Black grouse conservation in southern Scotland - Phase 2 Development of a regional strategic conservation plan

Prepared on behalf of the Scottish Borders Council, Forestry Commission Scotland, RSPB Scotland, Scottish Natural Heritage and the Lammermuirs Moorland Group. The views expressed by the author (s) of this report should not be taken as the views and policies of Scottish Natural Heritage, Forestry Commission Scotland, RSPB Scotland, Scottish Borders Council or the Lammermuirs Moorland Group.

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Dr Philip Warren
The Game & Wildlife Conservation Trust
The Coach House
Eggleston Hall
Eggleston
County Durham
DL12 0AG
Tel: 01833 651936
e-mail: pwarren@gwct.org.uk

EXECUTIVE SUMMARY

This document was drafted by the Game & Wildlife Conservation Trust on behalf of the project funders[1] to identify a strategic conservation plan to stop the decline of black grouse in southern Scotland and to then increase numbers and recolonise lost range. To deliver the conservation targets in southern Scotland the following priority actions have been identified:

Short term

- Increase breeding productivity and over-winter survival of black grouse within the core identified populations in the Tweedsmuir Hills and Moorfoot Hills in south east Scotland and the Galloway Forest Park in south west Scotland to provide recruits to re-colonise neighbouring areas. To be achieved through targeted habitat enhancements on the moor fringe implemented through agri-environment/woodland scheme applications and forest management, in combination with targeted predator management.
- Implement a robust surveying and monitoring strategy to establish locations of unknown leks and to monitor black grouse populations and thereby the success of management work promoted by this project.

Medium term

- Implement immediate conservation measures to safeguard small remnant populations in the Muirkirk Hills, East Galloway and Lowther Hills. Specifically, to retain and consolidate connectivity between black grouse populations in the west (Galloway Forest Park) with those to the east (Tweedsmuir Hills and Moorfoot Hills) through restoring and enhancing moorland habitat networks, forest restructuring and targeted broadleaf woodland planting.
- Promote range recolonisation into the Lammermuir Hills and Pentland Hills from the Moorfoots. Target habitat enhancements through agri-environment scheme applications on the fringes of heather moorland with full-time gamekeepers operating. Assess the need and potential for using translocation as a tool to expand the range into previously occupied habitats where conditions have been restored. All conditional on satisfying IUCN guidelines on translocations and as laid out in the 'Scottish code for conservation translocations' and the associated best practice guidelines.

Long term

- Retain and enhance population connectivity of the small satellite Langholm metapopulation with the Tweedsmuir Hills to the north through retaining and enhancing a heathland network east of Craik Forest. Investigate potential for similar linkage through Eskdalemuir to the north-east.
- Restore functional habitat links to enhance population connectivity between black grouse in the Galloway Forest Park with those to the south at Cairnsmore to create a larger more robust core population.

Project funders

Game & Wildlife Conservation Trust
RSPB
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Lammermuirs Moorland Group
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1. INTRODUCTION

Black grouse (*Tetrao tetrix*) were once widespread in Britain but have declined in both numbers and range over the past 100 years (Sharrock, 1976; Hancock *et al.* 1999). In recent decades the decline has accelerated, falling from an estimated 25,000 displaying males in the early 1990s (Baines & Hudson, 1995) to 5,100 males in 2005 (Sim *et al.* 2008). Two thirds of the remaining birds are now found in Scotland and here numbers declined by 29% between 1995/6 and 2005 (Sim *et al*., 2008). Trends varied between region with stability in the Scottish Highlands, but 49% and 69% declines in south west and south east Scotland which reduced numbers to an estimated 807 (516-1176 95% CI) and 257 (45-577 95% CI) males respectively. The reasons for the decline are well documented (Cramp & Simmons 1980, Baines 1994, Baines 1996). In southern Scotland these are linked to either the direct loss of moorland fringe habitats, or their degradation and fragmentation through agricultural intensification (Fuller & Gough 1999) and/ or commercial afforestation (Pearce-Higgins *et al*. 2007, White *et al*. 2013). Due to their threatened conservation status, black grouse have been red-listed as a species of high conservation concern (Eaton *et al*. 2015) and were a 'Priority Species' of the UK Biodiversity Action Plan (Anonymous, 1995) with its own Species Action Plan to restore both numbers and range. The Scottish Black Grouse Biodiversity Action Plan Steering Group continues to operate and has identified southern Scotland (defined as the area south of Glasgow and Edinburgh central belt) as a high priority for conservation action, together with Argyll and Loch Lomond and Trossachs National Park, where populations are also declining.

