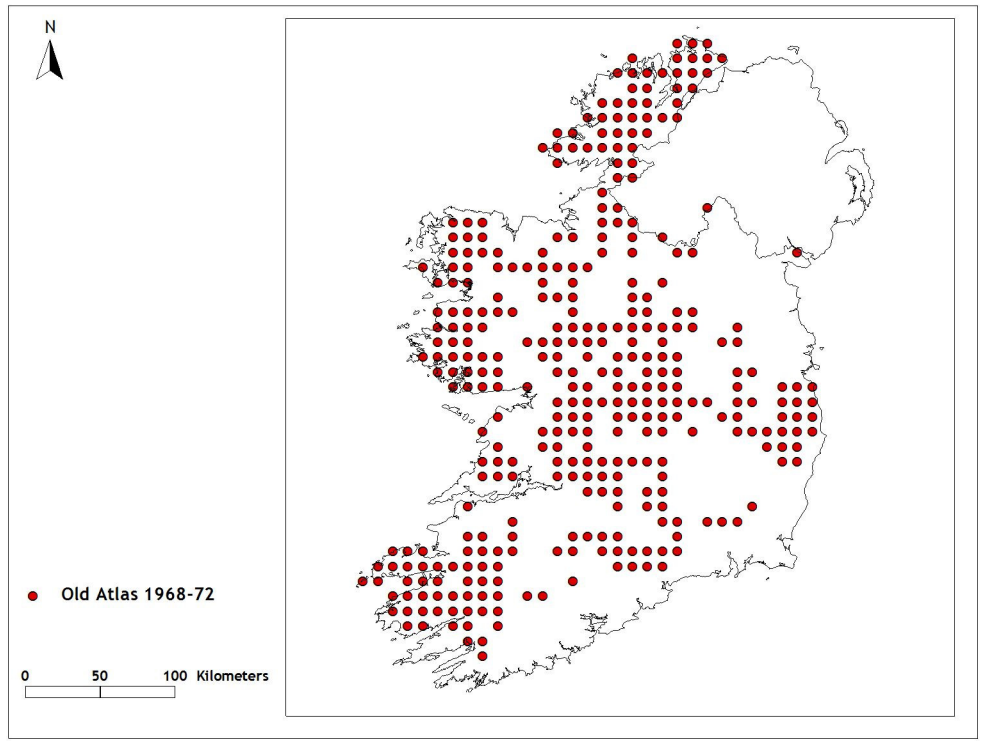


Figure 1: Historical distribution of Red Grouse in the Republic based on records of occupied 10km² from The Atlas of Breeding Birds in Britain and Ireland (Sharrock 1976).

Using CORINE Land Cover data (EEA, 2000) as an indicator of habitat suitability, any 1km squares identified as containing potentially suitable grouse habitat within each 10km square occupied by Red Grouse in the Old Atlas, were selected and pooled into two strata: **Region** and **Habitats**. In total, 5,963 1km² potential sites were identified across the country. Any 1km square with more than 60% suitable grouse habitat was included in the potential sampling area. ArcView GIS 3.2 (ERSI, California, USA) was used to compute landscape and habitat variables using the CORINE Land Cover Map[1] (EEA, 2000). Spatial Analyst 2.0 and Patch Analyst 3.1 extensions were used to compute the proportion of the survey area made up of six **land cover class** types:

1) Upland blanket bog- *CORINE Land Cover class 4.1.2.2.1* (see example in Plate 1)

[1] The CORINE Land Cover Project mapped various land-cover types found throughout Europe at a scale of 1:100,000 using satellite imagery. The base data used for this project is Landsat T.M. satellite imagery.

2) Mountain blanket bog- *CORINE Land Cover class 4.1.2.2.3* (see example in Plate 2 & Plate 4)
3) Lowland blanket bog- *CORINE Land Cover class 4.1.2.2.2* (see example in Plate 3)
4) Moors and heath- *CORINE Land Cover class 3.2.2* (see example in Plate 5)
5) Raised Intact bog*- *CORINE Land Cover class 4.1.2.1.2*
6) Raised Exploited bog *- *CORINE Land Cover class 4.1.2.1.1* (see example in Plate 6)

* Due to the insufficient number of sites that were suitable for survey in areas of exploited raised bogs, the two categories of Raised Intact Bog and Raised Exploited Bog ended up being grouped together under 'Raised Bog'.

Each survey site was assigned to one of the six land cover classes described above. These classes were selected out as being the most important predictors of grouse presence or absence at the landscape level.

Photo: Patrick Crushell

Plate 1: Area of upland blanket bog and dry heath mosaic (150m-300m a.s.l.) in Co. Mayo where Red Grouse were recorded during the survey.

Photo: Patrick Crushell

Plate 2: Site with Red Grouse present in area of mountain blanket bog (300m a.s.l.) in Co. Donegal

Photo: Patrick Crushell

Plate 3: Lowland blanket bog site (<150m a.s.l.) in Connemara where Red Grouse were recorded.

Photo: Sinéad Cummins

Plate 4: Mountain blanket bog site in the Macgillycuddy Reeks in Co. Kerry. Mosaic of heather, grass and exposed rock. Red Grouse were found along the lower slopes.

Photo: Patrick Crushell

Plate 5: Wicklow survey site, where Red Grouse were recorded on the national survey, made up largely of dry and wet heath.

Photo: Patrick Crushell

Plate 6: Raised bog site where Red Grouse were recorded during the Red Grouse Survey.

Previous studies suggested that the populations of Red Grouse in Ireland were low density but widely dispersed over a large geographical area (Watson & O'Hare, 1973) and therefore stratified random sampling would improve both precision and accuracy as it ensures proper regional and habitat coverage (Gregory *et al.*, 2004). Red Grouse have a clumped distribution in the Republic of Ireland, given their distinct habitat requirements. As random sampling is much less effective when distributions are clumped; sampling was targeted to only include potentially suitable areas for Red Grouse. In order to ensure that the random selection process took into account possible regional variation in densities, potential grouse squares were assigned to one of five regional categories (see Section 2.3).

2.2 Preliminary reconnaissance

The site selection process involved a number of steps:

1. ensure that any potential grouse habitat in the defined 'historic range' was included in selection process
2. identify sites with potential Red Grouse habitat
3. set up randomised list of sites
4. assess site suitability using aerial photos (Ortho 2000 Data OSi)
5. final selection based on ground truthing

2.3 Regional Classification

Five broad regions were chosen based largely on landscape and underlying geological characteristics (see Figure 2) and (with the exception of the Midlands Region with its raised bogs) followed the outline of upland areas in Britain and Ireland by Averis *et al*. (2004). Much of the bedrock in Ireland is limestone but with some areas of granite (e.g. Wicklow mountains) and sandstone (e.g. the far Southwest).

- **Northwest Border**: includes the counties Donegal, Cavan, Leitrim and Monaghan and north County Sligo. Differing to the Midlands region in terms of habitat and geology, lying to its south, the underlying geology is schist, gneiss or quartzite or granite with the remainder of the region made up of carboniferous rocks. It had the second largest area of potentially suitable grouse habitat, largely upland blanket bog but also contains areas of lowland and mountain blanket bog and heath.
- **Midlands**: holds the largest area of raised bogs. It was isolated from the surrounding areas of blanket bog and put into a separate region. Its underlying geology is mainly limestone and shale.
- **West Connacht**: includes the western halves of counties Mayo and Galway and largely contains lowland and upland blanket bog with some areas of mountain blanket bog and heath. Its underlying geology is mainly schist, gneiss, quartzite or granite with some areas further east of sandstone, shale and limestone. It had the largest area of potentially suitable habitat for Red Grouse.
- **East and South**: is the largest region in terms of land area although much of the region is unsuitable in terms of habitats for grouse. It includes counties Wicklow, Carlow, Waterford, Tipperary, Laois, Limerick and Clare and parts of Kildare, north Kerry, Offaly, northeast Cork and southeast Galway. Suitable grouse habitat in this region is largely upland and mountain blanket bog and heath with some patches of raised bog in Kildare, Offaly and north Kerry. The geology varies from more granite, shale and sandstone in the east (Wicklow and Carlow) to old red sandstone in the south (Waterford and Cork) to limestone further south and west into Tipperary and Clare.
- **Southwest**: includes southern parts of County Kerry and southwest County Cork. It largely made up of Old Red Sandstone and shale and with upland and mountain blanket bog the dominant habitat types with some areas of lowland blanket bog.

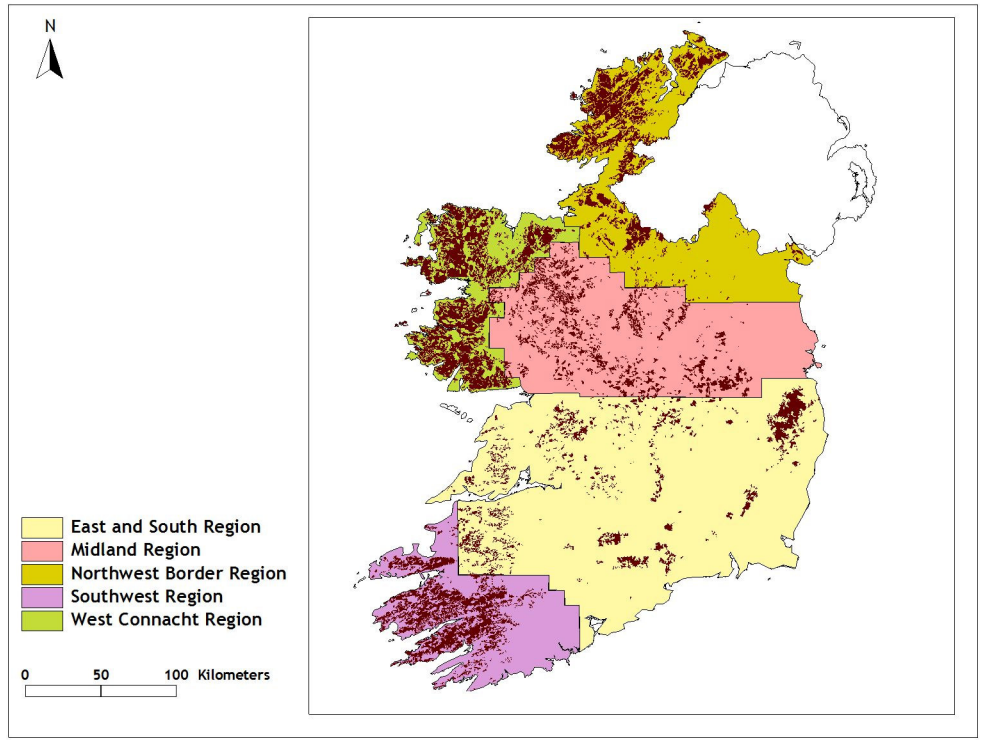


Figure 2: Regional classification of the Republic (Red Grouse Survey 2006-08). Areas of blanket bog, raised bog and heath are highlighted in brown.

2.4 Survey Design and Sampling Strategy

The primary count unit was that of territorial males occupying sites in the late winter to early spring period (December-March). At the outset, the survey design and methods took into account the sensitive nature of these ground dwelling birds. In order to minimise disturbance, the survey period of choice was restricted to the winter-early spring period, when male territoriality is heightened and prior to the breeding season when pairs may be more vulnerable to disturbance given that Red Grouse are largely single-brooded and ground nesters (Watson & Jenkins, 1963). As grouse do not disperse widely from their natal territories, the distributions in winter and the breeding season are considered to be concurrent. The majority of sites were visited once, with a sub sample of sites (N=64) surveyed in both field seasons.

2.5 Survey Units

The survey unit was a 1km^2. Given that this survey was carried out during a period when daylight hours are restrictive, an area of 1km^2 was deemed small enough to ensure proper coverage and large enough to detect any territorial birds.

2.6 Survey Equipment

The tape-playback equipment (Plate 7) consisted of a wireless megaphone (TOA Model ER- 2230W / 2930W) connected via a 3.5mm jack lead to an mp3 player containing the grouse call. Each member of the team was also provided with two-way radios (various models with ranges up to 1.5km) to facilitate communication at play-points and at any other time where necessary.

Photo: Fiona Farrell

Plate 7: Field staff member demonstrating the correct way to carry the megaphone between play-points in the survey square.

2.7 Methods Used

Given the extent of bog and heath habitats in Ireland, a number of methods were used in order to ensure widespread coverage of sites. The three methods for collection of data are given below and each in turn contributed to the overall picture of species range in the Republic of Ireland.

2.7.1 Counts with tape-playback

Songs or calls of grouse can be used to maximise counts of male grouse, particularly at lower densities when birds are known to be less vocal (Watson & Moss, 2008). The primary count unit for this method is the male. It relies on detection of any territorial males in the area being surveyed responding to the male grouse call being played. Given the low densities of grouse in Ireland, this method allows for improved detection not just of males but any incidental sightings of females and/or fresh signs of grouse presence at a site (Plates 8 and 9).

The main assumptions of this method were that:

1) Any suitable habitat within a survey square was covered
2) All surveyors were trained via workshops with the assumption that surveyors had an equal chance of detecting grouse and recording effort did not vary between surveyors
3) Location of fresh droppings indicated presence of a bird in the square
4) Time of day or date of survey did not influence responses by grouse to the tape

Responses were not unfavourably affected by weather conditions. Note that sites were not surveyed in adverse weather conditions.

2.7.1.1 Tape-playback transect methodology.

Plate 8: Fresh caecal or 'wet' dropping which is emitted from the blind gut of the grouse.

Photo: Fiona Farrell

Plate 9: Example of fresh 'dry' Red Grouse droppings with white urine caps still visible.

Any birds seen/heard or any signs such as fresh droppings (Plates 8 and 9) were marked on the field maps and recorded onto survey forms along with their locations (Grid Reference, if possible). The presence or absence of droppings (fresh/old) and/or feathers was important as they may indicate Red Grouse presence where no birds are actually sighted.

2.7.1.2 Effectiveness of tape-playback

- These methods are suitable for surveying areas with lower densities of grouse, as in Ireland, as the tape-playback entices territorial males to respond to the 'intruder' calls thereby giving a more accurate estimate of their density than transect methods without the tape.
- Relatively easy to use and allows for at least one 1km square to be covered by a team of two in a winter's day.

2.7.1.3 Study Sites for the Standardised tape-playback survey

A total of 491 1km^2 sites were surveyed in the periods December 1 2006 – March 31 2007 and December 1 2007 – April 7 2008. In order to assess any differences between years in numbers recorded at sites, a random sub-sample of 64 sites was surveyed in both field seasons (December 1 2006-March 31 2007 and December 1 2007-April 7 2008).

2.7.1.4 Survey Period for Tape-playback

The survey period for counts was restricted (Dec-Mar), in order to avoid disturbance pre-nesting which usually occurred in late April, early May (Watson & O'Hare, 1979a). All activities regarding the use of tape-playback were subject to regulation and carried out under licence from the National Parks and Wildlife Service. Line transect methodologies, which are widely used in bird surveys (Bibby et al., 2000), were adapted to incorporate the use of tape-playback with a short call of a male willow grouse played at six predefined points within the square (along alternate transects).

2.7.1.5 Survey Methods

A pair of observers, 250m apart, walked four transects across a 1km^2 at a slow steady pace in reasonable weather conditions. Where terrain allowed, transects were walked at 125m, 375m, 625m and 875m across the square in an east-west or north-south direction. At 250m, 500m and 750m along alternate transects, the call of a male willow grouse was played (for no more than 30 seconds) to see whether any birds in the area would respond. The three main types of responses were:

- Call back (assumed response of territorial males)
- Flush (bird would fly off either towards or away from the observer)
- Call back and flush (bird would call and fly off either towards or away from the observer)

2.7.2 Counts using dogs

To ascertain how effective the tape-playback method was at detecting grouse, repeat surveys were carried out in fifteen pre-selected areas (average area covered was 1.2 km^2) in Counties Wicklow, Cork, Galway, Tipperary, Sligo and Donegal, using dogs and the tape-playback method. Counts were usually conducted within three days of each other. Areas counted using dogs were demarcated using observers with handheld GPSs which subsequently allowed for these areas to be resurveyed using the tape-playback method. The number of handlers ranged between 2-7 individuals with breeds of dogs used largely red setters, English setters, pointers and springers.

Photo: Sinéad Cummins

Plate 10: A handler commanding two pointers on a count using dogs.

Up to 7 handlers, each with 1-3 dogs, were used to survey areas. This method was used to count Red Grouse in 15 defined areas throughout the country. These areas were then re-surveyed using tape-playback transects methodologies in order to ascertain how effective the widely used 'tape-method' was at detecting grouse.

2.7.3 Tape-playback versus dog counts

In order to assess the effectiveness of the tape-playback methodology, a number of areas in purported grouse habitats were surveyed using both dogs (Plate 10) and tape-playback methodology. The size of the areas surveyed was largely dependent on the areas covered by the handlers and their dogs. The boundaries of these areas surveyed were determined by project field staff using handheld GPS technology. These areas were mapped and any records of birds flushed by the dogs, marked onto field survey maps. These areas were then revisited by the field staff and counted using standard tape-playback transect methodologies. This was done to assess the error in detection using tape-playback (directed at territorial males) versus counts using dogs (directed at both sexes). The average time period between counts was 2.9 ± 4.3 days. One of the most important assumptions in interpreting these data is that the probability of detection was considered to be constant even though in the natural world, this is not always the case. As these sites were surveyed twice, once using dogs, once using tape-playback, Paired t-Tests were used to test for differences in numbers counted by each method. Density figures were cosine transformed to achieve a normal distribution prior to testing by the Kolmogorv-Smirnov test.

2.7.4 Casual Sightings and supplementary records database

Given the difficulties in surveying grouse occurring in low density populations, additional records from incidental sightings of birds by birdwatchers, hill-walkers, consultants and hunters, together with records from other surveys, were used to supplement the data collected by the standardised survey. This helped ensure that a more complete species range was identified.

2.7.5 Estimating species range

A subsample (N=64) of the 491 1km square sites was surveyed in both field seasons. In terms of inclusion in the final sample, the peak count was used. Sites were surveyed in both years to see whether there was any difference in densities recorded, which were examined using a Paired t-Test after $\log_{10}(x+1)$ transformation of the original count data.

The 'historic breeding range' was defined as all 10km squares with records of Red Grouse during the Old Atlas survey period of 1968-1972 (Sharrock, 1976). The national survey was focussed on resampling in this 'historic breeding range', as it was considered that this range was the most accurate representation of the species' past distribution in Ireland. Given the assumption that the New Atlas had under recorded the Red Grouse breeding range, it was assumed that the range detected by the Old Atlas was a more accurate representation of the 'potential' species range and it was unlikely that the grouse would be recorded outside of its former range.

The two distinct survey periods (over two winters 2006-07 and 2007-08) allowed for a widespread sample of sites to be completed across the five regions and across all suitable habitat types. As information on historic distribution with respect to habitat use in Ireland was lacking, sampling was in proportion to the area of heath and bog habitats within each region as categorised by CORINE Land Cover (EEA, 2000). In addition, any supplementary records received for the 2006-08 survey period were included in order to achieve as accurate a range as possible.

2.7.6 Population estimates

2.7.6.1 Methods for estimation

As the population was sampled in a stratified random manner, grouse densities in each stratum were calculated separately, based on field counts. By using the number of discarded 'unsuitable' sites in each stratum, the percentage suitability of remaining grouse habitat not surveyed in each stratum could be calculated. The mean numbers of 'males' and 'total grouse' recorded were calculated for each stratum (Region and Habitat type). These were multiplied by the total numbers of 'suitable squares' in each stratum. The resulting 'total grouse' figures for each stratum were then corrected for under recording of females using the correction figure obtained by the validation survey (see Section 2.7.3). The grouse densities in each stratum were multiplied by the area of 'suitable' grouse habitat in each stratum, to derive population estimates for that stratum. As 'suitability' of sites not surveyed differed between regions and densities differed across regions also, the sum of the regional estimates differs slightly from the national population estimate which was extrapolated using mean national density and suitability figures. Similarly the sum of the habitat estimates differs for the same reasons. Confidence limits for all population estimates were calculated using the bootstrap procedure, as this does not assume the data is normally distributed (Crawley, 2005).

2.7.6.2 Local population estimates

Similarly, estimates for localised populations of grouse in designated areas were derived using the information garnered from the tape-playback survey regarding regional densities and regional suitability of sites. Using regional density figures for grouse, together with areas of potential suitable grouse habitat (using CORINE Land Cover data, EEA, 2000), estimates of grouse populations on some designated sites (see Table 2A in Appendix 2) were derived. However, it is very important to note that these estimates are likely to be biased as CORINE Land Cover data does not give any indication of habitat quality, merely underlying habitat type. That is, areas identified as blanket bog may not possess suitable characteristics for grouse (such as adequate percentage heather cover). In addition, the use of broader scale regional density figures and regional suitability figures does reduce the accuracy of those calculated local

population estimates (it would be more preferable to use local density/suitability figures if available) but at the same time it does allow the generation of estimates for areas where few sites were actually surveyed.

2.7.7 Effect of elevation on patterns of distribution

Relationships between grouse densities and elevation were also examined. Minimum elevation, maximum elevation and the average elevation figures for each 1km square were calculated using map data in *ArcView GIS 3.2*.

2.7.8 Landowner permission

Given the difficulties in establishing ownership of many of the upland areas in Ireland, landowner permission was sought where possible. However, mostly surveyors accessed land with the understanding that they approach any local farmers or landowners on entry to request permission. No real problems with landowner access were encountered except for one incidence on Achill Island where permission was refused.

2.7.9 Unsuitable areas

The following habitats were considered unsuitable for Red Grouse and were not surveyed: built-up areas, enclosed arable or pastoral farmland, dense forest blocks, dense native woodland. Where possible, surveys were carried out in times of good visibility with little or no rain and avoiding strong winds (Beaufort scale: wind-force > 4).

2.7.10 Health and Safety

All surveyors were given instruction and provided with 'Health and Safety' guidelines prior to carrying out the field survey. In addition surveyors were provided with procedures for the correct carrying and use of the tape-playback equipment (Plate 7). Given the often remote and treacherous terrain of the sites, the methodology was devised so that observers were never more than 250m away from one another, in case of an emergency.

2.7.11 Response rate

2.7.11.1 Tape-playback methods

If the aim is to determine whether a species is present or absent then tape-playback may simply increase the chance of finding it (Evans *et al.*, 2007). To generate a reliable method, the probability of birds responding to the tape was held as constant as possible. This was aided by standardising the manner in which the tape was played and ensuring the tape was not played to any one individual too frequently, causing it to habituate and respond less frequently.

2.7.11.2 Time of day

The average time spent surveying a site was 1 hr and 35 mins (+/- SD 36 mins), with the average start time being 12:40 and finish time 14:16 (min 8:14, max 18:00). These figures highlight that the survey methods were conducive to working at any time during daylight hours and the average length of time to survey a square (excluding walking into the square) was not too excessive, which is important considering the time of year and types of terrain.

2.8 A survey of Red Grouse (*Lagopus lagopus*) habitat in Ireland 2007 – 2008

It is widely known that Red Grouse are associated with specific habitat types, namely bogs and heath. The appropriate assessment of the effects of habitat condition and land-use in these habitats on their distribution in the Republic of Ireland led to 'A survey of Red Grouse (*Lagopus lagopus*) habitat in Ireland 2007–2008', being carried out (abbreviated to RGHS in this report). A total of 100 1km square sites were selected for detailed habitat survey. These represented a stratified random subset of sites that were previously surveyed for Red Grouse as part of the national Red Grouse Survey. Patrick Crushell and Richard O'Callaghan conducted the botanical surveys and produced a final report, which detailed the data collection and methodology used (Crushell & O'Callaghan, 2008). In addition a set of maps were produced for each site surveyed (using ArcView GIS, Version 9.2), one detailing the extent and condition of habitats and a second showing the extent of various land-uses and the topography of each site. These botanical data were then incorporated into the analysis of this report in order to test whether habitat condition, particularly on blanket bog and heath, and land use had an influence on the current distribution of Red Grouse in Ireland.

The field survey methods used for the RGHS largely followed those originally developed by NPWS and the Department of Agriculture and Food to assess the impact of grazing [including assessing heather damage using McDonald (1993)] in upland and peatland habitats for the drafting of Commonage Framework Plans (NPWS and Department of Agriculture and Food, unpublished).

2.9 Data Analyses

Analyses used took into account problems with survey census data (Royle & Nichols, 2003) and assumed that the population sampled was closed to demographic processes such as mortality and movement. Problems with such data include:

1) spatial coverage bias - not all individuals in the population are exposed to sampling
2) detection bias - exposed individuals may go undetected
3) 'spatially referenced data' – closer samples may be more similar to each other than distant samples. In such cases it is recommended that the sample size should be as large as possible (Legendre *et al.*, 2002).

The first of the models (*Generalised Logistic Model with binomial error link*) used incorporated grouse presence or absence as the response variable with region and habitat types as the categorical variables. It was used to test whether there were any significant region or habitat effects (landscape level) driving grouse presence or absence. Model parsimony was reached after the removal of non-significant terms (using the F-test) from the models. The models were not overdispersed, although as the response variable was binomial, overdispersion was not a real concern (Crawley, 2005).

The second model (*Generalised Linear Model with binomial error link*) incorporated the more detailed habitat data collected as part of the Red Grouse Habitat Survey. Using data such as average heather height in squares, percentage damage to grouse habitats in squares and altitude data, we were able to assess with finer measures whether there were certain habitat structures/variables driving the distribution of Red Grouse populations. Given the smaller sample size (N=100), there were problems associated with this

analysis and density estimates could not be used as the dependent variable due to overdispersion (residual scaled deviance was much larger than the residual degrees of freedom). Also, as many of the variables collected were correlated, a simpler model was used that incorporated only those variables considered the most important after examination of the raw data across occupied and unoccupied sites.

Unless stated otherwise, any figures quoted in the main body of the text are the mean (± 1SD).

2.9.1 Statistical Software

All analyses were performed either in R (freeware Version 2.7.1) or S-Plus 8 .

3.0 RESULTS

3.1 Survey outcome

A large amount of data was collected for the national Red Grouse Survey, with 491 1km square sites specifically surveyed for Red Grouse. In addition a sub-sample of these sites (100 in total) was also assessed in detail by the accompanying Red Grouse Habitat Survey. After detailed scrutiny and analyses of the data collected, the most important results are presented in this section.

3.1.1 Overview

The population of Red Grouse was estimated at approximately 4,220 birds (95% C.L.'s 3,795 – 4,702) for the Republic of Ireland, including 2,310 males (95% C.L.'s 2,036-2,589). This gives a sex ratio of 1.2:1 for males to females. These derived population estimates were reached after evaluating the suitability of remaining areas of habitat in strata that were not surveyed. Red Grouse have been lost from an estimated 50% (using all records collected from 2006-08) of their former historical range, based on changes in occupancy of 10km squares from 1968 to 2008.

3.1.2 Survey coverage

A total of 491 1km^2 distributed across 188 10km^2 were surveyed between 2006 and 2008. This sample of 491 1km^2 was taken from an initial selection of 5,963 1km^2 potentially suitable grouse sites that were initially identified as possessing 'potentially suitable habitat' for Red Grouse using CORINE Land Cover Data (EEA, 2000). From this initial sample (N=5,963), 491 1km^2 were actually surveyed (8.2%) with 1,133 1km^2 (19%) dropped due to unsuitability (Figure 3A in Appendix 3) after assessment using aerial photographs and/or ground truthing. Using these numbers for dropped squares, the percentage suitability figures for all remaining 1km squares in each stratum were calculated and were used to derive regional population estimates (see Section 3.2).

3.1.3 Responses to tape-playback

Based on the assumption that the probability of a response in a square (P_s) is equal to the number of responses in that square (N_r) divided by the total number of grouse for that square (Ts) (excluding repeat responses).

$$P_s = N_r / T_s$$

The average probability of detection per square was 0.38 (± 0.46 SD).

3.1.4 Comparison of methods: error in detection of the sexes

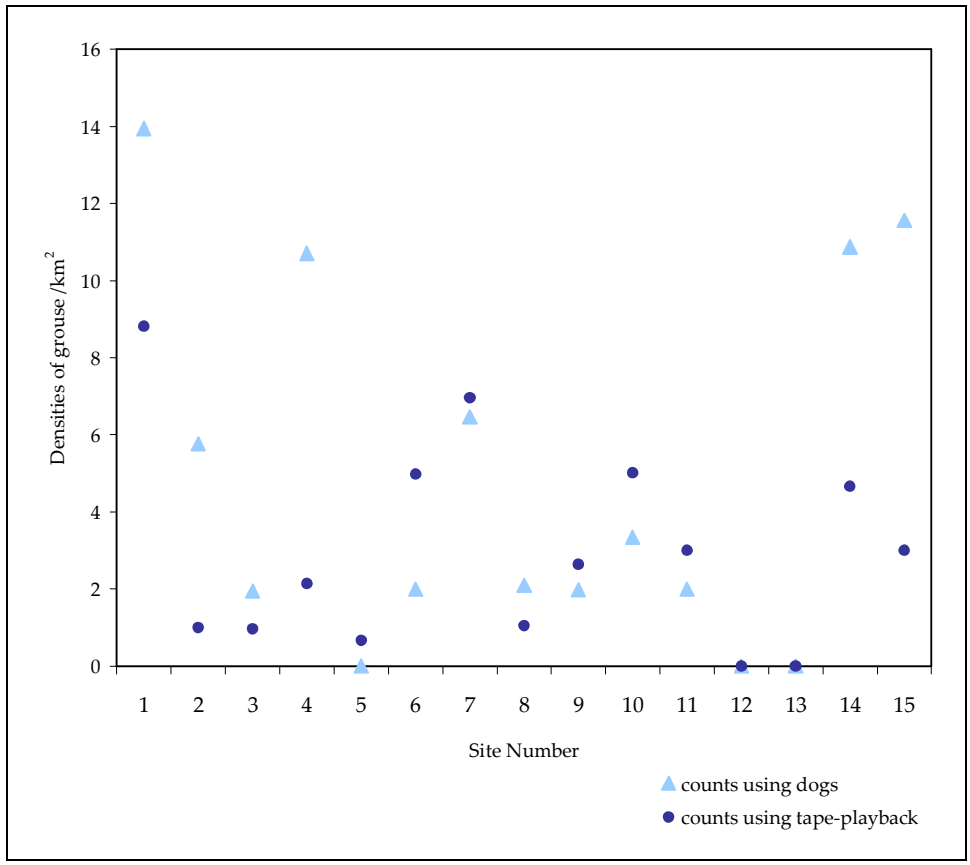


Figure 3: Scatter plot of the densities (per km^2) of Red Grouse detected in 15 sites using both dogs (filled squares) and tape-playback (empty circles).

It is evident from Figure 3 that there is variation between the two methods in terms of the densities of birds recorded, but at the majority of sites the densities were largely comparable. The results of the Paired t-test (Table 1) show that there was no significant difference in the densities of grouse recorded per unit area in sites surveyed using dogs and repeated using tape-playback methods. Grouse were seen in 13 out of 15 sites (with both methods detecting no birds in two sites and zero detection using dogs at another site). In addition, in a site where no actual birds were seen using either method, fresh droppings were recorded (assumption this site incorporated the territory of at least one bird) on the visit using dogs. The total number of birds detected using dogs was greater than the total number detected using tape-playback, as expected.

Table 1: Results of standardised repeat counts using dogs and tape-playback methodologies. The average area surveyed was 1.2 km ± 0.6 (N=15).

Method	Total No	Densities / km²
Tape-playback	62	2.99 ± 2.62
Dogs	90	4.84 ± 4.74
Paired t-Test		t value = 0.16
Comparison test of paired samples (cosine transformed densities)		d.f.=28
		P=0.9

3.1.5 Distribution at 10km level

The distribution of Red Grouse in the Republic of Ireland, based on occupancy of 10km squares surveyed as part of the tape-playback methodology, is shown in Figure 4. In total, 107 10km squares were occupied out of a total of 188 surveyed. Sites with 'fresh droppings' were labelled as having 'recent evidence' of grouse. An additional four sites with 'old droppings' or feathers and no grouse sightings were labelled as having 'past evidence' of Red Grouse but could not be deemed recently occupied.

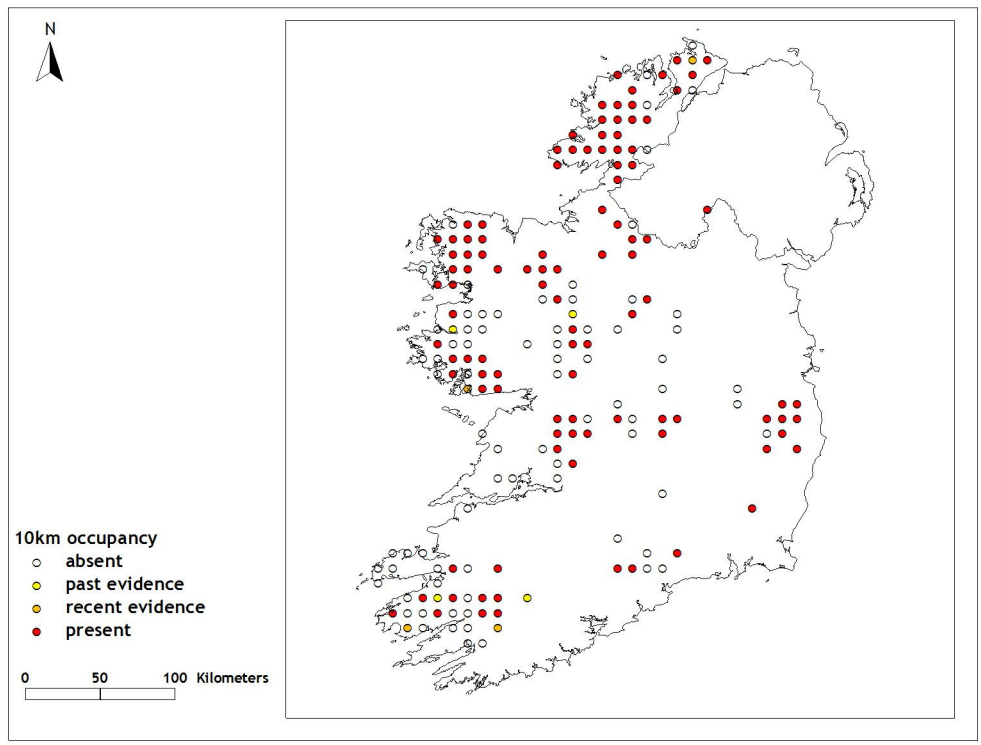


Figure 4: Distribution of Red Grouse at the 10km² level using results derived from the tape-playback survey. A total of 188 10km² were surveyed between 2006 and 2008.

3.1.6 Distribution at 1km level

The distribution of Red Grouse at a finer landscape level was assessed by looking at occupancy of 1km squares surveyed using tape-playback methods as part of the wider national survey. Overall, 229 of the 491 1km squares surveyed using tape-playback were deemed occupied (i.e. birds seen / fresh signs). Of these 229 occupied 1km squares, 30 also had records from the Casual Sightings database. From Figure 5, it is evident that there are a number of strongholds for the species.

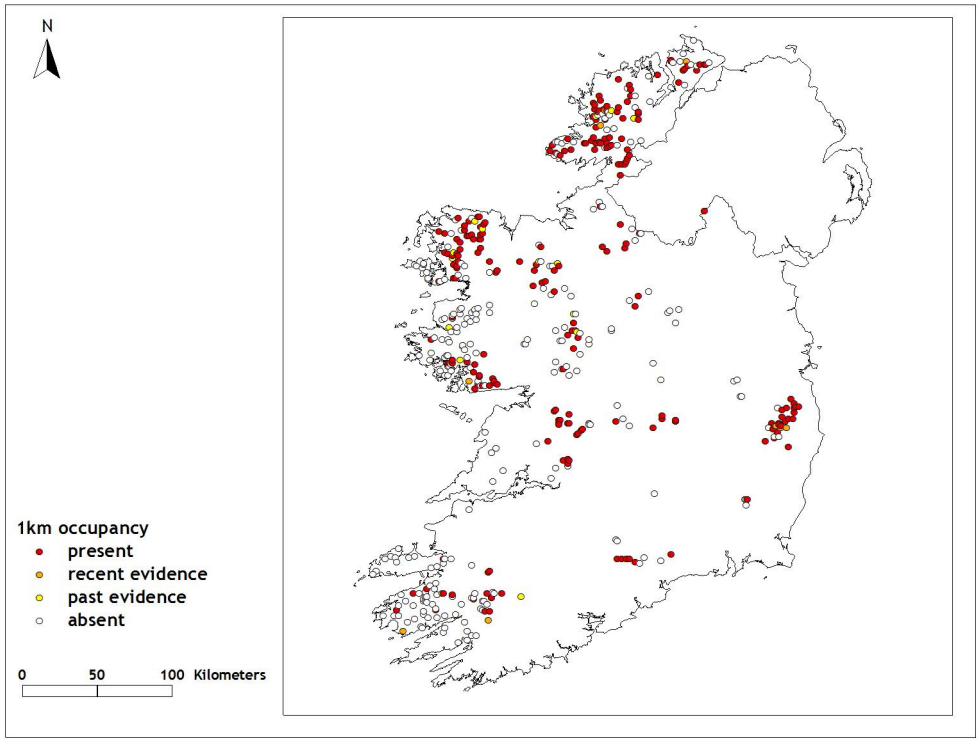


Figure 5: Distribution of Red Grouse at the 1km² level using results derived from the tape-playback survey. A total of 491 1km² were surveyed between 2006 and 2008.

On the east coast, most sites surveyed (24 out of 29) in the Dublin Mountains and Wicklow Mountains (*SAC 002122* and *SPA 004040*) were occupied by Red Grouse. In the Slieve Bloom Mountains (*SAC 000412*) in Counties Laois and Offaly, all five sites surveyed were occupied. In the southeast of the country, approximately half of all sites surveyed were occupied with records for Mount Leinster in County Carlow (Blackstairs *SAC 000770*) and the Knockmealdown Mountains and the Comeragh Mountains (*SAC 001952*) in Counties Tipperary and Waterford.

Occupancy in the Southwest region was poor, with positive records for only 15 out of 84 sites surveyed. Moving further up the west coast, there were some records for County Clare, mainly in the east (Slieve Bearnagh *SAC 002312*) and northeast of the county with most sites occupied across the border (12 out of 15) in southeast County Galway [Slieve Aughty Mts. (*SPA 004168*) and Loughatorick South Bog (*SAC 000308*)].

Red grouse survey 2006-08

In the West Connacht region, there was marked variation in occupancy between different areas, with over half of sites occupied in the Connemara Bog Complex (*SAC 002034*). However, further north and west there were few records for The Twelve Bens/Garraun Complex (*SAC 002031*) and Mweelrea/Sheeffry/Erriff Complex (*SAC 001932*) and none at all for the Maumturk Mountains (*SAC 002008*). In the Owenduff SPA/SAC (*SPA 004098/SAC 00534*) 13 out of 18 sites (lying partly or wholly within the SPA/SAC) were occupied. Further north and due east of the Owenduff, 22 out of 28 sites were occupied. Overall, the northern half of County Mayo had reasonable populations with grouse in 46 out of 70 sites. Moving further along the Irish coast, north-eastwards, there was a record for the Ox Mountains Bogs (*SAC 002006*) in Co. Sligo.

In the Northwest Border region there were a scattering of records for the Cuilcagh-Anierin Uplands (*SAC 000584*) and a record on Boleybrack Mountain (*SAC 002032*) in County Leitrim and on Slieve Beagh (*SAC 004167*) in County Monaghan. In Donegal, most sites were occupied (almost two thirds) with birds present in 13 out of 16 sites in Cloghernagore Bog and Glenveagh National Park (*SAC 002047*). On the Inishowen Peninsula, 11 of the 19 sites surveyed were occupied. On the Glencolumbkille Peninsula, 9 out of the 16 sites surveyed had grouse, while further east and south in the county there were records of grouse on Lough Nillan Bog (*SAC 000165*), Meenaguse Scragh (*SAC 001880*), Meenaguse/Ardbane Bog (*SAC 000172*) and Dunragh Lough/Pettigo Plateau (*SAC 001125*).

In the Midland region, all sites surveyed were on Raised Bogs (both exploited and intact). There were few records of Red Grouse with most occupied sites located in northeast County Galway, east County Mayo and County Roscommon. In east County Galway, Kilsallagh Bog (*SAC 000285*), Lisnageeragh Bog and Ballinastack Turlough (*SAC 000296*), Camderry Bog (*SAC 002347*) and Carrownagappul Bog (*SAC 001242*), had grouse records. In County Roscommon, Derrinea Bog (*SAC 000604*) had a record and there were further records on the raised bogs around the River Moy (*SAC 002298*).

3.1.7 Changes in species range in the last 40 years

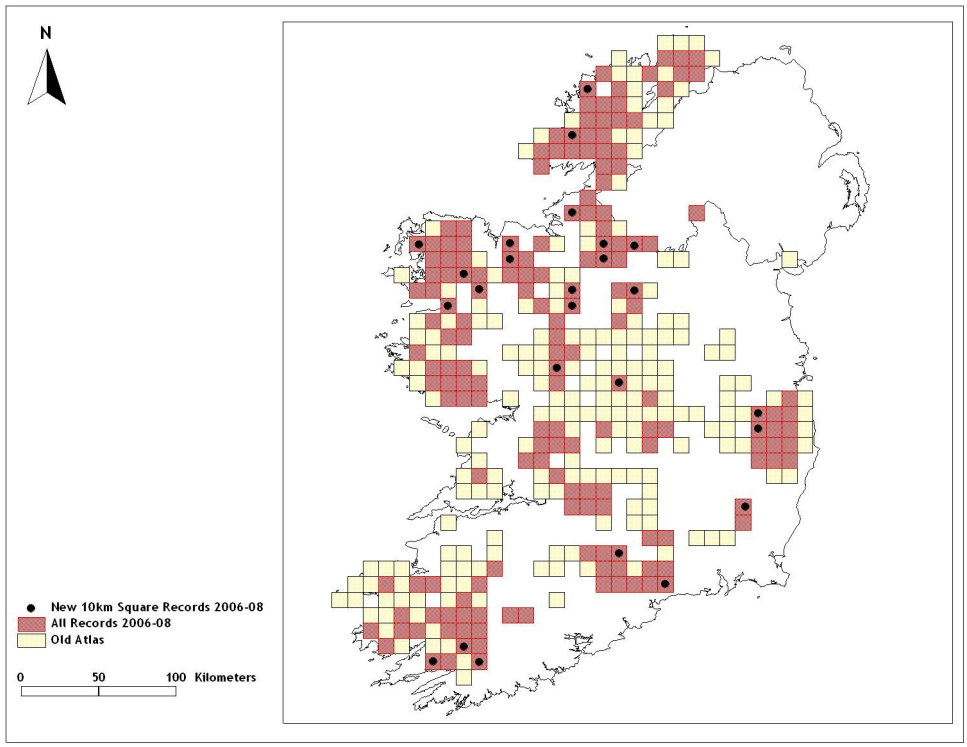


Figure 6: All records collected between 2006 and 2008 during the survey period.

Includes records from tape-playback survey, counts using dogs, incidental sightings and counts from other scientific surveys (see Table 2). New records for those 10km² not occupied in the Old Atlas (1968-1972) are also highlighted.

Records of Red Grouse presence or absence, from a number of sources, proved invaluable in improving on Figures 4 and 5 to give an overall picture of Red Grouse distribution in Ireland (Figure 6). The sources of these additional data are given in Table 2 along with their contribution. The addition of these supplementary records for the period 2006-08, was fundamental as it allowed an extra 65 10km squares to be added to the 107 10km squares deemed occupied by the tape playback survey, thereby giving a total of 172 10km squares occupied in the Republic of Ireland. Five of these extra 65 10km squares overlapped with sites already surveyed using tape-playback, but deemed unoccupied and only one of these records was of a grouse seen on site, the remainder were records of fresh caecal droppings or pellets. A total of 25 new 10km squares were identified by the RGS that were not occupied in the Old Atlas (1968-72).

Table 2: Sources of additional data on Red Grouse distribution 2006-08 only.

Source	No. of positive records	All records	% of positive records
Red Grouse Survey 2006-08	65	75	13%
(Records outside 1km survey square)			
Red Grouse Habitat Survey 2007-08	21		4.2%
Casual Sightings 2006-08	204	241	42.8%
	(+10 probable records)		
NPWS Conservation Rangers 2006-08	96	142	19.6%
	(+ 2 probable records)		
NPWS Research Staff 2007-08	12	20	4%
	(+ 8 probable records)		
Countryside Bird Survey	2		0.4%
Bogland Survey UCD	3		0.6%
IKC and NARGC Casual Sightings	62	68	12.4%
RGS-Standardised Counts	14	15	2.8%
Commonage Framework Plans	1		0.2%

Total tally thus far N=500 and includes records with recent evidence (probable) only i.e. fresh droppings. All records include areas that were surveyed for grouse that did not have positive sightings or signs (i.e. no droppings or only 'old' droppings).

Table 3: Changing distribution of Red Grouse from 1968-1972 to 2006-08 using changes in occupancy of 10km².

Region	Old Atlas	New Atlas	RGS 06-08 (Tape-playback)	All records 2006-08
Southwest	43	13	11	23
% decline		*70*	*74*	*47*
East and South	121	39	24	50
% decline		*68*	*80*	*58*
West Connacht	49	15	27	38
% decline		*69*	*45*	*22*
Midland	65	15	11	16
% decline		*77*	*83*	*75*
Northwest	67	25	35	45
% decline		*63*	*48*	*33*
Total	345	107	107	172
% decline	-----	***69***	***69***	***50***

Taking these supplementary data into account (Table 2), the decline in species range since the Old Atlas in 1968-72, is established at 50%. The magnitude of this decline does vary across regions (Table 3) with less severe losses in the Northwest and West Connacht regions and greater declines in the Midland region (75%) and the Southwest region (58%).

3.2 Population estimates

For those 64 sites that were surveyed in both 2006-07 and 2007-08, there was no significant difference in occupancy recorded across years (Wilcoxon z=0.5, d.f.=63, P=0.62) or in the mean densities recorded at sites (Paired t-Test t=1.4, d.f.=63, P=0.15) between years. As there was no significant difference between years, population estimates were not separated out across years.

Population estimates were determined by extrapolating the densities calculated for each stratum across the entire area of 'potentially suitable' habitat within each stratum so that regional population estimates could be derived. Table 4 clearly shows the regional differences in population estimates with greatest numbers in the Northwest and West Connacht regions and fewer birds in the Midlands and Southwest regions. Differences in grouse occupancy between regions were detected (see Section 3.2.3). However, differences in regional densities of birds across the 491 1km² could not be determined due to poor model fit. Given the distribution results highlighted in Table 3, these figures were not unexpected. The population of Red Grouse in the Republic is estimated at 4,200 (figure quoted to the nearest 100) after applying a correction factor for under-recording of females, with almost 55% of the total being territorial males (2,310).

Table 4: Population estimates with regional breakdown of estimated numbers.

Region	Male density/km² Mean ± CL's	Estimate of Total Males ± C.L.'s	National Estimate (correction factor*) Total Grouse No.s ± C.L.'s
East and South	1.22	323	685
	0.9 - 1.5	*255 - 395*	*542 - 804*
Midland	0.5	34	59
	0.3 - 0.9	*19 - 60*	*37 - 96*
Northwest	1.21	1286	2038
	1 - 1.4	*1060 - 1526*	*1702 - 2431*
Southwest	0.23	73	132
	0.12 - 0.3	*38 - 102*	*76 - 209*
West Connacht	0.64	773	1376
	0.5 - 0.8	*628 - 932*	*1120 - 1652*
Overall	0.79	2310	4218
	0.7 – 0.89	*2036 - 2589*	*3795 - 4702*

* The correction factor (1.31) was applied to account for under-detection of females using the tape-playback method. It was derived using repeat counts of defined areas using dogs and tape-playback (see Section 3.1.4). All figures in the right hand column are extrapolated, based on the sampling design.

Table 5 details the estimates for Red Grouse populations' sizes across habitat types (as identified using CORINE Land Cover Data, EEA, 2000). Mountain blanket bog came out as the most important habitat in terms of numbers, followed by upland blanket bog which together accounted for 75% of the total national population. Numbers on raised bogs were extremely low at only 2% of the national figure.

Table 5: Population estimates with habitat breakdown (using CORINE Land Cover classes) of estimated numbers.

Habitat	**Males**	**Total Males**	**National Estimate (correction factor)**
	Mean No. ± C.L.'s	± C.L.'s	**Total Grouse No.s** ± C.L.'s
Lowland Blanket Bog	0.52	327	578
	0.38 - 0.66	*239 - 412*	*447 - 760*
Moors & Heath	1.35	257	407
	0.83 – 1.9	*158 - 365*	*283 – 584*
Mountain Blanket Bog	1.0	1102	2116
	0.83 – 1.2	*906 - 1269*	*1749 - 2501*
Upland Blanket Bog	0.88	640	1061
	0.72 – 1.1	*524 - 794*	*863 - 1302*
Raised Bog	0.47	37	71
	0.28 – 0.81	*22 - 64*	*48 - 111*

* The correction factor was applied to account for under-detection of females using the tape-playback method. It was derived using repeat counts of defined areas using dogs and tape-playback (see Section 3.1.4). All figures in the right hand column are extrapolated, based on the sampling design.

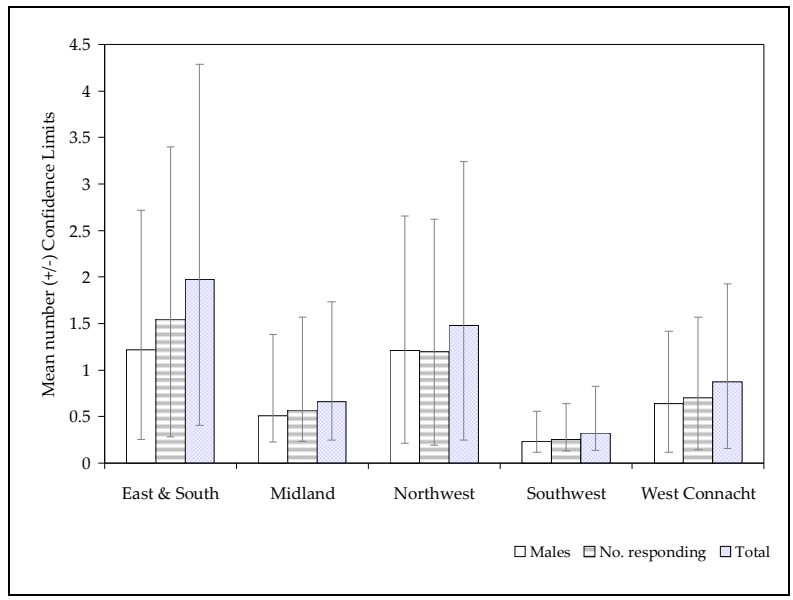


Figure 7: Average densities of Red Grouse across the five regional divisions of the 491 1km² surveyed as part of the tape-playback survey (2006-08).

3.2.1 Changes across Region Classes

Regional differences in densities of Red Grouse (Figure 7) reinforce the assumption that populations are more densely distributed in terms of numbers per unit area in some regions (East and South and Northwest) over others (Southwest and Midland).

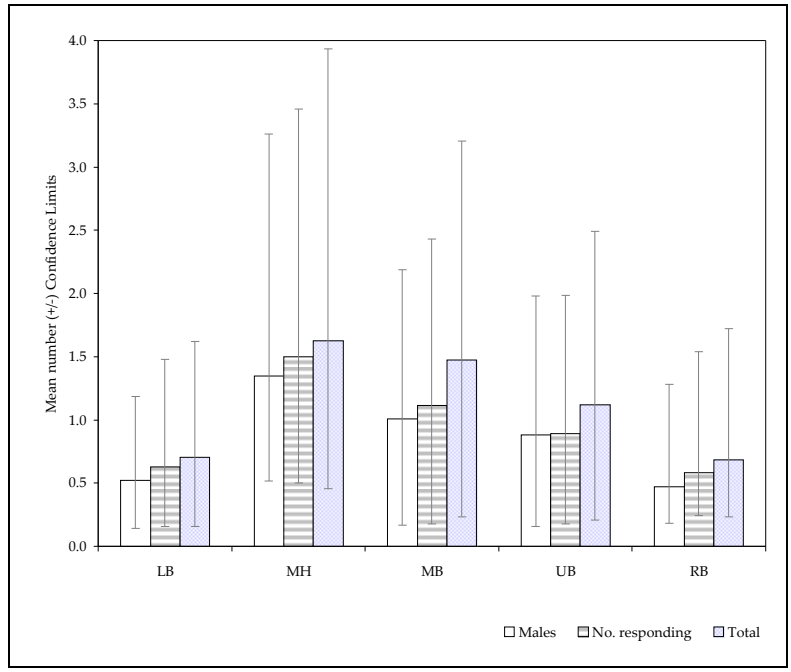


Figure 8: Average densities of Red Grouse across the main habitat classes (EEA 2000) identified for the 491 1km² covered as part of the tape-playback survey (2006-08).

Abbreviations used: LB (lowland blanket bog), MH (moors & heath), MB (mountain blanket bog), UB (upland blanket bog), RB (raised bog).

3.2.2 Changes across Habitat Classes

Differences in densities across habitat classes (Figure 8) show that the highest densities recorded were on mountain blanket bog, moors & heath and upland blanket bog habitats with lowest densities on lowland blanket bog and raised bog.

3.2.3 Results of GLIMS for all sites surveyed

Analysis of the occupancy data collected for the 491 1km^2 sites surveyed nationally showed that there were differences across both habitat and region classes in Red Grouse presence or absence, with these differences significant across regions (Table 6). An examination of the occupancy values across habitat classes reveals that occupancy on heath (at almost 70%) was the highest followed by mountain blanket bog (60%) and upland blanket bog (47%) with lower rates of occupancy on lowland blanket bog (37%) and raised bogs (28%). Regionally, sites in the East and South had significantly higher rates of occupancy (68%) compared to the Southwest (18%) which had the lowest rate, followed by the Midland (28%), West Connacht (45%) and Northwest (66%) regions. There was also a significant positive northerly effect in terms of geographic location, with sites more likely to be occupied moving northwards from the far southwest up through the country. As the Southwest region had the lowest rates of occupancy, this result is not surprising. As mentioned above, greater levels of occupancy were recorded in the East and South (most occupied sites in Co. Clare, Co. Laois and Co. Wicklow). Also a significant positive effect for elevation meant that sites in upland areas were more likely to be occupied than on lowland or raised bogs.

Table 6: Factors driving Red Grouse distribution.

Analysis of the main variables driving Red Grouse distribution. Presence/absence data for those 491 1km^2 survey sites were analysed using a minimum adequate binomial regression model. Parameter estimates are presented below.

Category	Estimate (logit scale)	S.E.	Z-value	P value
Intercept*	-3.19	0.8	-3.97	0.0001
Lowland Blanket Bog	-0.27	0.58	-0.46	0.64
Mountain Blanket bog	0.51	0.56	0.91	0.37
Raised bog	-1.13	0.96	-1.18	0.24
Upland blanket bog	-0.28	0.54	-0.51	0.61
Northwest	-1.14	1.1	-1.1	0.3
West Connacht	-0.75	0.8	-0.98	0.33
East and South	**1.27**	**0.5**	**2.54**	**0.01**
Midlands	0.11	1.1	0.1	0.91
Max Elevation (m)	**0.002**	**0.0008**	**2.08**	**0.038**
Northings	**.00001**	**0.000003**	**3.57**	**0.0004**

*Category estimates for' Moors & Heath' and the 'Southwest' were set to 0 and all other estimates given are relative to the intercept.

Note: Habitat was retained as a categorical variable in the model, as dropping it resulted in a significant change in the deviance (model fit). All non-significant terms were dropped.

3.2.4 Differences in the breakdown of habitats (CORINE Land Cover Data) across occupied and unoccupied sites

To see whether there were any differences in the areas of grouse habitats in sites where Red Grouse were present versus absent, the mean percentage area of habitats across survey sites, classified using CORINE Land Cover Data (EEA, 2000), was calculated. The most striking difference was that the total area of mountain blanket bog was greater across occupied sites whereas the opposite was the case for lowland blanket bog (Figure 9).

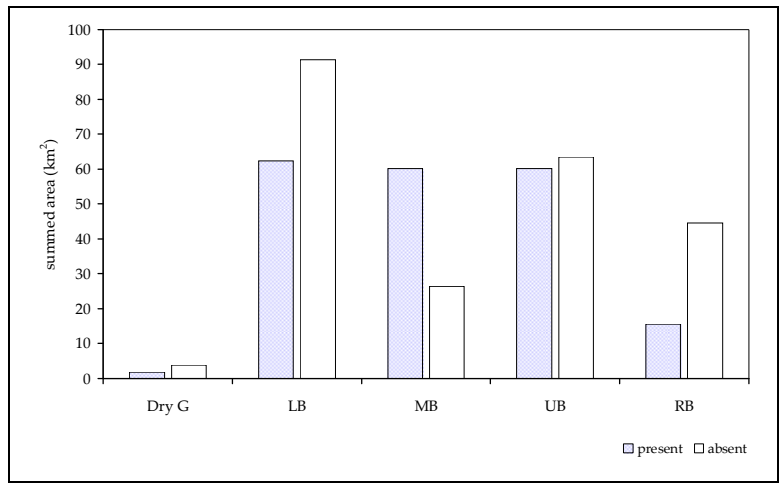


Figure 9: Summed area of main habitats (derived from EEA CORINE Land Cover Data 2000) present in the 491 1km square survey sites covered as part of the national Red Grouse Survey (2006-08).

Abbreviations used: DryG (Dry Grassland), LB (lowland blanket bog), MB (mountain blanket bog), UB (upland blanket bog), RB (raised bog).

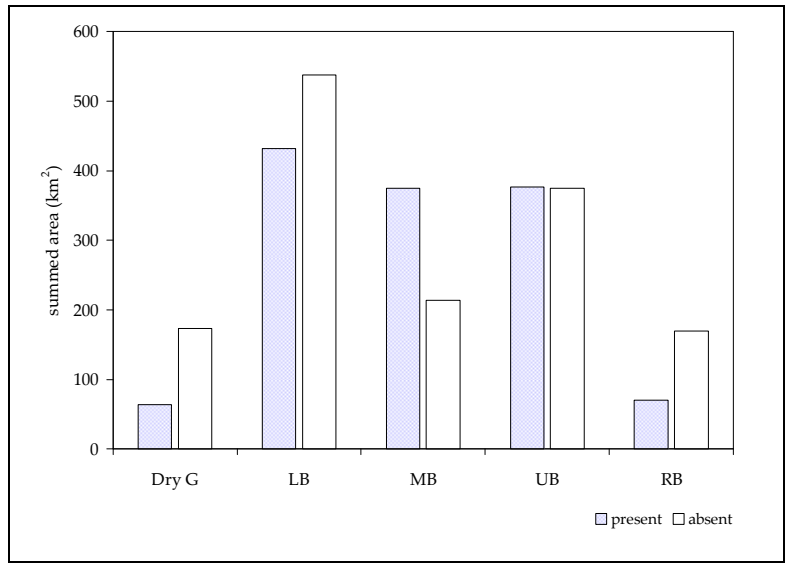


Figure 10: Summed areas of main habitats (derived from EEA CORINE Land Cover Data 2000) present in and around (a buffer zone of 1km²) the 491 1km square survey sites covered as part of the national Red Grouse Survey (2006-08).

3.2.5 Differences in the breakdown of habitats (CORINE Land Cover Data) within a buffer zone of 1km around occupied and unoccupied sites

Similarly when the habitats in the buffer zone of the nine 1km squares in and around survey sites were assessed for differences between occupied and non-occupied sites, the most marked difference was the greater area of mountain blanket bog in sites that were occupied by grouse (Figure 10). The inclusion of a 1km^2 buffer zone did not alter the results illustrated in Figure 9.

3.2.6 Differences in elevation between occupied and unoccupied sites

Red Grouse were found in sites with wide-ranging differences in elevation in the Republic of Ireland; the average maximum contour of sites where they occurred was calculated as 302m (± SD 192m) with a range of 30m-810m. In sites without records, the average maximum contour was 225m (± SD 170m) with a range of 10m-940m. These figures reflect the previous results in Section 3.2.3 that highlighted the importance of mountain blanket bog, a habitat occurring over 300m a.s.l., to Red Grouse. The average elevation figures of occupied sites and unoccupied sites across the main habitat classes are given in Table 7.

Table 7: Differences in the elevation of occupied and unoccupied sites across habitats (using CORINE Land Cover Classes)

Habitat	Occupied	Unoccupied
Moors & heath	392.7m ± 130	445.7m ± 234.9
Lowland blanket bog	132.8m ± 52.2	141.4m ± 64.7
Mountain blanket bog	419.7m ± 224.5	326.1m ± 238.5
Raised blanket bog	138.6m ± 133.9	71.2m ± 21.9
Upland blanket bog	283.5m ± 55.9	309.4m ± 80.6

3.3 Commonage Framework Plan Study links

3.3.1 Sites occupied by Red Grouse lying within Commonages assessed for grazing damage

The habitat classification used in the Commonage Framework Plans (NPWS and Department of Agriculture and Food, 1999) differs from that of CORINE Land Cover (EEA, 2000) with mosaics of two or more habitats classified into separate categories. An analysis of those sites surveyed for Red Grouse that also lay within 'commonage areas' assessed by planners indicated that the percentage of undamaged habitat was greater in sites that had Red Grouse and conversely the percentage of severely damaged habitat was greater in unoccupied sites (Figure 11). However, the proportion of damage (i.e. areas of moderate to severe damage as classified by CFPs) to habitats for those squares (N=328) assessed by CFPs (either partly or wholly) did have a significant negative effect on Red Grouse occupancy when tested using logistic regression with binomial errors (see results in Table 8). Similarly, when figures of damage were plotted for sites including a buffer zone of 1km around the survey sites, the same pattern was observed.

3.3.2 Any relationship between grouse densities and habitats as assessed by CFPs

Commonage areas that were a mosaic of blanket bog and wet heath featured strongly in sites that had Red Grouse present (Figure 12). Areas of dry heath were often in a mosaic with areas of wet heath and

grassland and therefore any strong associations between grouse densities and dry heath were harder to interpret.

3.3.3 Breakdown of habitat categories in a buffer zone of 1km in and around sites with and without grouse lying within Commonage.

Once again, an assessment of the breakdown of these habitat categories across occupied and unoccupied sites revealed a much greater percentage of blanket bog/wet heath mosaic in sites that had grouse versus sites that did not. As these data mirror the pattern in Figure 12, they were not plotted.

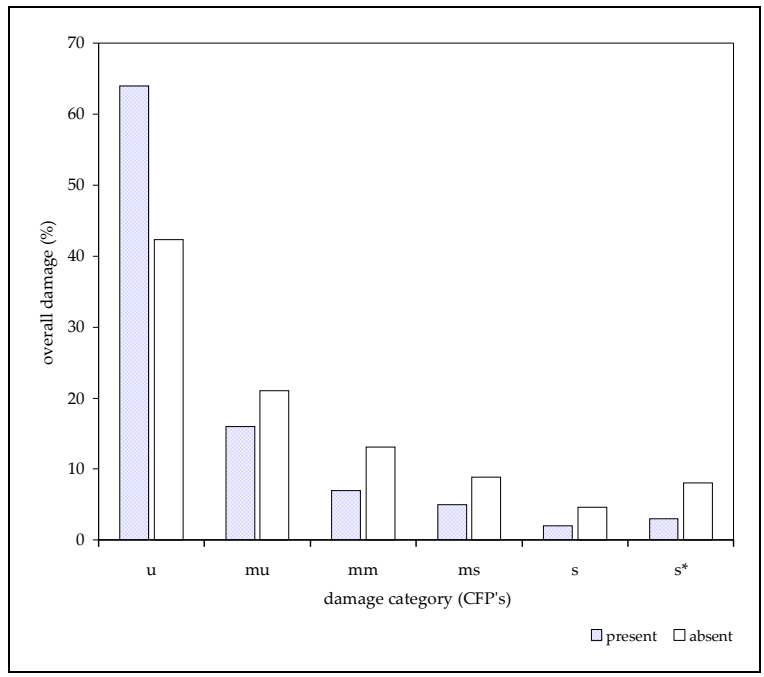
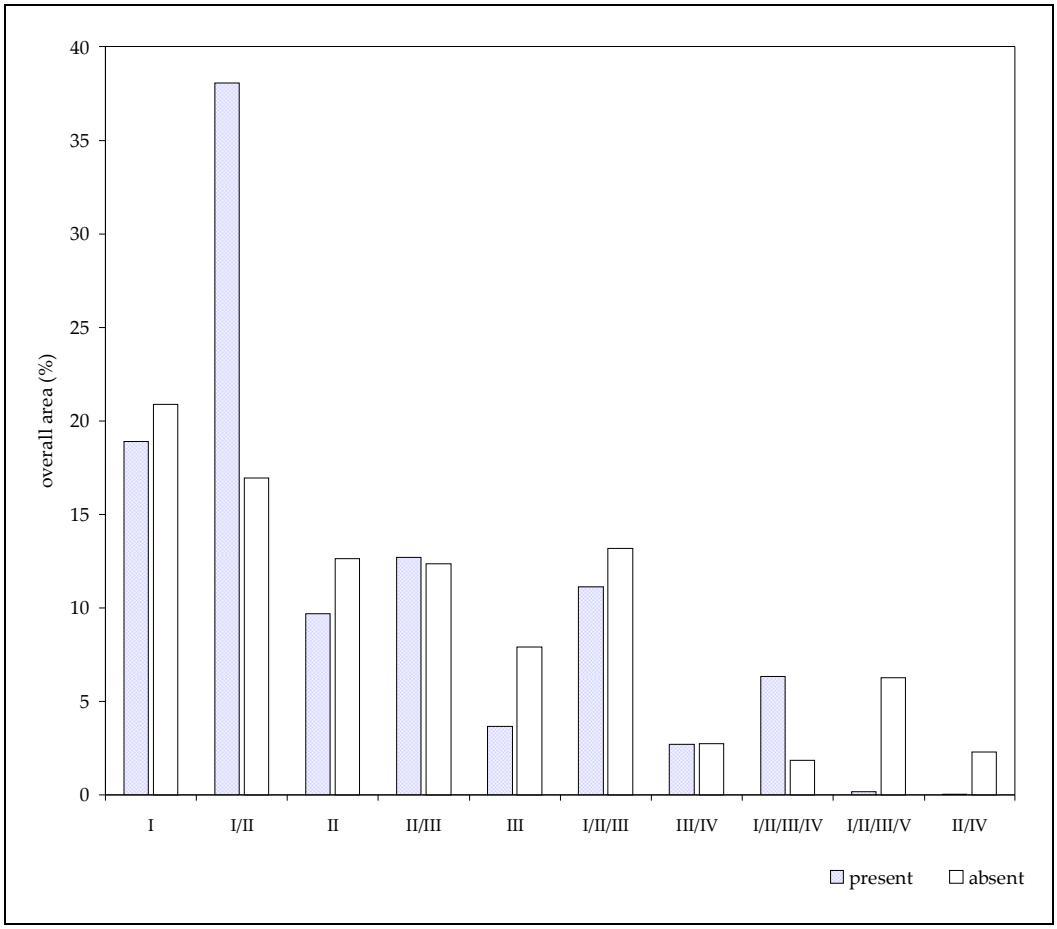


Figure 11: Differences in the total percentage damage figures across grazing damage categories between sites with Red Grouse present and absent during the national Red Grouse Survey (2006-08).

Note: categorical data on grazing damage assessments were collected by the Commonage Framework Plan Study. The total percentage damage in each category (u=undamaged, mu=moderate to undamaged, mm=moderate, ms=moderate to severe, s=severe, s*=very severe) across occupied/non occupied sites is given. See Appendix 12 (Table 2.3) for a full explanation of each of the damage categories. The total number of sites within commonage that had Red Grouse was equal to the total number of sites that did not, both at N=165.

Table 8: Parameter estimates were derived using a binomial regression model to test for the effect of grazing damage on Red Grouse occupancy in those 330 1km^2 sites where vegetation was assessed in part/ or whole by CFPs.

Category	Estimate (logit scale)	S.E.	Z-value	P value
Intercept*	0.0807	0.13	0.62	0.535
Damage categories				
(∑ mm, ms, s, s*)	-1.23	0.43	-2.83	0.005



COMMONAGE FRAMEWORK PLAN STUDY: HABITAT CLASSIFICATION SYMBOLS

BLANKET BOG	**I**
WET HEATH	**II**
DRY HEATH	**III**
GRASSLAND	**IV**
OTHER HABITATS	**V**

Figure 12: Breakdown of total area of habitats (classified according to C.F.P.s) in sites where Red Grouse were present or absent using results from the RGS 2006-08.

Note: The total number of sites within commonage that had Red Grouse was equal to the total number of sites that did not, N=165 for both.

3.3.4 Population estimates for those areas assessed by Commonage Framework Planners

Areas which have been and continue to be assessed for grazing damage by C.F.P. planners will play a very important role in future monitoring of grouse populations and their recovery in key areas, such as the Owenduff/Nephin SPA/SAC. If C.F.P. planners are to monitor vegetation for grouse, the *Molinia* dominated areas in wet heath (in peat depth zones of 15-80cm) which may have been classed as undamaged in the C.F.P. study would need to be highlighted as poorer areas for grouse due to the scarcity of heather or its complete absence. The suitability of any heather in these areas would have to be examined also.

Estimates of grouse populations were extrapolated for all commonage areas on a regional basis, using the same methods as those applied to generate national population estimate figures. Potentially suitable commonages lying within each region were identified using the spatial analyst tool in ArcView GIS 3.2 and population estimates were calculated using the regional density and suitability figures derived from the national survey. The results are displayed in Table 9 and clearly reflect regional differences in total areas of commonage, to an extent. Given that West Connacht and the Northwest possess almost 65% of all commonage areas in Ireland, it is perhaps not surprising they hold almost 94% of the estimated national population for commonages. This figure is in stark contrast to the Southwest, which despite having 18% of the total national commonage area, holds only an estimated 92 birds (<4% of overall population estimate). As only 1% of commonage lies in the Midland region, the total population estimate for commonage areas in this region is almost nil.

Table 9: Population estimates for all **Commonage areas** assessed by C.F.P.s with regional breakdown of estimated numbers.

Region	Male density / km² Mean ± *CL's*	Estimate of Total Males ± *C.L.'s*	National Estimate (correction factor*) Total Grouse No.s ± *C.L.'s*
East and South	1.22	212	449
	0.9 - 1.5	*168 - 260*	*356 - 582*
Midland	0.5	2	3
	0.3 - 0.9	*1 - 3*	*2 - 5*
Northwest	1.21	702	1124
	1 - 1.4	*579- 834*	*942 - 1337*
Southwest	0.23	50	92
	0.12 - 0.3	*26 - 72*	*54 - 145*
West Connacht	0.64	712	1268
	0.5 - 0.8	*579 - 834*	*1032 - 1523*
Overall	0.79	1389	2556
	0.7 – 0.89	*1230 - 1565*	*2303 - 2833*

* The correction factor (1.31) was applied to account for under-detection of females using the tape-playback method. It was derived using repeat counts of defined areas using dogs and tape-playback (see Section 3.1.4). All figures in the right hand column are extrapolated, based on the sampling design.

3.4 A survey of Red Grouse (*Lagopus lagopus*) habitat in Ireland 2007 – 2008

Potential grouse habitat occurs within all survey sites and covers a total extent of 8,544 hectares or 85% of the total area surveyed. Amongst the 100 1km squares surveyed for the RGHS, the most widely distributed habitat type is wet heath (HH3) (excluding mosaics of wet heath), which occurs in a total of 40 sites and covers an area of approximately 1700 hectares (17% of total area surveyed).

3.4.1 Effect of damage to grouse habitats on occupancy by Red Grouse

There was a negative effect of 'percentage cover of damage' in the square on grouse presence which was highlighted by the significant positive effect of 'percentage cover undamaged' the results of which are shown in Table 10. The average damage to grouse habitat in squares with Red Grouse (32.3% ± 30.7) was less than the average figure for those squares where they were absent (43.3% ± 35.7). In addition an overall score of grazing damage was given for each of the 100 survey squares assessed by the RGHS team. Based on these assessments, 13 of the 50 sites that did not have grouse were severely damaged (S*) from grazing whereas only three sites where grouse were recorded were classed as severely damaged (S*) (see Table 2.3 in Appendix 12).

The effect of average heather heights for the square was not significant (Table 10) although average heather heights were greater for squares that had grouse (19.6cm ± 8.1) than for squares that did not (16.1cm ± 8.7). In terms of elevation, sites with birds present had a significantly higher (Table 10) maximum elevation (296m ± 199) than those that did not (220m ± 170).

Table 10: Important habitat variables driving Red Grouse distribution.

Results of the analysis of the presence/absence data for those 100 survey sites assessed by the RGHS team that were analysed using a sequential binomial regression model.

Source	Estimate (logit scale)	S.E.	Z-vlaue	P value
Intercept	-0.17	0.75	-0.23	0.82
Heather height cm	0.003	0.03	0.096	0.92
% Cover undamaged	**-2.68**	**0.99**	**-2.69**	**0.007**
Max elevation m	**0.003**	**0.001**	**2.53**	**0.01**

3.4.2 RGHS Habitat Classification

Habitats in squares were assessed and classified largely using Fossitt (2000). Quite often areas assessed were made up of two main habitat types that formed a mosaic across the landscape and therefore these areas were classified as such. These categories were used to illustrate differences in heather heights across sites with and without grouse present (Figure 13). Across all habitat types suitable for Red Grouse, average heather heights were higher where birds were present.

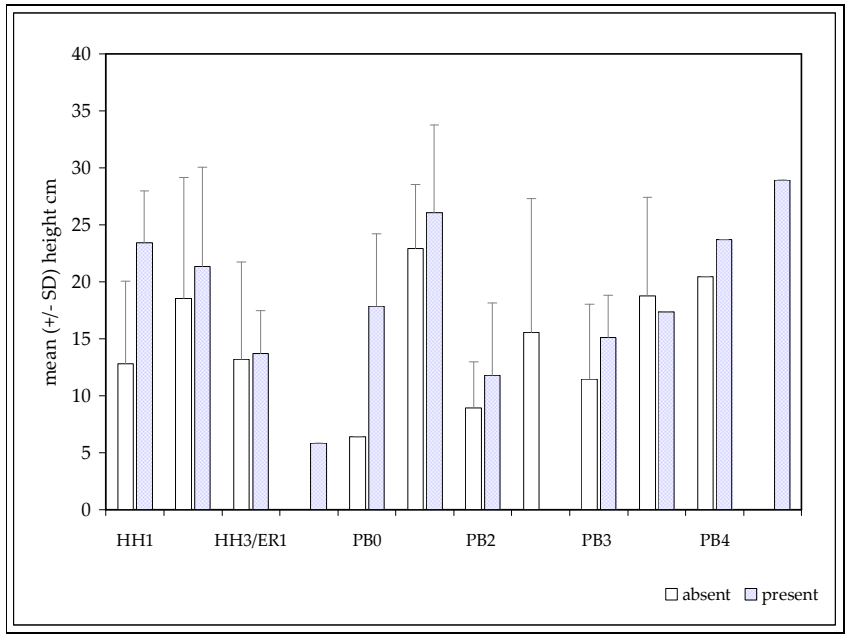


Figure 13: Overall mean differences in the average heather heights (cm) recorded across the main habitat types for those 100 1km square sites assessed by the Red Grouse Habitat Survey.

Habitat Classification (Fossitt 2000)	**Code**	**N**
Dry Siliceous Heath	HH1	10
Wet Heath	HH3	34
Wet Heath and Exposed Siliceous Rock Mosaic	HH3 / ER1	11
Montane Heath	HH4	1
Mountain Blanket Bog	PB0	3
Raised Bog	PB1	12
Upland Blanket Bog	PB2	6
Upland Blanket Bog and Wet Heath Mosaic	PB2 / HH3	2
Lowland Blanket Bog	PB3	12
Lowland Blanket Bog and Wet Heath Mosaic	PB3 / HH3	6
Cutover Bog – Regenerating	PB4.Regen	2
Eroding Blanket Bog	PB5	1

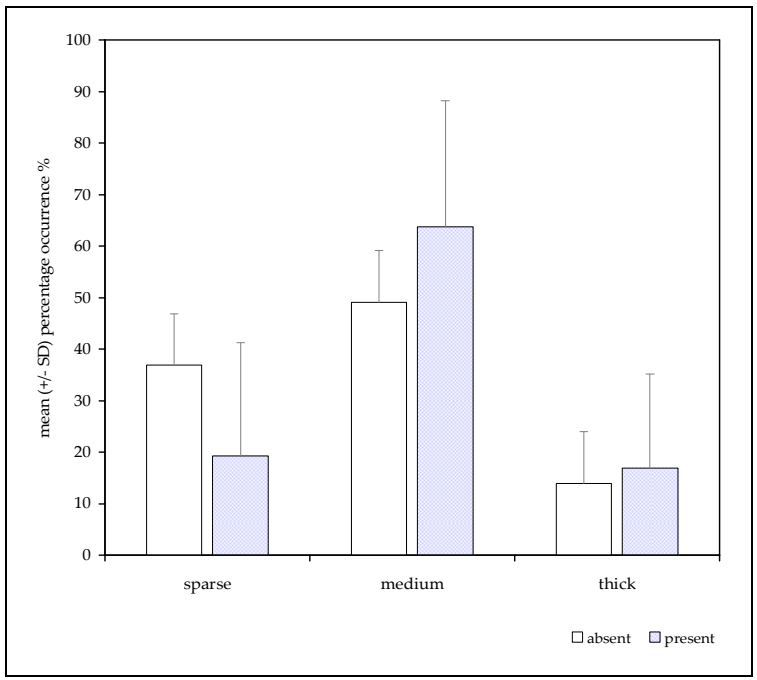


Figure 14: Overall mean differences in the percentage occurrence of heather cover categories between sites with Red Grouse present or absent which were assessed by the Red Grouse Habitat Survey.

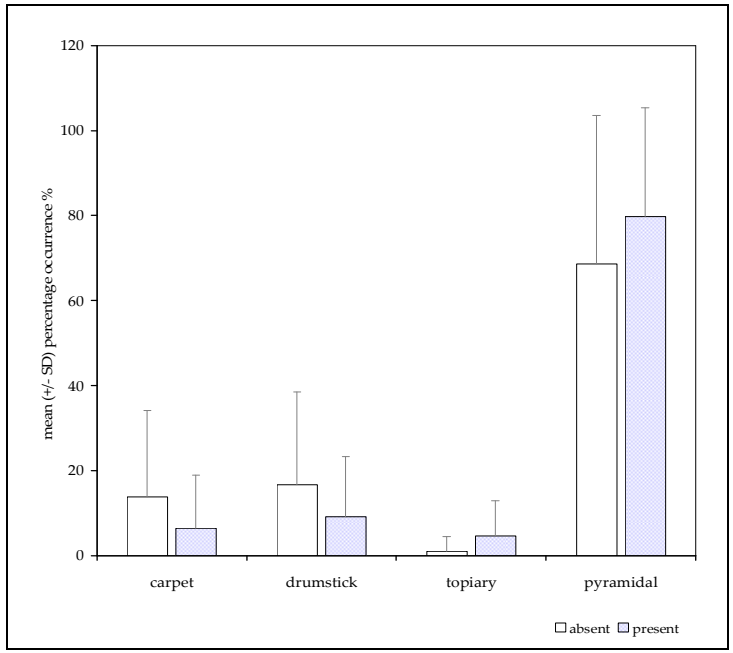


Figure 15: Overall mean differences in the percentage occurrence of heather growth forms between sites with Red Grouse present or absent which were assessed by the Red Grouse Habitat Survey.

Regionally, heather heights were greater in the East and South and Midland regions with lower average heights in the Northwest, Southwest and West Connacht regions (Table 11.1). The percentage damage to grouse habitats in survey squares was greatest in the Southwest with the least damage evident in sites in the East and South. In terms of heather structure, pyramidal and topiary growth forms occurred less frequently in the Southwest region, which was expected given the number of unoccupied sites there. Similarly, the occurrence of sparse heather cover was highest in the Southwest and lowest in the East and South and Midland regions.

Using the original habitat categories, whereby sites were classified for sampling purposes using CORINE Land Cover Data (EEA 2000), heather heights on raised bogs were greater than on upland blanket bog and mountain blanket bog (Table 11.2). Damage to grouse habitat by grazing ranged between 42-50% across all habitats except raised bogs, where grazing animals are least likely to occur. Heather structure and cover varied a little across the main habitat types. Pyramidal growth forms were the only type to occur on raised bogs and this growth form was the most common on lowland blanket bog and moors & heath. Thick heather cover was most prevalent on mountain blanket bog sites with the least cover on lowland blanket bog and moors & heath.

3.4.3 Habitat variables of importance

A number of habitat variables were good indicators of damage to grouse habitat in squares assessed by the RGHS team. The first was the 'percentage cover of ling heather' which was assessed at four randomly selected station points in each of the 100 squares assessed. Ling heather (*Calluna vulgaris*), is the most important heather species for Red Grouse in terms of providing food and shelter. Cover was greater in areas classified as being undamaged (31%) or moderately undamaged (32%) than those moderately to severely damaged (23%), severely damaged (16%) and very severely damaged (12%). Regionally, the percentage cover was greater in the East and South (32%) and the Midland (32%) regions with less cover in the Northwest (26%), Southwest (24%) and West Connacht (18%). Cover was highest on sites categorised as heath (36%) followed by mountain blanket bog (33%), raised bog (31%), upland blanket bog (23%) and lowland blanket bog (19%).

The percentage cover of bushy lichens was greater at stations with little or no damage compared to those that indicated more severe grazing pressures. Average depths of mosses and lichens did not differ greatly between sites with grouse (2.75 ± 2.9cm) and without grouse (2.62 ± 2.4cm).

3.4.4 Effect of percentage heather cover at sites on occupancy by Red Grouse

Using the visual data collected on heather cover (sparse, medium or thick) in each survey square assessed by the RGHS, sparse heather was more prevalent in sites where Red Grouse were not recorded and conversely there was a greater percentage of medium and thick heather cover in sites where birds were present (Figure 14).

3.4.5 Effect of heather structure at sites on occupancy by Red Grouse

Data collected on heather structure (carpet/drumstick/topiary/pyramidal) in each survey square assessed by the RGHS showed that higher stands (pyramidal and topiary growth forms) occurred more frequently in sites where grouse were recorded with carpet and drumstick growth forms more likely to be found in sites where grouse were absent (Figure 15).

Table 11.1: Breakdown of important habitat variables measured from the assessments carried out by the Red Grouse Habitat Survey.

Region	**Heather height (cm)** Mean (± SD)	**Damage to grouse habitat** % occurrence (± SD)	**Heather Growth Form** % occurrence (± SD)				**Heather Cover** % occurrence (± SD)		
			Carpet	*Drumstick*	*Topiary*	*Pyramidal*	*Sparse*	*Medium*	*Thick*
East and South	24.8 ± 8.6	24.5 ± 21.5	3.1 ± 8.1	5.9 ± 11.1	4.6 ± 8.7	86.3 ± 21.9	14.4 ± 19.3	63.8 ± 23.9	21.7 ± 22.9
Midland	23.7 ± 6.0	-	-	-	-	100	6.8 ± 8.9	70.3 ± 19.9	22.9 ± 18.2
Northwest	15.4 ± 6.9	45.4 ± 30.1	8.9 ± 13.3	14.2 ± 16.8	3.3 ± 6.4	73.5 ± 27.4	28.3 ± 29.7	54.8 ± 28.6	16.9 ± 21.6
Southwest	17.7 ± 9.5	54.4 ± 28.0	30.9 ± 22.8	22.8 ± 22.6	2.8 ± 8.4	43.4 ± 31.9	47.7 ± 33.4	36.7 ± 27.6	15.6 ± 20.2
West Connacht	13.2 ± 6.1	47.1 ± 37.9	6.6 ± 13.3	15.9 ± 21.6	2.7 ± 5.4	74.8 ± 30.0	33.8 ± 33.4	59.4 ± 31.8	6.8 ± 12.1
Overall	17.9 ± 8.6	37.8 ± 33.5	10.1 ± 17.1	12.9 ± 18.8	2.8 ± 6.6	74.2 ± 30.9	28.1 ± 30.7	56.4 ± 29.1	15.4 ± 6.6

Table 11.2: Breakdown of habitat variables across sites initially classified using CORINE Land Cover classes (EEA, 2000) measured from the assessments carried out by the Red Grouse Habitat Survey.

Landclass (CORINE)	**Heather height (cm)** Mean (± SD)	**Damage to grouse habitat** % occurrence (± SD)	**Heather Growth Form** % occurrence (± SD)				**Heather Cover** % occurrence (± SD)		
			Carpet	*Drumstick*	*Topiary*	*Pyramidal*	*Sparse*	*Medium*	*Thick*
Lowland B. bog	14.7 ± 6.3	45.8 ± 30.6	10.2 ± 19.5	14.1 ± 18.4	2.6 ± 5.5	73.2 ± 29.5	30.5 ± 33.2	62.5 ± 30.7	7.0 ± 11.5
Moors & heath	15.2 ± 7.2	50.3 ±16.8	6.0 ± 8.9	11.0 ± 12.9	7.0 ± 9.8	76.0 ± 25.4	23.7 ± 23.5	52.1 ± 24.9	7.0 ± 9.8
Mountain B. bog	18.7 ± 10.3	43.7 ± 29.6	13.4 ± 18.0	17.0 ± 19.7	6.0 ± 10.5	63.6 ± 33.3	25.2 ± 28.1	50.8 ± 30.9	24.0 ± 24.1
Upland B. Bog	18.6 ± 9.7	42.3 ± 38.3	13.9 ± 17.8	15.9 ± 22.2	1.5 ± 3.9	68.7 ± 34.1	40.2 ± 33.2	45.4 ± 26.5	14.4 ± 19.4
Raised B. Bog	23.3 ± 6.1	0 ± 0	-	-	-	100	6.7 ± 8.6	71.9 ± 20.2	21.4 ± 18.5
Overall	17.9 ± 8.6	37.8 ± 33.5	10.1 ± 17.1	12.9 ± 18.8	2.8 ± 6.6	74.2 ± 30.9	28.1 ± 30.7	56.4 ± 29.1	15.4 ± 6.6

3.4.6 Land Use and Topography

There were no real differences in the occurrence of land use types between occupied and unoccupied sites, with turf cutting present in 25% of sites with and without grouse. However fewer survey sites were occupied (N=8) that were assessed as being affected severely by turf cutting as opposed to sites where turf cutting was considered light to moderate (N=18). A total of 11 out of 14 sites, where grazing by sheep was assessed as being 'light', had grouse present. On the other hand, only 16 out of 36 sites where grazing was assessed as 'moderate – severe' to 'severe' had grouse present.

Active erosion (indicated by peat hags and gullies) was more common in sites without grouse (20% of sites) than in sites with grouse (12% of sites). Comparisons of other topographical features between sites such as the presence of open plains or valleys did not show any major distinctions between sites with and without grouse.

3.4.7 Important grouse habitats as identified by the RGHS

Wet heath (HH3), upland blanket bog (PB2) and lowland blanket bog (PB3) featured prominently in sites that were occupied by Red Grouse (Figure 16), along with regenerating cutover bog (PB4).

3.4.8 Remaining habitat variables of importance

Variables which might be important for grouse such as the occurrence of grit or certain plant species were also recorded at each station assessed by the RGHS. An assessment of these variables across habitats and regions revealed that grit (important aid for digestion in grouse) was more likely to occur in the Northwest (20%) and least likely to occur in the Midland (5%) and East and South regions (5%). Purple moor grass (*Molinia caerulea*) was more prevalent in the Southwest (17%) and East and South (14%) compared with the Northwest (12%), West Connacht (11%) and Midland (10%) regions. There was no real difference in the percentage occurrence of deer grass (*Tricohporum caespitosum*) between regions. Bog cotton (*Eriophorum angustifolium*), which is eaten by Red Grouse, occurred in 5-8% of stations assessed and was marginally more common in the Northwest (8%). Bell heather occurred in 17% of Midland sites compared to an average of just over 5% in the other regions. Dwarf willow (*Salix* spp.) was absent from all stations assessed and juniper (*Juniperus communis*) was only recorded at one station.

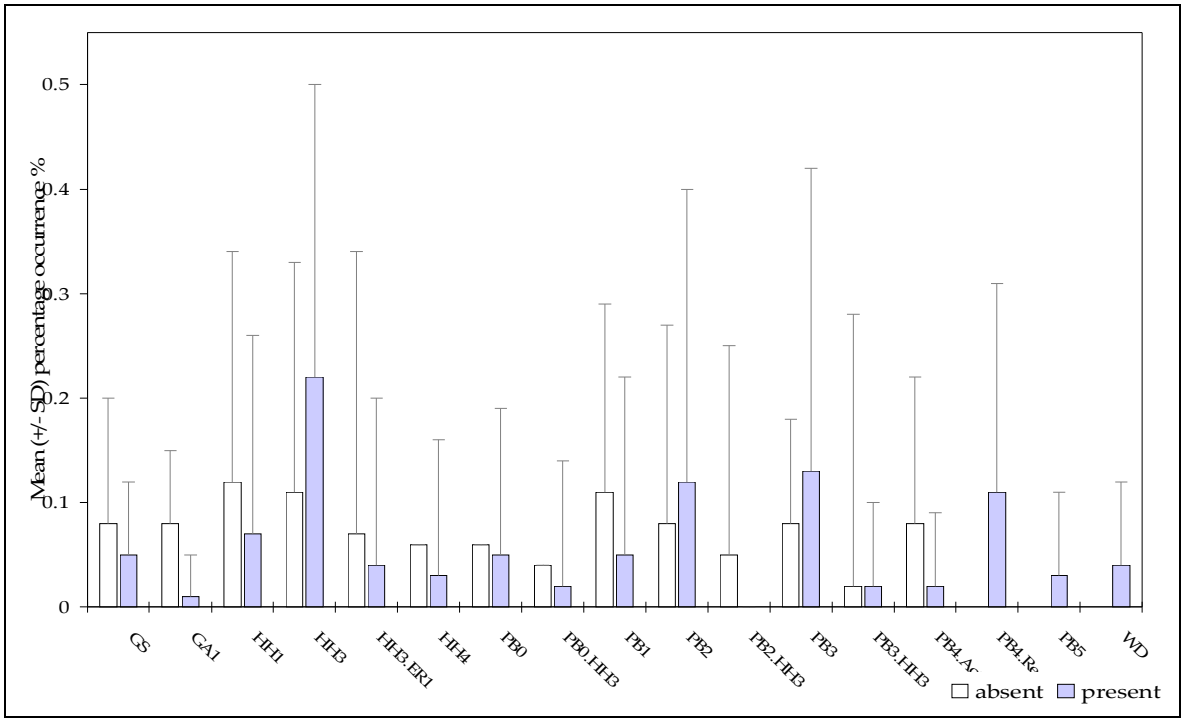


Figure 16: Overall mean differences in the percentage occurrence of the main habitat types between sites with Red Grouse present or absent.

Sites were assessed by the Red Grouse Habitat Survey and habitats classified largely according to Fossitt (2000).

Habitat Classification (Fossitt 2000)	**Code**
Semi-natural grassland	GS
Improved Agricultural Grassland	GA1
Dry Siliceous Heath	HH1
Wet Heath	HH3
Wet Heath and Exposed Siliceous Rock Mosaic	HH3/ER1
Montane Heath	HH4
Mountain Blanket Bog	PB0
Mountain Blanket Bog and Wet Heath Mosaic	PB0/HH3
Raised Bog	PB1
Upland Blanket Bog	PB2
Upland Blanket Bog and Wet Heath Mosaic	PB2/HH3
Lowland Blanket Bog	PB3
Lowland Blanket Bog and Wet Heath Mosaic	PB3/HH3
Cutover Bog – Actively Worked	PB4 Activ
Cutover Bog – Regenerating	PB4 Regen
Eroding Blanket Bog	PB5
Conifer Plantation	WD

3.5 Designated Sites

3.5.1 Sites lying within SAC

The total areas of all sites occupied by Red Grouse that also lay within SACs were calculated (Appendix 4). Important areas identified were 'Cloghernagore Bog and Glenveagh National Park (*Site Code 002047)*' 'Connemara Bog Complex (*Site Code 002034*)' and 'Owenduff/Nephin Complex (*Site Code 000534*)'.

3.5.2 Sites lying within SPA

For sites surveyed within SPAs (Appendix 5), the most important in terms of 'occupied sites' were the Owenduff/ Nephin Complex (*Site Code 004098*), the Slieve Aughty Mountains (*Site Code 004168*) and the Wicklow Mountains* (*Site Code 004040*).

3.5.3 Local population estimates

In order to account for the total populations of grouse in the full extent of these designated areas (SACs and SPAs), population estimates (see Table 2A in Appendix 2) were extrapolated for some of the more important sites (see Methods *Section 2.7.5.2*). The following designated sites hold important populations of Red Grouse: Connemara Bog Complex SAC (328 birds), the Owenduff/Nephin SPA/SAC (184 birds) and the Slieve Aughty's SPA (130 birds). It is important to note that these estimates are extrapolated using regional density and suitability figures and therefore they do not account for local variation in densities of birds and habitat suitability.

* For the Wicklow Mountains SPA (4040), the estimate is based on the current SPA boundary and not the proposed one, which is considerably larger.

3.6 Other bird species and mammals of note

In addition to Red Grouse, surveyors recorded bird and mammal species (including grazing animals) of importance. The percentage occurrence of these species across all occupied and unoccupied sites is listed below (Table 12).

Table 12: List of mammals and important bird species noted in the 491 survey sites.

Species Recorded	**Occurrence in occupied squares (N=231)**	**Occurrence in unoccupied squares (N=260)**
Badger *Meles meles*	4.9%	4.5%
Hare *Lepus timidus hibernicus*	11.8%	13.2%
Fox *Vulpes vulpes*	7.9%	6.3%
Deer (all spp.)	13.2%	6.1%
Sheep	20.6%	34.2%
Cattle	5.9%	9.4%
Raven *Corvus corax*	18.9%	24.4%
Hooded Crow *Corvus corone*	12%	16.9%
Golden Plover *Pluvialis apricaria*	11.2%	5.3%
Buzzard *Buteo buteo*	1%	0.4%
Hen Harrier *Circus cyaneus*	1.8%	2%
Peregrine Falcon *Falco peregrinus*	3.3%	1.6%
Merlin *Falco columbarius*	1%	1.2%
Kestrel *Falco tinnunculus*	1.8%	3.1%
Snipe *Gallinago gallinago*	16.7%	17.3%
Woodcock *Scolopax rusticola*	3.1%	2.4%
Golden Eagle *Aquila chrysaetos*	1%	0.8%
Sparrowhawk *Accipiter nisus*	0.4%	0.2%

4.0 DISCUSSION

The probability of a population persisting in the long-term is a function of the degree of loss of suitable habitat from the landscape (Norris & Palin, 2002). The distribution results of the national survey indicate the Southwest and Midland regions as those most changed, with contractions of almost 50% and 75% respectively in these regions' defined historic breeding ranges. The probable causes of these losses are discussed later. The 491 1km survey squares can be regarded as a snapshot in time of a metapopulation, made up of several distinct populations together with areas of suitable habitat which are often unoccupied (Hanski, 1999). This survey will provide a baseline for future national surveys and in order to ensure proper monitoring of our Red Grouse populations it was important that the methods used were repeatable and straightforward. The area of suitable grouse habitat was so large that ground surveys could not be conducted across the whole extent. Instead, the sampling followed allowed inferences to be made about the areas not sampled based on results for those areas sampled.

4.1 Potential sources of bias

Potential sources of bias, with proximity of sites surveyed being close to one another and the probability of either missing birds and /or double counting of individuals whose territories may range over a number of 1km squares was a consideration. Also observer differences could have been a problem. However, given that all observers participated in a survey training workshop before surveying sites, this potential source of bias was ameliorated. The time spent in a survey square depended on the terrain, the area to be covered and the observer. Where possible it was recommended that observers traversed a site at a constant walking pace, although obviously steeper terrain affected the length of time spent in a square.

As there was no significant difference in numbers of birds recorded in survey sites between years, year of survey was not considered to be important and results for both field seasons were pooled. The sampling range was limited to 10km squares in the Republic of Ireland which had records of grouse in the Old Atlas. Therefore any newly colonised squares since then were omitted from the survey sampling pot. However, additional records for newly colonised squares were picked up through the 'Casual Sightings' programme of work which was set up at the outset of the survey to receive any incidental sightings of Red Grouse or records of fresh signs i.e. pair roosts.

4.1.1 Standardised counts using dogs and tape-playback

Validation work (see Section 3.1.3) demonstrated that counts using dogs proved more successful in detecting both sexes but that overall differences in detection of Red Grouse between tape-playback and dog methods were not significant. Given the variation in abundance between sites, a detection factor was calculated by carrying out a repeated measure of 15 sites using two count methods: counts using dogs (traditional count method) and line transect counts using tape-playback. Differences in the detection of grouse by these two methods facilitated the adjustment of the population estimates by applying a 'correction factor of 1.31' to all survey square counts generated using the tape-playback method. Adjusting the national population estimates with this correction factor increased the total estimate of birds for the Republic of Ireland by almost a third.

4.2 Red Grouse population estimation

The emphasis for this survey was placed on the number of sample units or 1km squares occupied by Red Grouse, with sampling based on detection/non-detection of birds in survey squares. The results of this survey indicate that there has been a 50% decline in the species range in the Republic of Ireland, which includes the addition of records from other sources i.e. Causal Sightings database (Table 3). The addition of all incidental records since 2000, extends the species range even further (See Appendix 6) with positive records for an additional 44 10km squares. The overall population estimate of 4,200 birds (Table 4), pre breeding season, for the Republic of Ireland lies within those limits estimated back in the early 1990's (Gibbons *et al.*, 1993) although such historical national estimates were largely based

on supposition. This survey is the first to offer a reliable estimate against which future surveys can be compared.

4.2.1 Regional trends

There was much regional variation in the magnitude of the declines in species range (and population estimates) with greatest losses in the Midland, East and South and Southwest regions (Table 3). Some of these losses were reflected in the number of males recorded (Table 4), with lowest densities in the Southwest region. Densities in the East and South region were the highest nationally but the overall estimated decline in range in this region was high, at 58%. This result serves to highlight the importance of assessing both current species range and abundance. Overall, the distribution results indicate a contraction in range, particularly in some regions, to core areas or strongholds where populations remain quite healthy (e.g. densities of 1.2 males/km^2 in the Northwest and East & South regions). However, if such contractions were to continue, then the resilience of these populations could be ultimately tested.

4.2.2 Strongholds

Using the national survey results, estimates of local population figures were generated (Table 2A in Appendix 2). However, as these local population figures were extrapolated using densities per unit area and percentage suitability of remaining un-surveyed sites for the five sampling regions, there are certain anomalies which have been highlighted. For example, the figure for the Wicklow Mountains SPA is considered to be an underestimate, at 96 birds. As this SPA (whose current area is due to increase in the near future) lies within the East and South region, its population estimate was calculated using the overall suitability figure for this region of just under 30%. Employing regional estimates of suitability may be too coarse; local suitability (which could be higher or lower than regional estimates) is not considered as it is beyond the remit of this survey. Also many of the sites occupied by Red Grouse (N=12) in the Wicklow Mountains lie outside the SPA. As a result, the inclusion of all potentially suitable habitats in the Wicklow and Dublin Mts. (using CORINE Land Cover Data, EAA, 2000), as well as lands not designated, gives a population of 324 grouse pre-breeding season.

Conversely, figures for the Maumturk Mountains and the Mweelrea/Sheefry Complex are judged overestimates as these areas are largely no longer suitable for Red Grouse due to insufficient heather cover and damage from sheep overgrazing. For those commonage areas assessed for vegetation damage on the Mweelrea/Sheefry Complex (excluding the one site where grouse were recorded), the total area of moderate to severely damaged ground was over 46% (using data from C.F.P.s). Similarly for the Maumturk Mountains the overall damage figure for these categories was 33%. In this instance the predicted local populations are total overestimates derived from regional suitability figures that do not reflect local variation in grazing damage and habitat suitability for Red Grouse.

4.2.2.1 Owenduff SPA/SAC

The estimated population for the Owenduff (See full details in Appendix 2, Table 2A) of 184 birds (95% C.L.'s 150-220) is less than the 363-427 birds given for the same area by Murray & O'Halloran (2003). However their figures were derived by a process of extrapolation from average densities of individuals (1.42-1.67 / km^2) in 12 1km squares surveyed and did not take into account suitability of habitat in the remaining areas of the Owenduff. Using their methods, the population estimate for the Owenduff is 374 individuals (including correction factor of 1.31). However this estimate is based on the total extent of the SPA/SAC and does not take into account how suitable that total area is for Red Grouse particularly given the extent of damage caused by overgrazing in the Owenduff (with areas severely damaged by grazing reaching 30% on areas assessed by C.F.P.s).

On balance, despite some anomalies, these generated figures serve as approximate estimates of populations in key sites throughout the country (Table 2A in Appendices) and are largely in agreement with estimated populations based on local knowledge.

4.2.3 Populations on Commonages

Approximately 60% of the estimated national population of Red Grouse occupy Commonages (Table 9). Therefore it is important that these areas continue to be monitored regularly by planners to ensure stocking densities are optimal and in line with the recovery of vegetation from any grazing damage. Monitoring of these areas is key not only in terms of assessing the condition and recovery of Annex I habitats such as blanket bog but also it could serve a dual purpose in monitoring Red Grouse populations in these areas which account for a significant portion of the national population.

4.3 Influence of landscape, land use and habitats on distribution of Red Grouse

The data collected by the RGHS (2007-8) and the C.F.P.s (1999-2007), was used to gauge the importance of habitat quality in determining grouse occupancy, with particular reference to grazing damage assessments. Impacts of sheep grazing, in particular, on Red Grouse distribution in those sites partly or wholly within commonage areas were negative (Table 8). The percentage of undamaged habitats was greater in sites occupied by Red Grouse (Figure 11). In terms of habitat class information generated by C.F.P.s, mosaics with wet and dry heath featured more heavily in sites with grouse than those where they were absent (Figure 12).

Despite potential grouse habitat occurring in all sites surveyed by the RGHS, a large proportion of the habitat is likely to be unsuitable for Red Grouse due to damage that has been caused by different land-use practices (*see further details in* Appendix 12). Sheep grazing is the most widespread land-use. Coniferous plantation forestry and mechanical peat extraction are also commonplace and likely to impact on the occurrence of Red Grouse within the sites surveyed.

4.3.1 Important Habitats for Red Grouse

The most important habitats for Red Grouse, identified by the RGHS, were wet heath, upland blanket bog and lowland blanket bog (Figure 16). This result reaffirms previous results of important grouse habitats, as classified according to both CORINE Land Cover data (EEA, 2000) (Figure 9) and Commonage Framework Plans (Figure 12). All data sources highlight the importance of blanket bog (lowland, upland and mountain) and heath categories (particularly wet heath) as preferred grouse habitats. Raised bog, that has not been totally exploited for peat or that is old cutover with regenerating heather, can support good numbers of Red Grouse in suitable areas with highest counts of nine birds recorded in a 1km square in east Galway. However, the majority (98%) of the national population is now confined to blanket bog and heath (Table 5).

4.3.2 Habitat Quality Measures

Many studies in Ireland have highlighted the close association between grouse numbers and percentage heather cover (Watson & O'Hare, 1979b, Murray & O'Halloran, 2003, Bracken *et al*., 2008, O'Connell, 2008). Measures of heather quality such as heather growth form, height and cover occurred more frequently in sites occupied by Red Grouse. Average heather heights, collected from 20 random points in each survey square assessed by the RGHS, were greater in sites that had Red Grouse (Figure 13) although there was no significant positive relationship between Red Grouse presence and height of heather (Table 10). This result is not unsurprising given that although taller heather is important for cover and nesting, it is the younger shoots (higher in nutrient content) which are preferred for eating (Miller, 1979). Sheep tend to prefer patches of newly regenerating vegetation, particularly in summer (Lance, 1983), which leads to direct competition with grouse for young heather shoots. In the winter, heather is one of the few plants of blanket bog that is evergreen and therefore sheep become increasingly dependent on it through the winter (Grant *et al*., 1976). Heather cover categories (medium and thick) were more likely to occur in occupied sites (Figure 14) although this association was not significant (Results Section 3.4.1). Finally, the more preferred heather structure forms for Red Grouse (i.e. pyramidal and topiary) were more prevalent in sites that had grouse than those which did not (Figure 15), but not significantly so after this variable was dropped from the model. Habitat variables were measured and collected across an entire 1km square and were not specifically targeted to those areas where grouse were seen. Therefore, it is not unexpected that variables such as heather cover and preferred heather structure did not differ significantly between

sites with grouse and those sites which had none. A more targeted approach of taking measures within known territories of birds, taking into account different habitats and regions, should yield significant results.

4.3.3 Importance of heather cover

Results from the RGHS indicate that heather cover, particularly 'medium' heather cover, has an influence (Figure 14) on Red Grouse occurrence with more suitable medium heather cover likely to be present in other regions than the Southwest (Table 11.1). Greater medium heather cover is more preferable than woody old heather (is not as suitable for feeding). The Southwest had the greatest percentage of 'sparse' cover which may explain somewhat, why densities in this region are so low (Table 4). Comparing heather structure, pyramidal forms were far more prevalent in other regions than the Southwest. These results suggest that heather quality measures are less suitable for Red Grouse in the Southwest. The Southwest was the poorest in terms of heather cover with the highest percentage of carpet heather forms (31%), three times the national average. The big gaps in Red Grouse range in the Southwest are likely have been influenced by historical and more recent changes in suitable grouse habitat extent as well as habitat quality, particularly on bogs below 300m a.s.l.. Most of the populations remaining in the Southwest are on mountain blanket bog, with Red Grouse recorded on only one of 28 sites classified as lowland blanket bog and on one out of 29 sites classified as upland blanket bog. In the Midland region, any potentially suitable Red Grouse sites remaining usually had reasonable heather cover and heather quality.

4.3.4 Elevation

The elevation of sites surveyed may explain some of the variation in site occupancy between regions as it had a significant effect on grouse occupancy (Table 6). For all regions, except West Connacht, the average elevation of sites was considerably greater in sites that had Red Grouse present. West Connacht accounts for almost 35% of the total area of lowland blanket bog (<150m a.s.l.) which is likely to have accounted for the difference in the elevation of occupied sites between it and the other four regions.

An examination of elevation across habitats revealed that the average elevation of occupied sites (Table 7) was less on areas of lowland blanket bog, upland blanket bog and moors & heath. In contrast, the elevations of occupied sites on mountain blanket bog and raised bog were greater. These differences across habitats are probably a reflection of landscape and the changes that occur at different elevation heights. Interestingly on raised bogs, the higher average elevation of occupied sites may be due to the birds avoiding hollows and areas of lower ground which tend to be much wetter (poorer heather growth) than on the higher domes on raised bogs.

Regional differences in the elevation at which conifers are planted might partly explain the differences in the average elevation of occupied sites across regions. The average elevations at which forestry is planted in the East and South (245m ± 106) and Southwest (227m ± 99) are much higher than in the Northwest (174m ± 94), West Connacht (149m ± 84) and Midlands (93m ± 48). While these differences probably mirror the actual regional changes in elevation, they may also indicate the effect on local grouse populations of forestry planted on upland and mountain blanket bog areas across the country but particularly in the two regions which have suffered big losses in 'historic breeding range'; the Southwest (-47%) and East and South (-58%). The brunt of afforestation in these regions would appear to be on upland blanket bog (150-300m a.s.l.). Consequently Red Grouse populations are more restricted to mountain blanket bog (>300m a.s.l.) in these regions, particularly given the other pressures from agriculture and development in more lowland areas.

4.4 Areas in decline

The most striking declines in range are in the Southwest, Midland and East and South regions (Table 3). Declines in the Midland region can be largely attributed to large-scale mechanical peat extraction which has seen the conversion of huge areas of once suitable raised bog, to cutaway bogs (Foss *et al.*,

2001). Peat has been harvested for fuel, electricity production and the manufacture of horticultural products. From a total extent of 310,000 hectares, it is estimated that only 18,000 hectares of Raised Bog of conservation value remains (Derwin & MacGowan, 2000). If all of this area was suitable for Red Grouse, then the potential population on these areas of Raised Bog of conservation value would be 85 birds (95% C.L.: 50-146) which is only marginally greater than the figure estimated for the national survey 71 birds (95% C.L.: 48-111). In the East and South, forestry is the most likely problem with around a third of all *Coillte* forestry planted in this region contributing to the losses of once suitable land area for Red Grouse. Densities in this region are the highest nationally, therefore where suitable habitat remains, populations are quite healthy.

From its extensive range in the past (Figure 1), Red Grouse distribution is now much restricted in the Southwest region, with thinly dispersed populations confined largely to the higher slopes of the Macgillcuddy Reeks and also parts of the Paps and Derrynasaggart Mountains. Overgrazing by sheep and deer populations has created less than ideal conditions for grouse with *Molinia* now widespread. The spread of *Molinia* can be a sign of overgrazing and/or it may proliferate as a result of extensive and repeated burning. Regional differences in heather heights across sites sampled for the Red Grouse Habitat Survey (Table 11.1) showed lower than average heights in the Southwest compared to the East and South region which not only had the greater heather heights but also had the highest densities of males per unit area (1.22/km^2) of all regions. Further investigation of the data showed that the average area of damage to grouse habitats in survey squares in the Southwest was marginally greater than in the Northwest and West Connacht and much greater than in the East and South region. Although sites in the Southwest had the greatest damage from grazing and among the lowest levels of occupancy and densities of grouse per unit area, the Northwest and West Connacht regions both have reasonable grouse populations despite high levels of damage too (Table 4). Therefore any assumptions based on vegetation damage assessments should be treated with caution and more emphasis placed on interpreting the other habitat data collected by the RGHS (Appendix 12).

4.4.1 Link between populations on Commonages and damage assessments

For those commonages that were occupied by grouse lying within designated areas, the average area of moderate to severe grazing damage was 10% with most sites assessed as having little or no grazing damage by the C.F.P.s. The most prominent sites with figures exceeding 10% damage were '**K**illarney **N**ational **P**ark, Macgillycuddy Reeks and Caragh River Catchment SAC' and the 'Owenduff/Nephin SAC/SPA' with total figures for moderate to severe damage of 12% and 37% respectively. In 'K.N.P. SAC' Red Grouse were present in 10 out of 39 (26%) sites surveyed whereas on the 'Owenduff/Nephin SAC/SPA', Red Grouse were present in 13 out of 18 (72%) sites surveyed lying partly/wholly within the SAC/SPA. This difference in occupancy suggests that grazing damage may not be the only factor negatively affecting grouse distribution. The Owenduff/Nephin SAC/SPA in north County Mayo is surrounded by areas of blanket bog that hold reasonable populations of grouse. By contrast, Killarney National Park SAC is surrounded largely by steep areas of blanket bog, which are dominated by *Molinia* (refer to *RGHS* Appendix 12) and have little or no grouse present. Recent and historical data exist for Red Grouse densities in north Mayo [range from 1.4 – 1.7/km^2 (Murray & O'Halloran, 2003) to 5/km^2 (Watson & O'Hare, 1979)], but similar historical data for populations in County Kerry is lacking. Therefore assumptions about historically lower densities in County Kerry cannot be made. The geographic location of these national parks may have an influence with Red Grouse populations within KNP more isolated from other populations and therefore more susceptible to adverse changes in habitat quality. Any positive changes in habitat quality in suitable habitats in the Southwest region could be offset by the lack of neighbouring Red Grouse populations that could potentially expand and recolonise those former areas from which grouse have been lost.

4.4.2 Causes of decline

The impact of land use changes on Red Grouse and indeed other upland breeding bird species has been well documented (Watson & Moss, 2008). Many of these changes are irreversible, however, measures are being taken to restore habitat quality, in particular to address damage from sheep grazing (with the introduction of *Farm Plan Scheme for Designated Areas and Commonage*). The

importance of the association between Red Grouse and percentage heather cover and heather structure was assessed using data collected by the RGHS. While there was a definite trend towards better heather cover and taller more pyramidal forms in sites with Red Grouse, no significance in these trends was detected in the analysis.

4.5 Limiting factors of populations in Ireland

The range decline of Red Grouse in Britain of 30% (Gibbons *et al.*, 1993) is far less than that of the Republic of Ireland. Such differences can be partly explained by the economic benefits of Red Grouse in Britain, where many populations are intensively managed for shooting. Also, the distribution of Red Grouse across habitats in Ireland differs to Britain with a significant portion (almost 20%) of their former range in Ireland on raised bogs (Figure 1). Despite the patchiness of much of the remaining grouse habitat in Ireland, populations have persisted even in more isolated areas (Allen *et al.*, 2005). There are a number of factors which limit Red Grouse populations in terms of species range and potential for expansion. Current pressures include overstocking, peat extraction, drainage, burning, extensive forestry plantations (fragment grouse populations and act as refuges for predators like foxes and hooded crows) and infrastructural developments (new access roads to service windfarms allow vehicular access and may increase disturbance) with which have negative impacts either through direct loss of once suitable habitat or by leading to inferior habitat quality for grouse populations.

4.5.1 Sedentary Nature

Philopatry is evident in Red Grouse populations, with young males breeding near where they hatch while hens move further from natal areas to avoid inbreeding (Watson & Moss, 2008). This sedentary nature can make populations more vulnerable to rapid habitat changes and population may not be able to adapt quickly enough to such changes.

4.5.2 Productivity

Despite no recent data on productivity for Irish populations, it is known that most males pair with a single female and pairs are generally single-brooded (Lance, 1976). Breeding female numbers are largely determined by the numbers of territorial males (Moss *et al.*, 1996, Mougeot *et al.*, 2003a, 2003b). It has been suggested by Watson & Moss (2008), that burning and overgrazing has had a detrimental effect on all willow *Salix* sp. on Irish moors, where many unmated male Red Grouse occur. The sex ratio of territorial Red Grouse in spring is usually fairly even, but a large male excess tends to occur on poor soils, especially in years when densities are high or declining. Based on the adjusted figures for this survey, males accounted for approximately 55% of the population which does suggest a small surplus.

4.5.3 Negative impacts of commercial forestry, large-scale peat extraction and inappropriate burning practices

Large scale afforestation schemes have had the greatest impact on blanket bog in the Republic of Ireland with planting on 27% of the area of blanket bogs and in terms of the effect of peat extraction on Raised bogs, only 8% remain intact (Foss *et al.*, 2001). Such fundamental changes to the Irish landscape have no doubt contributed to the contraction of Red Grouse populations from their once extensive range. Evidence of burning was found in just under a fifth of sites (19%) surveyed by the RGHS, with the damage from burning considered severe in 8% of the 100 sites surveyed. These results highlight that burning of heather is still a relatively common practice but anecdotal evidence from some regions (i.e. Wicklow Mountains National Park & SPA) suggests that inappropriate burning, particularly outside the burning period of September 1st to March 31st (*Wildlife (Amendment) Act 2000*), is a concern.

4.5.4 Detrimental effects of grazing

At low density, sheep or cattle grazing can be beneficial by making paths that allow grouse access into tall heather and livestock droppings can encourage agricultural weeds, which are good food for Red Grouse in the spring, prior to breeding (Watson & Moss, 2008). Red Grouse prefer to eat shoots that are 20-35cm high (Moss *et al.*, 1972). The average heather heights (19.6cm) of occupied sites in the national survey were greater than sites where birds were absent (16.1cm) albeit this difference was not

statistically significant. Grazing levels were considered low across a third of sites (Appendix 8) and steps have been taken in the past few years to ensure appropriate levels of stocking on commonages.

The quality of food available for Red Grouse has suffered as a result of overgrazing by sheep and deer and too frequent burning. These practises have almost eradicated willow and birch scrub (whose buds were eaten in the past by Red Grouse particularly in periods of heavy snowfall) with overgrazing favouring grasses, sedges and rushes (because the growing point of these plants is at the very bottom of the stem and stays undamaged if an animal eats the shoot tip) (Watson & Moss, 2008). EU subsidies (1970s to 1990s) per head of ewes and cattle encouraged overstocking, particularly on marginal lands that were of little value to arable farming. Coupled with poor animal welfare in some areas and increased sheep mortality, the resultant carcasses encouraged increases of predators such as foxes, crows, ravens and gulls (Watson & O'Hare, 1980).

In Britain, the Black Grouse *Tatrao tetrix* has also suffered serious declines as a result of sheep overgrazing (Baines *et al.,* 1996). Studies in the North Pennines have shown that numbers and breeding success of Black Grouse increased following reductions in sheep grazing, particularly in the autumn and winter (Games and Wildlife Conservation Trust, 2008). Such restrictions facilitate increased numbers of insects, particularly larvae, which are important for chicks (Buchanan *et al*., 2006).

4.5.5 Predators

More predators from richer habitats can encroach upon bogs fragmented by developments. Likely Red Grouse habitats are becoming increasingly patchy and enriched by agriculture, planting and fertilising of trees, leading to more grassy vegetation thereby increasing numbers of prey, such as rodents and rabbits, for local predator populations (Watson & O'Hare, 1979, Madders, 2003). Unlike Britain, where the effect of predators on Red Grouse populations has been studied (Thirgood *et al.,* 2000, Redpath *et al*., 2001) the dynamics of predators and their effect on populations in the Republic of Ireland was outside the scope of this study. Any important predators seen on survey squares were recorded, with raven, hooded crow and fox the most common (Table 12) although there were no apparent differences in the percentage occurrence figures of the main potential predators of Red Grouse between occupied and unoccupied sites. The low percentage occurrence of known 'non corvid' predators like hen harrier and peregrine falcon suggests that they may not have a big effect on local grouse populations. From studies in Britain, it is known that certain avian predators, such as hen harriers, can affect populations on local grouse moors, particularly those which are managed for shooting (Redpath & Thirgood, 1997).

4.5.6 Shooting

In Britain, the number of Red Grouse shot fell by 50% over the course of the 20th century with declines largely blamed on habitat losses, although avian predators did limit numbers in areas recovering from population crashes (Thirgood *et al*. 2000c). Shooting of Red Grouse in the Republic of Ireland is on a much smaller scale than in Britain and is confined largely to suitable areas where private landowners have granted permission. Information on shooting bag records of the NARGC for the early 1990s, gave annual bag returns of 2,000-3,000 birds (Butler, 1993). Bag returns in England have been gradually decreasing since the early 1990s and indications are that bag returns in Ireland have followed suit. In Scotland, returns have been quite good in recent times, albeit the 2004-07 period was below average (Games and Wildlife Conservation Trust, 2008). In Britain, Red Grouse benefit from interest in their conservation from hunters and those that participate in field trials* (Watson & Moss, 2008). The equivalent groups in Ireland, the N.A.R.G.C. and the I.K.C. acted in an advisory capacity on the PSG and volunteered members that took part in the national survey.

* Field trials involve dogs competing to find grouse before awaiting their handlers, without flushing the birds (Watson & Moss, 2008).

4.5.7 Climate change

Scientists predict a warmer, wetter and windier Britain and Ireland in the future (Hulme & Jenkins, 1998). Grouse are a cold adapted species and warmer climate will not usually benefit them and the

rate of change may be so fast that unexpected impacts may occur (Watson & Moss, 2008). A more detailed study of the effects of predators (on breeding success, and overwinter survival) and climate were outside the remit of this survey but should be considered for future research. To fully understand the dynamics that are driving grouse populations in Ireland, a more detailed examination of those demographic processes that might be influencing their distribution and abundance is needed.

4.5.8 Burning

In Scotland, the burning of heather or 'muirburn' for grouse and sheep is used to generate a patchwork of young and old heather which is beneficial to grouse in providing older stands for cover and young shoots for food (Watson & Moss, 2008). However in Ireland, most incidences of burning or rather over-burning are not managed like 'muirburn' in Scotland and are generally not specifically managed for grouse but used to create suitable grazing for sheep. Burning every three to four years shifts heather towards grass, sedge or rush and can damage underlying peat irreparably leading to erosion (Watson & Moss, 2008). Traditional turf cutting, mechanical turf cutting and industrial peat extraction have accounted for a loss of 47% of the original area of peatlands in Ireland (Malone & O'Connell 2009). Direct impacts of such practices can lead to increased grazing by sheep and deer with more cover of grasses and increases in the tick population (Watson & Moss 2008). The encroachment of bracken is also a problem in many areas as previously it would have been controlled by grazing cattle but with the increases in sheep numbers through the 1980's and 1990's and inappropriate burning practices, bracken took hold on many of the lower slopes of former grouse hills. It can produce chemicals to deter other plants; in particular it has a detrimental effect on heather species.

5.0 CONCLUSIONS

This survey benefited from using records acquired from more than one source with a more complete picture of the current species range achieved through the collection of data from surveys using tape-playback and supplementary data collected from other sources (see Table 2 in *Results Section*). A 50% decline in Red Grouse range since the Old Atlas of 1968-1972 is less than that previously thought (Gibbons *et al.*, 1993), although the extent of the decline was greater in some regions than others. Populations in Ireland are intrinsically linked with habitat availability and habitat quality. The habitat quality measure 'percentage area undamaged from grazing' was the most important habitat variable significantly affecting grouse distribution. Percentage heather cover (in particular *Calluna*) also had a positive influence, albeit not a significant one.

The fractured nature of the range of Red Grouse in Ireland has probably led to the isolation of certain populations and the ability of these populations to survive and expand is uncertain given the lack of current information on fundamental life history traits. Given the broad extent of suitable grouse habitats in Ireland, very little of which is exclusively managed for Red Grouse, populations will always exist at lower levels than on shooting estates where active measures are taken to boost populations (Allen *et al.*, 2005). Making judgements on whether these populations are persisting at 'naturally' low densities or are in decline is difficult without more robust data on their breeding productivity and survival following natal dispersal. Almost 98% of the national population is now distributed across blanket bog and heath, with only 2% remaining on raised bogs. Given how quickly the fate of populations can change, with a 75% decline in former breeding range in the Midland region since 1968, the importance of regular monitoring of remaining populations and implementing measures to ensure the continuation of these populations has become all too apparent. Such actions are vital particularly to avoid any further contractions in range and to ensure the future conservation of Red Grouse populations in Ireland.

6.0 RECOMMENDATIONS

The following recommendations should link into any proposed Species Action Plan for Red Grouse in the Republic of Ireland. A Red Grouse Species Action Plan would require full participation and consultation with interested stakeholder groups, with most currently sitting on the Project Steering Group.

6.1 Current Status of Red Grouse

6.1.1 In Ireland, Red Grouse *Lagopus lagopus scoticus* are a sub-species of Willow Grouse *Lagopus lagopus* which have a circumpolar distribution and are largely found on tundra, bogs and heaths. More recently the classification of Red Grouse has been updated to *Lagopus lagopus scotica* (David & Gosselin, 2002). Any past delineation between the British '*scoticus*' and the Irish '*hibernicus*' subspecies (Hutchinson, 1989), has been disputed (Freeland *et al*., 2006). Recent and past introductions of British birds to Ireland are likely to have had some effect on the 'gene pool' of the native birds. A more recent genetic study (McMahon *et al*. submitted) carried out by the Irish Grey Partridge Trust, UCD and the University of Uppsala, Sweden provides evidence that '*hibernicus*', the supposed Irish endemic, is a valid subspecies. The national survey made no attempt to distinguish between '*scoticus*' and '*hibernicus*' birds in the field as there is much phenotypic variation between individual birds and any such attempts would more than likely be confounded by observer bias.

6.1.2 Ling heather *Calluna vulgaris* is integral to the life cycle of Red Grouse, as it constitutes the biggest portion of their diet, particularly heather aged between 2-8 years, (Savory 1978) and they also require heather for shelter and for nesting (Jenkins *et al*. 1963). In the past, some suitable areas for Red Grouse in Ireland (largely on private estates) have had heather management and predator control in place to improve local conditions for Red Grouse in order to boost local populations for hunting. In the spring, cotton grass shoots are an important food source for adults as they are much higher in essential nutrients like protein and phosphorous than heather (Watson & Moss, 2008). The prevalence of insects on blanket bogs in the summer is also an important food supply for young grouse chicks (Savory, 1977).

6.1.3 The Red Grouse has been a species of conservation concern since the late 1990s and remains on the current Red List in Ireland (Lynas *et al*., 2007). The national survey estimated that the breeding range in the Republic of Ireland has declined by 50% in the last 40 years with the current population estimated at 4,200 adult birds. Overall, the national average of 1.1 adults/km^2 (95% C.L.s 1.0 - 1.2) is low but there is variation across regions and habitats.

6.1.4 The current breeding range of Red Grouse in the Republic of Ireland stands at 172 10km squares occupied, taking into account all records collected by the national survey 2006-08. This compares with a 'historical breeding range' of 345 10km squares (i.e. a 50% contraction in range).

6.1.5 Red Grouse are on the Red List of Birds of Conservation Concern in Ireland and are protected under the Wildlife Act and listed under Annex III/I of the EC Council Directive on the Conservation of Wild birds (79/409/EEC). Annex II lists those species which may be hunted but in such a manner so as not to endanger their conservation.

6.2 Factors influencing Red Grouse decline

EU subsidies for sheep farming and forestry have had a negative effect on grouse populations in Ireland and Britain with declines further compounded by bracken encroachment, improper or poor burning practises, while the effects of hunting on grouse numbers are poorly understood (Watson & Moss, 2008).

6.2.1 The substantial loss of suitable grouse habitat in the Republic of Ireland to afforestation and large-scale mechanical peat extraction has directly impacted on populations. It has decreased the area of the former breeding range of Red Grouse and also fragmented and isolated localised populations. Given their largely sedentary nature (Wernham *et al*., 2002), these

changes are likely to have restricted emigration/immigration between populations and thereby likely to have negatively influenced the distribution of Red Grouse in Ireland.

6.2.2 Overgrazing, particularly by sheep, has had a considerable effect on Red Grouse distribution and populations by affecting the quality of the heather available for the birds to eat. Sheep directly compete with grouse for heather and while grouse do not need vast quantities of heather to survive, the quality and nutritious content (nitrogen and phosphorous levels) of the heather is very important and can have an effect on their breeding density and breeding success (Moss, 1972, Moss *et al*., 1972). Grouse will preferentially select heather plants of a certain age (2-7 years), height and certain parts of heather plants in order to gain nutrients required (Savory, 1978), particularly pre-breeding season. Sheep, cattle and deer grazing can severely reduce vegetation cover in winter, sometimes leaving vegetation so short it no longer acts as a safe haven for birds from predators (Watson & Moss, 2008).

6.2.3 Undergrazing can also be a problem with undergrazed heather growing too tall and rank making it less favourable (Watson & Moss, 2008). While blanket bog is a semi-natural habitat that will largely remain intact, heath requires some management i.e. grazing and/or muirburn in order for it not to revert to scrub and/or woodland.

6.2.4 Muirburn or the burning of heather moorland for the purposes of maintaining optimum heather age for both sheep and grouse, is a practice that has been around since the late 1800s. However, if it is done too frequently or infrequently, it is no longer beneficial to grouse (Scottish Muirburn Code 2008 – www.scotland.gov.uk./Resource/doc/158517/0042975.pdf).

6.2.5 Grouse are considered a cold adapted species largely confined to higher latitudes of the western Palearctic within arctic, subarctic, boreal and marginally into temperate zones (Cramp & Simmons, 1980). Climate change is likely to influence Red Grouse distribution in Britain and Ireland with a predicted shift north westwards in the breeding range of Willow Grouse (and the sub species Red Grouse) by the end of the 21st Century (Huntley *et al*., 2007).

6.2.6 Further investigation would be required to ascertain whether louping ill, a disease of the central nervous system transmitted by the sheep tick *Ixodes ricinus* (Timoney, 1972), and/or strongylosis, a disease caused by the parastic caecal threadworm *Trichostrongylus tenius* (Newborn & Foster 2002), are prevalent amongst Red Grouse populations in Ireland. The lack of records suggest that such diseases have not had any great effect on Red Grouse populations in Ireland, which occur at much lower densities than in eastern Scotland and northern England which have been the areas worst affected by disease outbreaks (Hudson, 1986, Hudson *et al*., 1992).

6.2.7 The impacts of predators on Red Grouse populations in Britain have been widely documented (Redpath, 1991, Redpath & Thirgood, 1997, Thirgood *et al*., 2000a, 2000b) although their influence on populations in Ireland is less well understood.

6.2.8 Although damage from the heather beetle has been reported in Northern Ireland (Anon 2008a) there have been no recent anecdotal reports in the Republic of Ireland.

6.3 Planning and implementation of conservation measures

One of the limitations to using distribution data derived from atlas surveys in conservation planning is their coarse resolution relative to the needs of local planners. By a process of extrapolation, estimates of local populations on important areas and/or designated sites were derived (see Appendix 2, Table 2A). Although these estimates are merely a guide to expected population levels, regular monitoring in these areas would allow for any significant changes to be determined.

6.3.1 The importance of a Red Grouse Species Action Plan

The results of the national Red Grouse Survey 2006-08, should provide the basis for a national **Species Action Plan** for Red Grouse in the Republic of Ireland with the aim of maintaining existing populations and implementing measures to increase numbers and range where needed. Areas with actual populations of Red Grouse are crucial for the conservation of the species. These areas are the remnants (meta-population) of a formerly much larger and contiguous distribution and quite often are only inhabited by a few individuals. As productivity and overwintering data

for Red Grouse populations in Ireland is lacking, more detailed research is needed, particularly to discern how well populations in fringe areas are doing compared to those in more stronghold areas.

A Species Action Plan for Red Grouse will need to identify key sites for management action. This will be facilitated by interpreting the data collected as part of the national Red Grouse Survey and discriminating areas:

- where grouse are present (given priority)
- considered close to existing populations
- which could act as stepping stones
- that could potentially expand

A Species Action Plan will need to state which groups/agencies are responsible for each action, what specific tasks need to be derived from each action and what level of priority is given to each action. Ultimately, a time-scale would have to be worked out for each action so as to set clear targets.

6.3.2 Management issues

In Britain, the Red Grouse is now a *Biodiversity Action Plan Species* and in Northern Ireland it is listed as a *Priority Species* under the Northern Ireland Biodiversity Strategy unlike the Republic of Ireland where, despite being Red Listed (Lynas *et al*., 2007), it has not been targeted for such measures. In April 2008, 'The Northern Ireland Species Action Plan - Red Grouse *Lagopus lagopus scotica'* was published by the Environment & Heritage Service in which a number of actions to target the current population of 202 pairs in Northern Ireland are outlined.

6.3.2.1 Low density populations in Ireland

In northern England in 2007, over 50 adults per km^2 [post breeding season densities of 200 grouse per km^2] were recorded whereas in Scotland lower densities were recorded with 25 adults per km^2 [post breeding season densities 60 birds per km^2] (Games and Wildlife Conservation Trust Review, 2008). Irish populations appear to be less cyclical and exist at much lower densities (Watson & O'Hare, 1979b) on average 1.1 adults/km^2 and up to 9 adults per km^2 recorded in higher density areas (RGS 2006-08). Today, very little management of grouse habitat occurs in the Republic of Ireland besides some management of heather on Powerscourt Paddock in the Wicklow Mts. (*Management Plan for Wicklow Mountains National Park 2005-2009,* Anon 2005), and in some small pockets scattered across counties Donegal, Leitrim, Waterford, Carlow and Cork. Any attempts at management of populations in Ireland should be mindful that densities here are much lower than in Britain and measures that are used successfully there, may not always be suitable in the Irish context.

6.3.2.2 Management of shooting

Red Grouse shooting in Britain (usually driven shoots with beaters) occurs after the breeding season (from August 12th), and is supposed to target the population surplus, allowing the core population to sustain itself through the winter with less competition for territories. In Ireland, any shoots tend to involve 'walked up' shooting using dogs (Butler, 1993). The problem in Ireland is how do you define the 'a sustainable level of shooting' in a low density population of Red Grouse? This and other difficulties concerning managing grouse populations in the Republic of Ireland for the future will have to be addressed more fully through a Species Action Plan and further research on the population dynamics of the species.

A more managed approach to shooting in the Republic of Ireland, where it occurs, should be adopted for the benefit not only of grouse populations but also for the future of grouse shooting here. In particular where shooting occurs on lands owned by Coillte, and other major landowners, grouse management strategies should be developed and hunting monitored more closely. In the Republic of Ireland the open season is more restricted (Sept 1 – Sept 30 *(30 days)*) than in Northern

Ireland (Aug 12 – Nov 30 *(108 days)*). There are measures to redress this imbalance with a proposed review of shooting practices in Northern Ireland and the possibility of a temporary ban on shooting in counties where populations are critically low (Anon, 2008a). Concerns have been expressed for Red Grouse populations along the border with Northern Ireland (particularly along the Cavan/Fermanagh border) which has an earlier start (see above) to the open season.

6.3.2.2.1 Bag Returns

In the Republic of Ireland, reported annual bag returns of up to 2,400 birds (1990-1997), are over ten years old (Henderson & Tierney, 2000) with indications that this figure is now considerably less. Red Grouse are given specific protection under *Article 7 of the Birds Directive* (EEC 79/409 1979) with the State bound to ensure that hunting of Red Grouse does not jeopardise conservation efforts. At present, no hunting occurs on NPWS lands (Floyd, 2004). The potential impacts of shooting on Red Grouse populations in these areas would have to be taken into account should NPWS change its policy on shooting. Bag return data from any birds shot in the season can be used in certain statistical analyses to examine trends in grouse populations. However returns are needed from many estates over several years and any results can be influenced by hunting effort which can vary across years (Cattadori *et al*., 2003) often leading to an exaggeration of the size of population fluctuations (Watson & Moss 2008). Bag returns for all Red Grouse shot could feed into a Species Action Plan and any measures to monitor their long-term productivity and survival. It will be important to ensure that returns reflect hunting effort in order for these data to be used as a management tool.

6.3.2.3 Habitat Management

The positive effects of patch and strip burning of dry heath, to create a mosaic of heather ages, on Red Grouse numbers is known (Picozzi, 1968). Management of moors for Red Grouse can also benefit other bird species, increasing densities of breeding Golden Plover, Curlew and Lapwing (Tharme *et al*., 2001). However, unregulated heather burning can adversely affect grouse populations, other wildlife and peatlands causing irreparable damage to the underlying peat substrate and often leading to the replacement of heather with grasses (Hudson, 1995). An action plan for Red Grouse should incorporate appropriate heather management in grouse habitats while taking into account the sensitive nature and levels of protection (*EU Habitats Directive*) afforded to these habitats, i.e. blanket bog, raised bog, wet heath and dry heath, in Ireland.

6.3.2.4 Introductions of Red Grouse of British origin

There have been many anecdotal reports of introductions of birds '*scoticus*' from Scotland and England to try and improve the vigour of local populations (Watson & Moss, 2008). This practice was frequent in the late 19th and 20th centuries* when shoots on private estates were commonplace (Butler, 1993). In more recent times, fewer introductions have been reported, although the release of pen-reared 'British race' birds still occurs in Counties Cork and Galway (pers. comm.). The likelihood of these birds mixing with local populations, makes it harder to distinguish birds of purported Irish race '*hibernicus*' from their British counterparts without further investigation into their genetic make-up, which may not always prove conclusive (Freeland *et al*., 2006). If the consensus is that there is a definite Irish race (appearance is different although genetically it might be similar to *scoticus* birds), then the continued importation of birds from Britain should be prevented so as not to dilute Irish stock further.

* There is historical evidence of one such introduction in the form of a letter from a Frank S. Graham (North Yorkshire) who sent over 12 brace of live grouse to the gamekeeper of Screebe Lodge, Maam Cross, Co. Galway). A copy of this telegram was kindly provided by Dominic Berridge of NPWS (refer to Appendix 11).

The conflicting evidence on the taxonomic status also creates management problems. In the Northern Ireland Species Action Plan for Red Grouse (Anon., 2008a), separate measures and targets are outlined for populations deemed to be *scoticus* and *hibernicus*, although the distinction between the two groups was based largely on phenotypic characteristics recorded by numerous

observers during a survey of Red Grouse in Northern Ireland in 2004. Most observers in the national Red Grouse Survey 2006-08 in the Republic of Ireland did not make such distinctions. In the field such observations were prone to bias and considered to be subjective and often affected by light conditions. More importantly not all birds were seen closely enough to merit making such judgements.

6.3.3 Proposed aims of a Red Grouse Species Action Plan

1) To prevent any further contraction in the historic breeding range of Red Grouse and ensure measures are taken to maintain current populations in the Republic of Ireland, with a forward plan to improve habitat quality in key areas so as to ensure the population can survive. Measures to reduce stocking densities of sheep in Commonage areas badly damaged by overgrazing are now in place. It is hoped that such measures will ensure the recovery of blanket bog, and heather, in those areas which have not been too severely damaged over the past 30 years. The appropriate levels of sheep grazing should ensure that any Red Grouse co-existing in these areas will have better percentage cover of heather in their territories. It also means that Red Grouse will have the potential to expand into areas that were previously lost to sheep grazing.

2) The current population of Red Grouse in Ireland exists in low densities, relative to its counterparts in parts of Britain. Historically this difference may not have been as great as there were many areas managed for Red Grouse shooting. However, any future efforts to increase their densities will require a lot of investment, as the management of any suitable grouse areas to produce a reasonable surplus of birds for hunting, is both labour intensive and costly. Such investment is important in terms of maintaining expertise and ensuring there is a source of birds to emigrate into other low-density populations. However, the location of any areas targeted for management should be prioritised and also it is important to point out that populations in Ireland will never attain the high peaks and troughs of intensively managed populations as in eastern Scotland and northern England.

3) More research is required on Red Grouse ecology, in particular on life history traits such as breeding success and over-winter survival in low density populations. In Britain there is conflicting evidence as to whether territorial birds have greater over-winter survival than non territory holding birds. What percentage, if any, of the Irish population do not hold territories? Some authors believe the proportion of non-territory holding birds is higher in low density populations (Watson & Moss, 2008). Indeed the population estimates extrapolated from the national survey results do indicate a slight bias in sex ratio with 55% being male.

4) Monitoring of populations, by undertaking repeat surveys in key areas, will allow for estimation of trends over time. If a monitoring programme is well designed, it can be a research tool in its own right, on the condition that suitable data are collected.

5) To improve and expand existing Red Grouse populations. Any attempt to restore populations through much of the former range is probably unfeasible as so much of historically suitable habitat has been irreparably destroyed, primarily through land use changes, in particular large-scale afforestation on blanket bogs and mechanical exploitation of raised bogs. In certain circumstances rehabilitation of afforested bog and heath can be achieved if the tree canopy has not closed and if other factors have not altered the peatland hydrology irreversibly. A recently completed Life Project on 'Restoring Raised bog in Ireland' (Project No: Life 04 NAT/IE/000121) by Coillte highlights the potential for such rehabilitation to take place with the main work involving the felling of trees and the blocking of drains to ensure the water table is back up to the level of the peat to allow peat forming sphagnum mosses to regenerate. Engaging with stakeholders such as Coillte and Bórd Na Móna, important landowners of raised bogs, will be important if any restoration programme is to be attempted.

6) The species range could be enlarged and abundance levels improved in some areas with the potential for some isolated populations to be reconnected via habitat corridors. It may be possible in areas with suitable landscape ecological characteristics that are close to extant populations

(close to presence areas). Areas with potentially suitable Red Grouse habitat but without birds present can act as stepping stones to significantly increase the viability of the population.

6.3.4 What is important for Red Grouse populations?

First and foremost habitat improvement of areas which would still be classified as potentially suitable for Red Grouse but which have suffered from the effects of inappropriate land use. Areas also exist where the species is absent despite habitat being apparently suitable.

6.3.4.1 Develop Regional Plans

- Identify key areas
- Tailor measures to these areas
- Link with local Biodiversity Action Plans

6.3.5 Current Action

1. The Commonage Framework Plans, which assessed appropriate grazing levels on commonages, are intended to restore vegetation to overgrazed commonages, mostly in hill areas on peat. The Single Farm Payment, which removes incentives for overgrazing, is conditional on adhering to the Commonage Framework Plan and agreeing to appropriate levels of destocking.
2. The *Peatlands 2020 Conservation Plan – halting the loss of Peatland biodiversity* by the IPCC, hopes to develop a national strategy for the conservation and management of all peatland types in Ireland (Malone & O'Connell 2009). It is hoped this plan will strengthen the government's policy commitment to protecting and managing peatland sites, including grouse habitat (bogs and heath). Continued management of heath (a semi-natural habitat) is necessary to prevent it reverting to scrub/woodland (Cross, 2006). An examination of damage to a total area of 1,845 km^2 of heath (wet and dry) assessed by the CFP study in the European Dry Heath (4030) Conservation Status Assessment Report, showed that half the total was damaged to some extent.

6.3.6 Proposed Future Actions

1. Where appropriate, agri-environment schemes should contain habitat prescriptions to benefit Red Grouse, particularly in areas targeted for conservation purposes i.e. in strongholds and key corridors between more isolated populations. Incentives should be given to private landowners in these areas to manage their lands for Red Grouse. Planners could ensure they follow certain codes of practice with respect to burning, predator control where appropriate.
3. Encourage and support habitat management for Red Grouse. A five year management trial to assess the effects of appropriate habitat management and predator control on nesting success of Red Grouse. Such measures could also benefit other upland breeding bird species such as Golden Plover and Dunlin. Appropriate grazing levels to benefit Red Grouse and other upland breeding bird species in Ireland need to be determined.
4. Follow up on policy by Forest Service (Dept. of Agriculture, Fisheries and Food) to ensure that no further areas of heath and blanket bog will be planted.
5. Strive for sustainable planning on blanket and raised bogs
6. Site protection policies should be included in local Biodiversity Action Plans. Important Red Grouse habitats/areas should be safeguarded from inappropriate development through the planning process. Sensitivity mapping, which would incorporate recent data, could facilitate planners in making appropriate judgements.
7. Given the extent of forestry planted at higher elevations in the Southwest, there is potential in the future to benefit grouse populations there with the restoration of some areas previously forested back to blanket bog and heath.
8. The importance of corridors of 'suitable grouse habitat' to connect isolated populations has been highlighted in the previous section. Such corridors are vital to allow for the movement of Red

Grouse, which tend to be sedentary in nature. This supports designation of large bog/heath SACs/SPAs/NHAs and mosaics and also highlights the need to adopt a strategic approach to the selection of the best sites for habitat rehabilitation/restoration to allow isolated Red Grouse populations to reconnect. Obviously management measures that will be adopted for Red Grouse conservation in SACs will need to be assessed prior to the implementation of any such measures to ensure they are also compatible with the conservation of the habitat and/or species features for which a given SAC is designated.

9. Examining the interactions between the various factors that are likely to have an effect on grouse populations (life history traits, predation, shooting, habitat quality) and determining the sustainability of said populations is complex. The support and promotion of proper management of Red Grouse populations would be an important step. Determining whether current levels of shooting are likely to impact on the current population is needed before NPWS can advise on the sustainability of the current levels of shooting.

10. Consider notifying areas with high densities of breeding Red Grouse as pNHAs and identify the proportion of the population which are not on designated lands.

6.3.6.1 Important to liaise with relevant stakeholders

The drafting of any Species Action Plan will require consultation with interested stakeholder groups. Some of the key organisations that should be involved in the drafting of such a plan are listed below.

- An Taisce, BirdWatch Ireland, the Irish Kennel Club, Irish Peatland Conservation Council, Irish Uplands Forum, The Irish Grey Partridge Trust and the National Association of Regional Game Councils
- Landowners (particularly major state landowners such as Coillte and Bórd Na Móna)
- Government departments (Agriculture, Fisheries and Food) and agencies (Teagasc, Heritage Council)
- Farmers and farming organisations (including the Irish Farmers Association)

6.3.6.2 Habitat recommendations

1) Restoration to ensure patch connectivity at the landscape scale and plant species composition or structure at the community scale, with the understanding that management at either scale may have an effect on the other. The Northern Ireland Species Action Plan for Red Grouse recommends the restructuring of upland forest blocks (including rehabilitation of clear-felled areas on former upland heath and blanket bog) to enhance grouse habitat.

2) Ideally, isolated and fragmented Red Grouse populations would be reconnected via habitat corridors, where possible. Reconnecting populations will heighten their ability to withstand various stochastic events and increase gene flow among them. Many potentially suitable areas exist and with current policies on destocking (C.F.P's) it is likely that some range expansion will occur naturally. Information on how far Red Grouse can move over unsuitable habitats is lacking in the Irish context. A targeted approach involving radio-tracking of individuals in key populations, would allow for such information on dispersal to be gathered. In addition, a comparison of breeding productivity and overwinter survival between populations that are isolated and those which are not would provide key information in determining whether the fragmentation of the specie 'historical range' is likely to influence its survival in the future.

3) An Action Plan should identify those critical areas that require priority action in the short term. In particular, the loss of range on the Raised bogs in the Midland region should be addressed in any such action plan.

4) Understanding the relationship between Red Grouse and the habitats in which they live is crucial. The prioritisation of habitats to be managed is vital to allow efficient management in regions. It is necessary to tailor management plans to the needs of Red Grouse in local regions as

populations in the east of the country are different to those in the west in terms of threshold densities, and therefore they may respond differently to management measures etc.

5) The potential effects of land use (i.e. grazed commonages/ turf cutting, forestry), habitats and habitat quality on Red Grouse breeding success and over-winter survival, particularly of chicks, needs to be explored.

6) The effects of disease (louping ill), parasites (Strongyle worm) and the heather beetle *Lochmaea suturalis* on Irish populations are poorly documented. Research is needed to determine if any of the above influence grouse populations. In Britain, recent mild, wet winters and wet summers have caused severe heather beetle problems and the damage caused to heather is a worry to landowners and conservation organisations e.g. the *Moorland Association*, (refer to website@moorlandassociation.org).

6.3.6.3 Population monitoring recommendations

- Spring population surveys for Red Grouse should be standardised so that local, regional and national population estimates are directly comparable.
- Methods for assessing yearly production in areas where they are shot need to be identified. Currently there is little if any monitoring of populations in these areas. NPWS are responsible for ensuring that shooting of Red Grouse is carried out sustainably and for maintaining favourable conservation status of Red Grouse. A more active role by NPWS in monitoring grouse harvests i.e. collecting bag return data, by liaising with relevant partners (N.A.R.G.C.) would be an important step. It is vital to develop monitoring of those Red Grouse populations that are subject to hunting. Future efforts should evaluate the effects of season open dates and season lengths on recruitment into spring populations. We cannot rely fully on Scottish or English data as parameters of Red Grouse populations there may be different, particularly given densities in the Republic of Ireland are much lower.
- A number of designated sites (SPAs/SACs) contain significant Red Grouse populations (Appendix 2). There is potential for positive, site specific management to maintain the favourable condition of habitats in some of these areas to the benefit of grouse populations while being mindful of any potential conflicting conservation interest.

6.3.6.4 Further research required

More research is needed on Red Grouse in order to implement appropriate conservation measures. Further information on the demographics of Red Grouse and their ecology (with particular reference to diet, spatial requirements and over-winter survival) is necessary to fully tackle the most pressing concerns. The Irish population is not in immediate danger of extinction, but help is needed with respect to boosting numbers in fringe areas where populations are in decline and in conserving stronghold areas to allow the national population to potentially expand their range in the future.

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8.0 APPENDICES

Appendix 1 List of current and past members of the Red Grouse Survey Project Steering Group

PSG MEMBER	ORGANISATION
Dr Sinéad Cummins Dr Stephen Newton	BirdWatch Ireland
Kenny Bucke	Bórd Na Móna
Barry Coad	Coillte
Frank Macken John Muldowney	Department of Agriculture, Fisheries and Food
Martin Gavin	Irish Farmers Association
Liam McGarry	Irish Game Protection Association
James Dalton	Irish Grouse Ground Conservation Committee
Christy Davitt	Irish Kennel Club
Caroline Hurley Sara Malone	Irish Peatland Conservation Council
Jack Meath	Landowners Alliance
Dr James Dunne Des Crofton	National Association of Regional Game Councils
Dr Liam Lysaght	National Biodiversity Data Centre
John Wilson Jim Kelly Peter Carvill	National Parks and Wildlife Service (HQ)
Sue Callaghan Damian Clarke Leonard Floyd Ben McCabe Tony Murray	National Parks and Wildlife Service (Regional)
Catherine Keena	Teagasc
Cliona O'Brien (formerly L.Lysaght)	The Heritage Council
Prof. John O'Halloran Chairman of PSG	University College Cork
Helen Lawless Lenka Mulligan	Wicklow Uplands Council

Appendix 2 Sites that hold or held important populations of Red Grouse

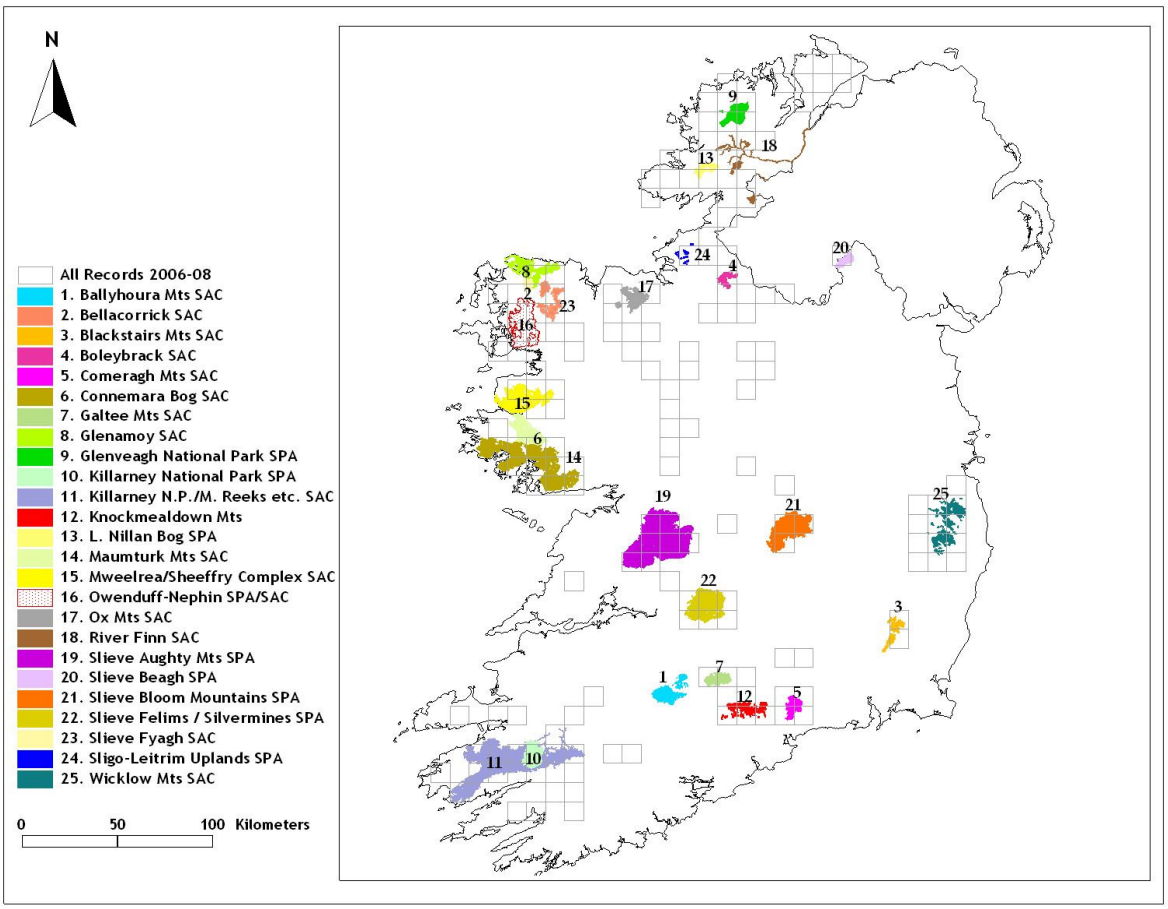


Figure 2A: Distribution of all grouse records (2006-08) across important blanket bog areas (most designated either SAC or SPA) that are or were once suitable for Red Grouse.

Table 2A: Figures given below are crude estimates of the populations of Red Grouse in some protected areas of blanket bog throughout the country. These figures were derived using calculated suitability factors for each region (which are not site specific), the mean density of birds (adjusted using the correction factor*) and the total area of each SAC / SPA.

N.B. Given a priori knowledge of these areas, some of these estimates are probably an overestimate (areas highlighted in orange) while others are likely to be an underestimate (areas highlighted in blue).

Area	**Designation**	**Region**	**Suitability Factor**	**Each Region** **Mean Males ± *CL's***	**Total Males** ***± CL's***	**Population Estimate (correction factor*) ± *CL's***
Ballyhoura Mts.	SAC	E & S	0.29	1.22 *0.96-1.49*	2.7 *2.1-3.3*	5.7 *4.5-6.7*
Boleybrack	SAC	Northwest	0.7	1.21 *1.0-1.44*	26.6 *21.2 – 30.5*	41 *34.4 – 48.8*
Bellacorrick	SAC	West Conn.	0.67	0.64 *0.52-0.78*	36.8 *29.9-44.4*	65.5 *53.3-78.7*
Blackstairs Mts	SAC	E & S	0.29	1.22 *0.96-1.49*	16.2 *12.8-19.8*	34.2 *27.1-40.2*
Comeragh Mts	SAC	E & S	0.29	1.22 *0.96-1.49*	10 *7.9-12.3*	21.2 *16.8-24.9*
Connemara Bog	SAC	West Conn.	0.67	0.64 *0.52-0.78*	184.0 *149.7-222.1*	327.7 *266.9-393.6*
Galtee Mts	SAC	E & S	0.29	1.22 *0.96-1.49*	15.6 *12.3-19.0*	32.9 *26.1-38.7*
Glenamoy	SAC	West Conn.	0.67	0.64 *0.52-0.78*	45 *36.7-54.4*	80.2 *65.4-96.4*
Glenveagh National Park	SPA	Northwest	0.7	1.21 *1.0-1.44*	53.3 *43.9-63.3*	85.1 *71.1-101.5*
Killarney N.P., Mac. Reeks etc.	SAC	Southwest	0.31	0.23 *0.1-0.33*	34.1 *17.8-48.9*	62.1 *36.9-98.9*
Knockmealdown Mts	N/A	E & S	0.29	1.22 *0.96-1.49*	29.8 *23.6-36.5*	63.2 *50.1-74.2*
Lough Nillan Bog	SPA	Northwest	0.7	1.21 *1.0-1.44*	31.8 *26.3-37.9*	50.9 *42.7-60.6*
Maumturk Mt.s	*SAC*	*West Conn.*	*0.67*	*0.64* 0.52-0.78	*39.4* 32.1-47.6	*70.2* 57.2-84.3
Mweelrea/Sheeffry Complex	SAC	West Conn.	0.67	0.64 *0.52-0.78*	70.5 *57.4-85.1*	125.6 *102.3-150.9*

Table 2a contd.

Owenduff-Nephin	SPA/SAC	West Conn.	0.67	0.64 0.52-0.78	103 83.8-124.3	183.5 149.5-220.4
Ox Mts	SAC	West Conn.	0.67	0.64 *0.52-0.78*	39.8 *32.4-48*	70.9 *57.7-85.2*
River Finn	SAC	Northwest	0.7	1.21 *1.0-1.44*	20 *16.5-23.8*	32.1 *26.9-38.1*
Slieve Aughty Mts	SPA	E & S	0.29	1.22 *0.96-1.49*	61.7 *48.7-75.5*	130.6 *103.5-153.5*
Slieve Beagh	SPA	Northwest	0.7	1.21 *1.0-1.44*	15 *12.4-17.8*	24 *20-28.6*
Slieve Bloom Mts	SPA	E & S	0.29	1.22 *0.96-1.49*	22.2 *17.5-27.2*	47 *37.3-55.2*
Slieve Felims/Silvermines	SPA	E & S	0.29	1.22 *0.96-1.49*	16.4 *12.99-20.1*	34.8 *27.6-40.9*
Sligo-Leitrim Uplands	SPA	Northwest	0.7	1.21 *1.0-1.44*	3.9 *3.2-4.6*	6.2 *5.2-7.41*
Wicklow Mts.	SAC	E & S	0.27	1.22 *0.96-1.49*	45.5 *36-55.7*	96.4 *76.4-113.3*

Correction factor * of 1.31 was the estimated figure of under-recording of female birds (see Section 3.1.4) and was used to derive overall estimates for populations (pre-breeding season) in those sites listed above. **N.B. These figures are based only on the national survey results and in some cases more accurate estimates may be available for local populations.**

Appendix 3 Unsuitable 1km² sites dropped from the initial selection of sites

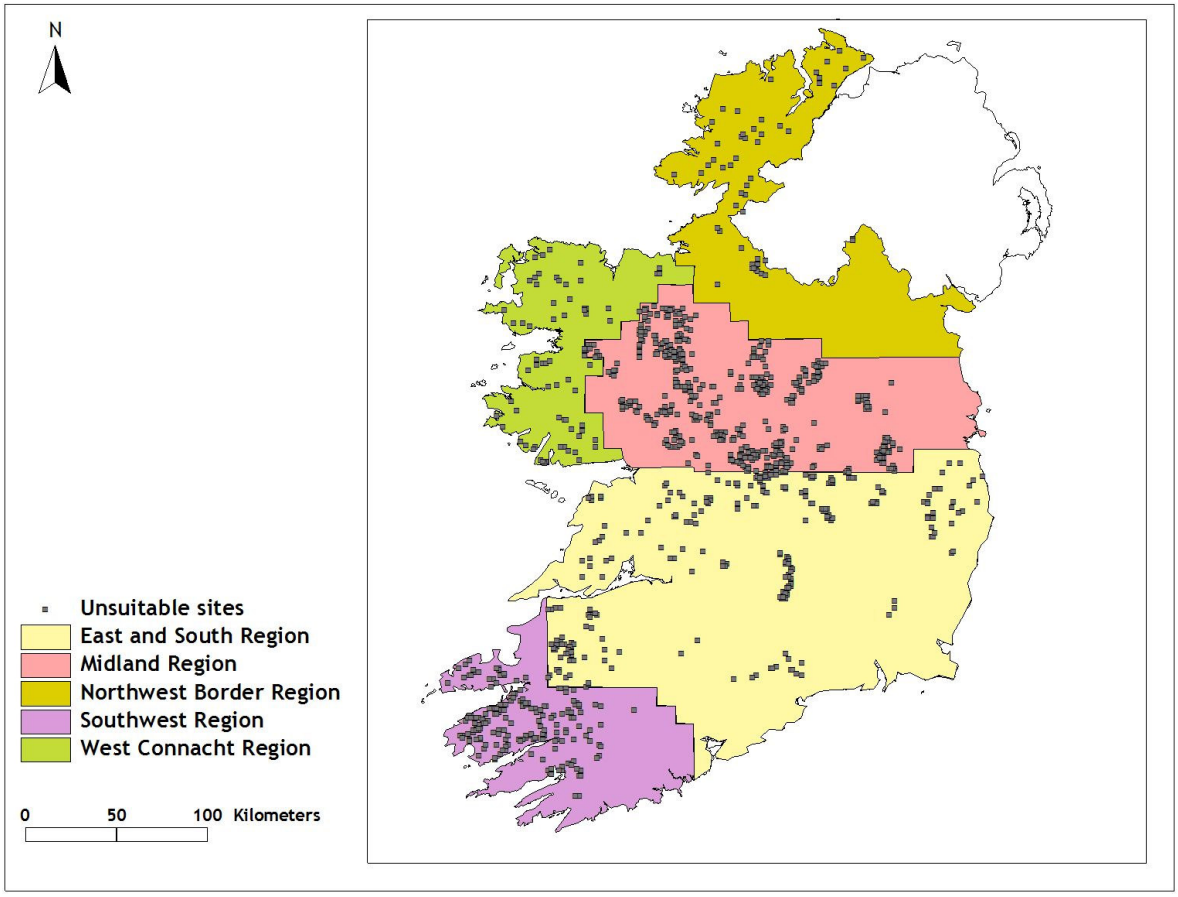


Figure 3A: Unsuitable 1km² sites that were dropped during the course of the survey.

Appendix 4 Red Grouse recorded in SACs

Table 4A: SACs in which grouse were recorded during the national Red Grouse Survey 2006-08

Site Code	Name	No. of 1km squares with grouse	Total Area / km² surveyed within SAC
001403	Arroo Mountain	1	0.53
001922	**Bellacorrick Bog Complex**	**8**	**6.76**
000770	Blackstairs Mountains	1	0.98
002032	Boleybrack Mountain	2	0.97
002347	Camderry Bog	1	0.94
000476	Carrowmore Lake Complex	1	0.99
001242	Carrownagappul Bog	1	1.00
002047	**Cloghernagore Bog and Glenveagh National Park**	**16**	**12.51**
001952	Comeragh Mountains	1	1.00
002034	**Connemara Bog Complex**	**18**	**16.42**
000485	Corraun Plateau	1	1.00
000584	Cuilcagh - Anierin Uplands	3	2.95
000604	Derrinea Bog	1	0.76
001125	Dunragh Loughs/Pettigo Plateau	4	2.71
000142	Gannivegil Bog	2	1.01
000500	Glenamoy Bog Complex	6	5.48
001912	Glendree Bog	1	1.00
000647	Kilcarren-Firville Bog	1	0.88
000365	**Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment**	**10**	**9.64**
000285	Kilsallagh Bog	1	0.92
000296	Lisnageeragh Bog and Ballinastack Turlough	1	0.94
002176	Leenan River	1	0.11
000297	Lough Corrib	1	0.73
001818	Lough Forbes Complex	1	1.00
000301	Lough Lurgeen Bog/Glenamaddy Turlough	1	0.81
000165	Lough Nillan Bog (Carrickatlieve)	5	2.45
000308	Loughatorick South Bog	3	1.75
000168	Magheradrumman Bog	1	0.66
001880	Mennaguse Scragh	1	0.93
000172	Meenaguse/Ardbane Bog	2	0.8
000173	Meentygrannagh Bog	1	0.6
001932	Mweelrea/Sheeffry/Erriff Complex	1	1.00
002012	North Inishowen Coast	1	0.03

Table 4A contd.

Site Code	Name	No. of 1km squares with grouse	Total Area / km² surveyed within SAC
000534	**Owenduff/Nephin Complex**	**13**	**11.00**
002006	Ox Mountains Bogs	1	1.00
002301	River Finn	1	0.41
002298	River Moy	2	0.21
002312	Slieve Bernagh Bog	4	2.92
000412	Slieve Bloom Mountains	7	4.49
000189	Slieve League	1	0.69
002185	Slieve Mish Mountains	1	1.00
000190	Slieve Tooey/Tormore Island/Loughros Beg Bay	2	1.98
001913	Sonnagh Bog	1	0.28
002031	The Twelve Bens/Garraun Complex	1	1.00
002122	Wicklow Mountains	24	21.97
Total Area of SACs with grouse		**158**	**127.4**
Total Area of SACs with no grouse		*163**	*126.5*

* No. of 1km squares surveyed that were partly or wholly within SACs in which no grouse were recorded.

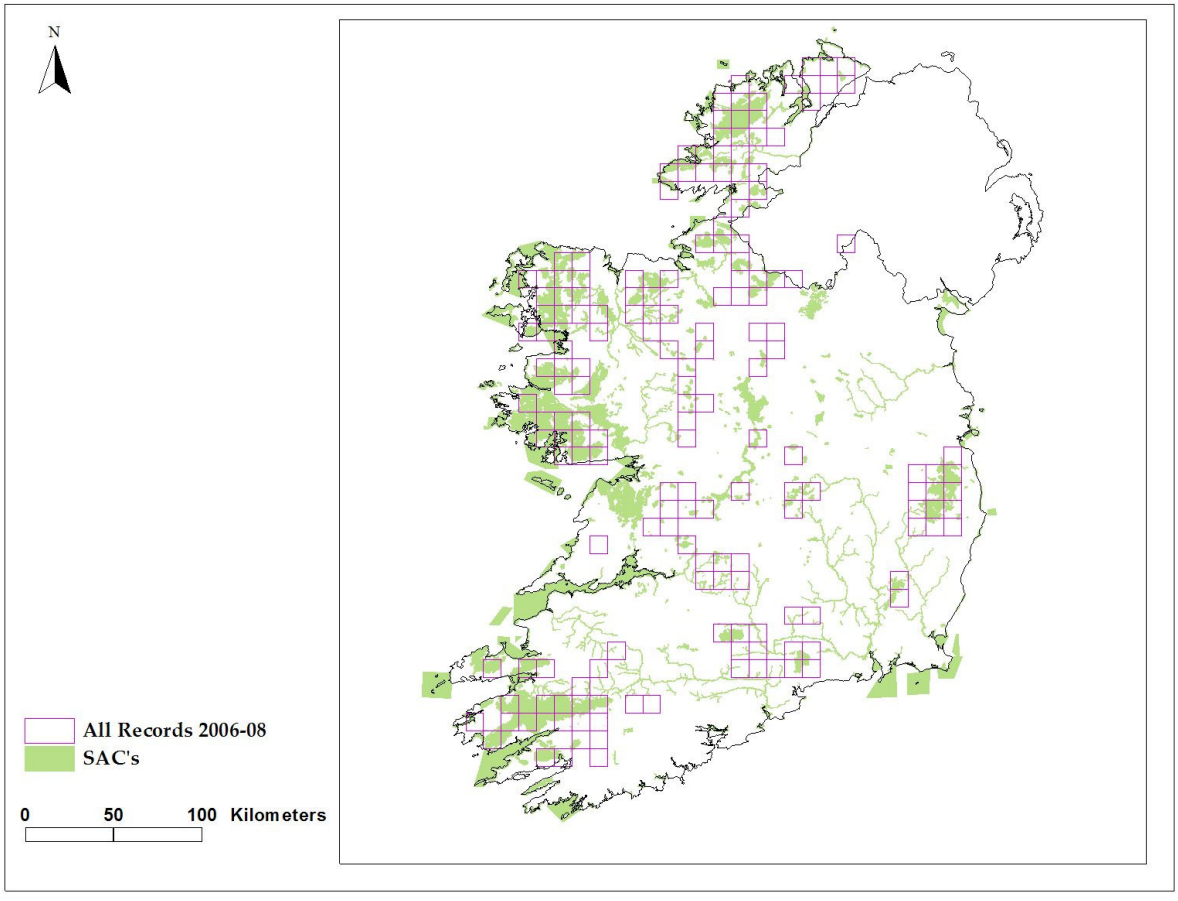


Figure 4A: Distribution of all records of Red Grouse (at 10km level) across SACs collected during 2006-08, including casual sightings, which form the national Red Grouse Survey database.

Appendix 5 Red Grouse recorded in SPAs

Table 5A: SPAs in which grouse were recorded during the national Red Grouse Survey 2006-08

Site Code	Name	No. of 1km squares with grouse	Total Area / km² surveyed within SPA
004039	Glenveagh National Park SPA	2	1.39
004106	Lough Barra Bog SPA	1	0.76
004110	Lough Nillan Bog (Carrickatlieve) SPA	4	2.45
004098	**Owenduff/Nephin Complex SPA**	**13**	**11.37**
004099	Pettigo Plateau Nature Reserve SPA	1	0.48
004168	**Slieve Aughty Mountains SPA**	**14**	**13.80**
004167	Slieve Beagh SPA	1	1.00
004160	Slieve Bloom Mountains SPA	4	5.01
004150	West Donegal Coast SPA	1	0.25
004040	**Wicklow Mountains SPA**	**13**	**10.65**
Total Area of SPAs surveyed with grouse		55	48.20
Total area of SPAs surveyed without grouse		*18**	*11.42*

* No. of 1km squares surveyed that were partly or wholly within SPAs in which no grouse were recorded.

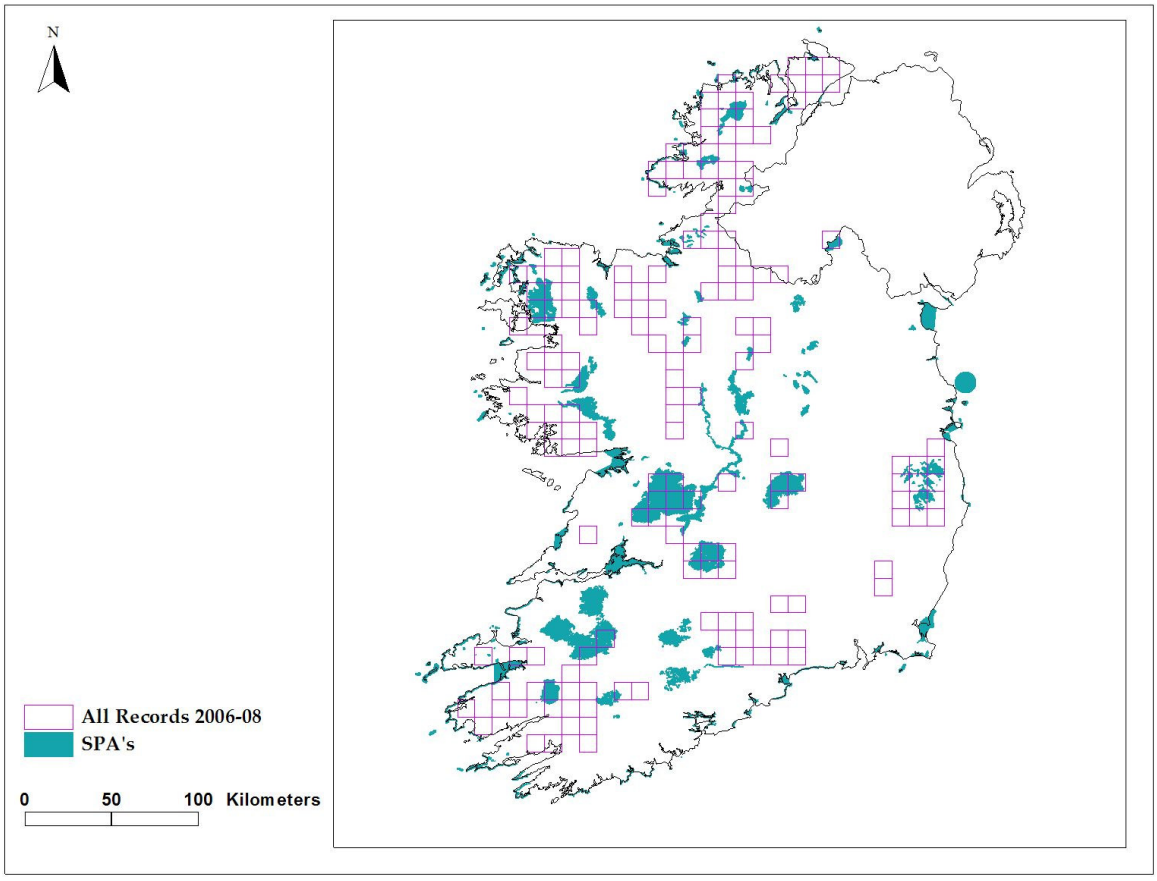


Figure 5A: Distribution of all records of Red Grouse (at 10km level) across SPAs collected during 2006-08, including casual sightings, which form the national Red Grouse Survey database.

Appendix 6 All sources of additional Red Grouse sightings data from 2000-2005 (pre-RGS period)

Table 6A: Sources of additional data on Red Grouse distribution pre 2006 (2000-2005)

Source	No. of positive records
Preliminary Red Grouse Survey 2005	18
Third Mid-Shannon Report	5
Casual Sightings 2000-2005	83
NPWS Conservation Rangers 2000-2005	54
NPWS Research –Tony Murray- Owenduff Survey 2003	6
Countryside Bird Survey	18
NPWS Raised Bog Report	23
Upland Bird Survey 2002-04	67
Commonage Framework Plans	163

Total tally for pre 2006 is N=437 and includes records with recent evidence (probable) only i.e. fresh droppings.

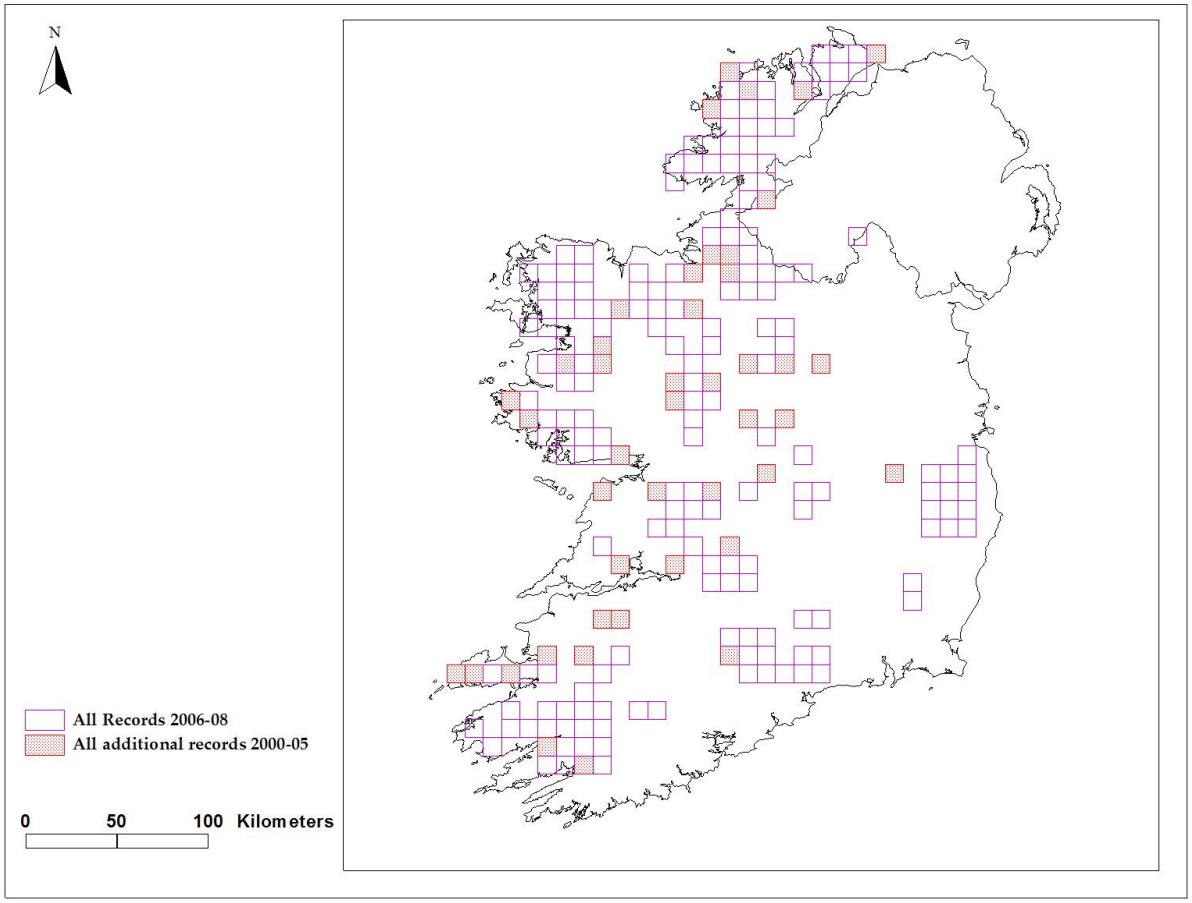


Figure 6A: Map of all additional 10km squares that had records for Red Grouse from 2000-05 (red squares) and all records (empty squares) collected during the survey period (2006-08).

Appendix 7 Assessment of grazing pressures across those survey sites (N=313) where it was noted by observers.

Grazing Assessment	Number of sites
Low level	120
Low - moderate level	2
Moderate level	94
Moderate - high level	16
High level	81

Appendix 8 List of tape-playback survey participants: Red Grouse Survey 2006-08.

Survey Member	Organisation
Christopher Cullen	BWI Project Field Staff 2006-07 and 2007-08
Fiona Farrell	BWI Project Field Staff 2006-07 & NPWS Conservation staff 2007-08
Tyrone Nelson	BWI Project Field Staff 2006-07
Mike Trewby	BWI Project Field Staff 2006-07
Blanaid O'Connell	BWI Project Field Staff 2007-08
Michalina Miklos	BWI Project Field Staff 2007-08
Marc Shorten	BWI Project Field Staff 2007-08
Sinéad Cummins	BWI Project staff
Olivia Crowe	BWI Staff Volunteer
Stephen Newton	BWI Staff Volunteer
Gareth Thomas	BWI Staff Volunteer
John Cromie	BWI Board Member / Volunteer 2006-07
Leo Creedon	BWI Volunteer 2006-07
Padraic Fogarty	BWI Volunteer 2006-08
Anita Langstone	BWI Volunteer 2006-08
Roger Mc Naughton	BWI Volunteer 2006-07
Liam O'Brien	BWI Volunteer 2006-07
John Reed	BWI Volunteer 2006-07
Cathal Ruane	BWI Volunteer 2006-07
Adam Rybka	BWI Volunteer 2006-07
Jim Sheehan	BWI Volunteer 2006-08
Moray Souter	BWI Volunteer 2006-08
Ralph Sheppard	BWI Volunteer 2006-07
Penny Bartlett	NPWS Regional Conservation Staff
Michael Bell	NPWS Regional Conservation Staff
Carl Byrne	NPWS Regional Conservation Staff
Mark Byrne	NPWS Regional Conservation Staff
Noel Bugler	NPWS Regional Conservation Staff
Nicola Carroll	NPWS Regional Conservation Staff
Damian Clarke	NPWS Regional Conservation Staff
Cameron Clotworthy	NPWS Regional Conservation Staff
Miriam Crowley	NPWS Regional Conservation Staff
William Cormacan	NPWS Regional Conservation Staff
Paschal Dower	NPWS Regional Conservation Staff
Brian Duffy	NPWS Regional Conservation Staff
Triona Finnen	NPWS Regional Conservation Staff
Ann Fitzpatrick	NPWS Regional Conservation Staff
Leonard Floyd	NPWS Regional Conservation Staff

Paddy Graham	NPWS Regional Conservation Staff
Emma Glanville	NPWS Regional Conservation Staff
John Griffin	NPWS Regional Conservation Staff
Clare Heardman	NPWS Regional Conservation Staff
Rob Holloway	NPWS Regional Conservation Staff
Emmett Johnston	NPWS Regional Conservation Staff
Judith Kelemen	NPWS Regional Conservation Staff
James Kilroy	NPWS Regional Conservation Staff
Robert Lundy	NPWS Regional Conservation Staff
David Lyons	NPWS Regional Conservation Staff
Emer Magee	NPWS Regional Conservation Staff
Colm Malone	NPWS Regional Conservation Staff
John Matthews	NPWS Regional Conservation Staff
Robbie Millar	NPWS Regional Conservation Staff
Ben Mc Cabe	NPWS Regional Conservation Staff
Larry Mc Daid	NPWS Regional Conservation Staff
Lee Mc Daid	NPWS Regional Conservation Staff
Dave Mc Donagh	NPWS Regional Conservation Staff
Anthony McElheron	NPWS Regional Conservation Staff
Seamus Mc Ginty	NPWS Regional Conservation Staff
Eoin Mc Greal	NPWS Regional Conservation Staff
Dave Mc Namara	NPWS Regional Conservation Staff
Susan Moles	NPWS Regional Conservation Staff
Irene O'Brien	NPWS Regional Conservation Staff
Aonghus O'Donaill	NPWS Regional Conservation Staff
Ger O'Donnell	NPWS Regional Conservation Staff
Barry O'Donoghue	NPWS Regional Conservation Staff
Tim O'Donoghue	NPWS Regional Conservation Staff
Danny O'Keeffe	NPWS Regional Conservation Staff
Denis O'Higgins	NPWS Regional Conservation Staff
Michael O'Sullivan	NPWS Regional Conservation Staff
Anthony Prins	NPWS Regional Conservation Staff
Tim Roderick	NPWS Regional Conservation Staff
Andrew Speer	NPWS Regional Conservation Staff
Patrick Smiddy	NPWS Regional Conservation Staff
Melinda Swann	NPWS Regional Conservation Staff
Rebecca Teesdale	NPWS Regional Conservation Staff
Roy Thompson	NPWS Regional Conservation Staff
Andrea Webb	NPWS Regional Conservation Staff
E. Byrne	NPWS Volunteer

Leo Creedon	NPWS Volunteer
Caroline Hurley	NPWS Volunteer
Julie Vangenot	NPWS Volunteer
B.Mc Inerney	NPWS Volunteer
James Cormacan	NPWS Volunteer
Julie Vangendt	NPWS Volunteer

Appendix 9 List of participants in counts using dogs.

Includes participants using dogs in 15 sites surveyed as part the 'validation of methods' section of the national Red Grouse Survey in 2008 and those that sent in additional records of grouse for the 'Casual Sightings Database'. Note: Not all participants had dogs. Dogs used included Red Setters, English Setters, Pointers, and Springers.

Survey Member	Organisation
Hugh Brady	I.K.C.
P. Butler	N.A.R.G.C.
David Byrne	I.K.C.
T.J. Brady	I.K.C
Peter Brady	N.A.R.G.C.
Shane Brennan	N.A.R.G.C.
T.C. Clarke	N.A.R.G.C.
Kieran Coleman	N.A.R.G.C.
Connacht Field Trials Club	I.K.C.
Christopher Cullen	BWI Project Field Staff 2006-07 and 2007-08
Dr Sinéad Cummins	BWI Project staff
Ken Cunningham	N.A.R.G.C.
Michael Cunnigham	N.A.R.G.C.
Peter Curran	N.A.R.G.C.
Jimmy Dalton	I.K.C.
Christy Davitt	I.K.C.
John Dempsey	N.A.R.G.C.
Patrick Diver	N.A.R.G.C.
Paul Doherty	N.A.R.G.C.
Aidan Dunne	I.K.C.
Dr Jimmy Dunne	N.A.R.G.C.
Tommy Dunne	I.K.C.
Patrick Dunning	N.A.R.G.C.
Roberts Edwards	N.A.R.G.C.
S. Fleming	I.K.C.
Padraic Gilroy	N.A.R.G.C.
Billy Grace	I.K.C.
David Healy	N.A.R.G.C.
Kieran Herety	N.A.R.G.C.
Eddie Hynes	N.A.R.G.C.
Henry Kelly	N.A.R.G.C.
Seamus Kavanagh	N.A.R.G.C.
Niall Keenan	N.A.R.G.C.
T. Kiernan	I.K.C.
Brian Kirwan	I.K.C.
Michael Lawrence	N.A.R.G.C.

Patrick Lawrence	N.A.R.G.C.
Seamus Lawrence	N.A.R.G.C.
Philip Lee	N.A.R.G.C.
Chris Lindsay	N.A.R.G.C.
Gordon Little	N.A.R.G.C.
Eamonn Mahoney	N.A.R.G.C.
Martin Mannion	N.A.R.G.C.
Joe Mc Brearty	N.A.R.G.C.
Robert Mc Collum	N.A.R.G.C.
Joe McGill	I.K.C.
Michalina Miklos	BWI Project Field Staff 2007-08
Joe Mc Loughlin	N.A.R.G.C.
Michael Mc Loughin	N.A.R.G.C.
P. Mc.Carthy	N.A.R.G.C.
P. Mc. Nulty	N.A.R.G.C.
Declan Mc Namara	N.A.R.G.C.
Michael Murphy	I.K.C.
Eddie Murray	N.A.R.G.C.
Ken Murray	N.A.R.G.C.
Dr Stephen Newton	BWI staff Volunteer
Brendan O'Brien	N.A.R.G.C.
Blanaid O'Connell	BWI Project Field Staff 2007-08
Padraic O'Grady	N.A.R.G.C.
John O'Leary	N.A.R.G.C.
Jerry O'Mahony	N.A.R.G.C.
Maurice O'Mahoney	I.K.C.
Fr. S. O'Neill	I.K.C.
Brian O'Sullivan	N.A.R.G.C.
Pat Reape	I.K.C.
Pat Rohan	I.K.C.
Neil Ryan	I.K.C.
Marc Shorten	BWI Project Field Staff 2007-08
Dessie Sloyan	N.A.R.G.C.
Keith Somers	N.A.R.G.C.
John Wade	N.A.R.G.C.
Damien Walsh	N.A.R.G.C.
Kieran Walsh	I.K.C.
Ray Walsh	N.A.R.G.C.
David White Jnr.	N.A.R.G.C.

Appendix 10 List of observers that submitted records to the casual sightings database.

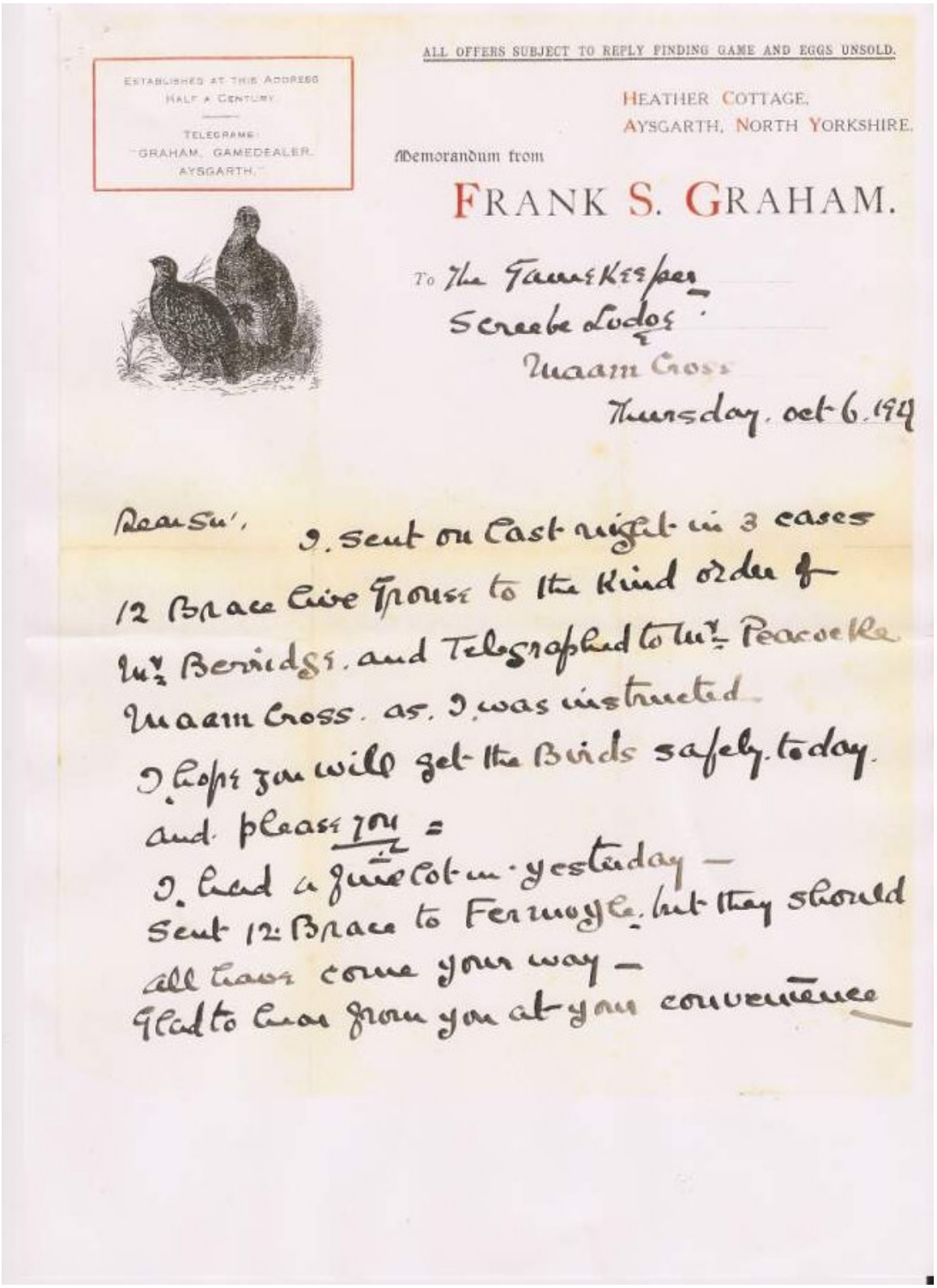
Observer	Affiliation (if known)
Adrian Meaney	
Adrian Rooney	
Aine Lynch	NPWS
Alan Davies	
Alison Phillip	BWI Staff
Aonghus O'Donaill	NPWS
Barry O'Donoghue	NPWS
Blanaid O'Connell	BWI Staff
Brendan Deane	
Carl Byrne	NPWS
Catriona Douglas	NPWS
CBS Survey	BWI Survey
Celia & Michael Caplice	
Chris Cullen	BWI Staff
Chris Peppiatt	BWI Member
Ciara O'Mahony	NPWS
Colin Barton	BWI Member
D McDonagh & B McInerney	NPWS
D. Norriss & Dr D. Tierney	Merlin Survey 2007 - NPWS
D.J. O'Riordan	
Dave Perry	
David McDonagh	NPWS
Denis Cullen	
Denzil Jones	
Dick Ryan	
Dr. Don Cotton	BWI member
Dr Andy Bleasdale	Commonage Framework Plan Study- NPWS
Dr D. Butler	
Eamonn Buckley	
East Coast Bird Report	
Eimear Byrne	
Emmet Gavin	
Eoin Bassett	
Eoin Mc Greal	NPWS
Fergal Monaghan	NPWS - C.F.P.s
Fergal Murphy	
Fintan Bracken	UCD

Fiona Farrell	NPWS
Gareth Thomas	BWI staff
Gerard Owens	
Gerry Donnelly	
Gyr Falcon	
Irene O'Brien	NPWS
Irish Peatland Conservation Council- Records	IPCC
James Cormacan	
Jamie Durrant	BWI
Dr Jervis Good	NPWS
Jim Sheehan	BWI Member
John Burke	
John Cromie	BWI Board Member/ Chairman
John Lovett	BWI member
John Lynch	
John Matthews	NPWS
John Moriarty	
John O'Connor	NPWS
John Shackleton	
John Sheehy	
Judit Kelemen	NPWS
Julie Vangenot	NPWS Volunteer
Kieran Grace	BWI Board Member
Liam O'Donnell	BWI Member
Michael Trewby	BWI Staff
Martin Ruane	
Melinda Swann	NPWS
Micahel Bell	NPWS
Micahel Hackett	NPWS
Michael Bell	BWI member
Michael Meeney	
Michael Monahan	
Michael Roche	
Michalina Miklos	BWI Staff
Mike Walker	
Niall Hatch	BWI Staff
Nicholas Gray	BWI
Noel Bugler	NPWS
NPWS Blanket Bog Report	NPWS
NPWS Raised Bog Report	NPWS

Dr Patrick Crushell	Wetlands Surveys Ireland
Paddy Fenton	
Padraig Comerford	NPWS
Pat Lynch	
Pat Quinn	
Pat Twomey	BWI Member
Dr Patrick Crushell & Richard O'Callaghan	RGHS - NPWS
Patrick Gallagher	Mountain Log
Paul Hillis	BWI Member
Paul Walsh	BWI Member
Peter O'Toole	NPWS
R & B Beemster	
Ralph Shephard	BWI Member
Robert Northridge	
Roger McNaughton	BWI Volunteer
Rupert Butler	
Sean Pierce	BWI Member
Dr Sinéad Cummins	BWI Staff
Ted Rearden	
Third Mid-Shannon Bird Report 2000-2003	
Tim Roderick	NPWS
Tony Murray	NPWS
Tony Nagle	BWI Member
Upland Bird Survey 2002-04	BWI
William Cormacan	NPWS

Appendix 11 Historical evidence of Red Grouse '*scoticus*' introductions into Ireland

Below is a copy of an original letter sent regarding a delivery of live grouse from Britain to Screebe Lodge in the west of Ireland in the 1920s. The owner of Screebe Lodge at the time was a Mr. Richard Berridge (1870 - 1941).



ESTABLISHED AT THIS ADDRESS HALF A CENTURY

TELEGRAMS: "GRAHAM, GAMEDEALER, AYSGARTH."

ALL OFFERS SUBJECT TO REPLY FINDING GAME AND EGGS UNSOLD.

HEATHER COTTAGE,
AYSGARTH, NORTH YORKSHIRE.

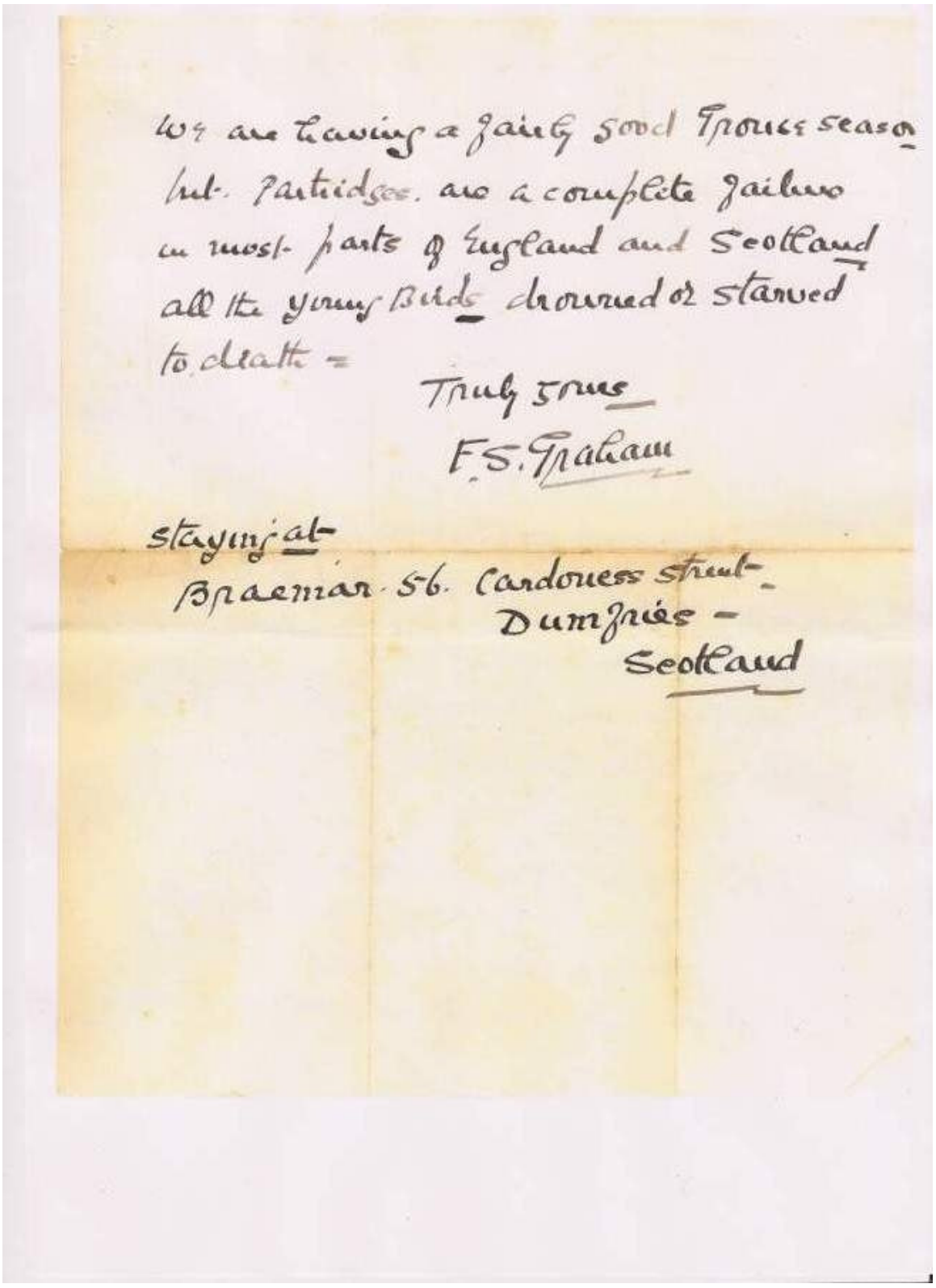
Memorandum from

FRANK S. GRAHAM.

To The Gamekeeper
Screebe Lodge
Maam Cross

Thursday. oct 6. 1924

Dear Sir, I sent on Last night in 3 cases 12 Brace Live Grouse to the Kind order of Mr. Berridge. and Telegraphed to Mr. Peacocke Maam Cross. as. I was instructed. I hope you will get the Birds safely today. and please you = I had a fine Cot-in yesterday — Sent 12 Brace to Fermoyle. but they should all have come your way — Glad to hear from you at your convenience



We are having a fairly good Grouse season but Partridges are a complete failure in most parts of England and Scotland all the young Birds drowned or starved to death =

Truly Yours

F.S. Graham

staying at

Braemar 56 Cardoness Street

Dumfries

Scotland