To help conserve black grouse in southern Scotland, the Game and Wildlife Conservation Trust (GWCT) in partnership with Scottish Natural Heritage (SNH) and the Southern Uplands Partnership (SUP) in 2013/14 completed a desk based project (Phase 1) - 'Black grouse conservation in southern Scotland' to consider how the size and management of moorland patches related to black grouse occupancy and their numbers in southern Scotland (Warren *et al*. 2014). The key findings were that heather (*Calluna vulgaris*) moorland and acid grassland were the dominant habitat components within lek ranges, corresponding to similar findings from the North Perthshire, Argyll and Inverness regions of Scotland (White *et al*. 2013) and from northern England (Warren *et al.* 2011). Leks (display sites) situated on moorland where gamekeepers were employed to produce grouse for driven shooting had twice as many cocks attending. The study identified 27 moorland patches occupied by black grouse, six of which supported 90% of all remaining males (n=538 males) with two of these, the Moorfoot Hills and Tweedsmuir Hills supporting 62% of all males. Overall, 70% of moorland patches larger than 50km^2 were occupied, in contrast to only 5% of patches less than 10km^2. Only one large moorland patch larger than 100km^2, the Lammermuir Hills, was unoccupied.

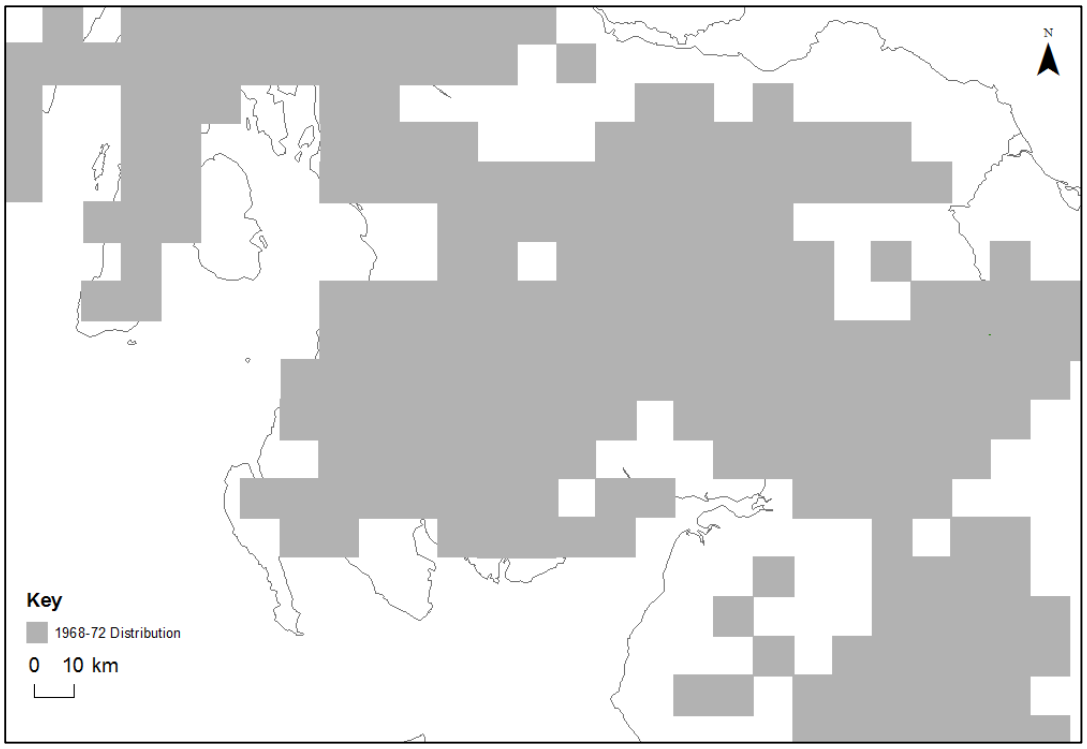
The long term viability of black grouse in southern Scotland is dependent on implementing conservation measures, which, in the short term, stop the decline of the population, whilst identifying and assessing the feasibility of establishing habitat corridors to enhance connectivity and to facilitate future range recolonisation. In this paper we outline a strategic approach that could deliver these objectives.

1.1 Distribution and abundance

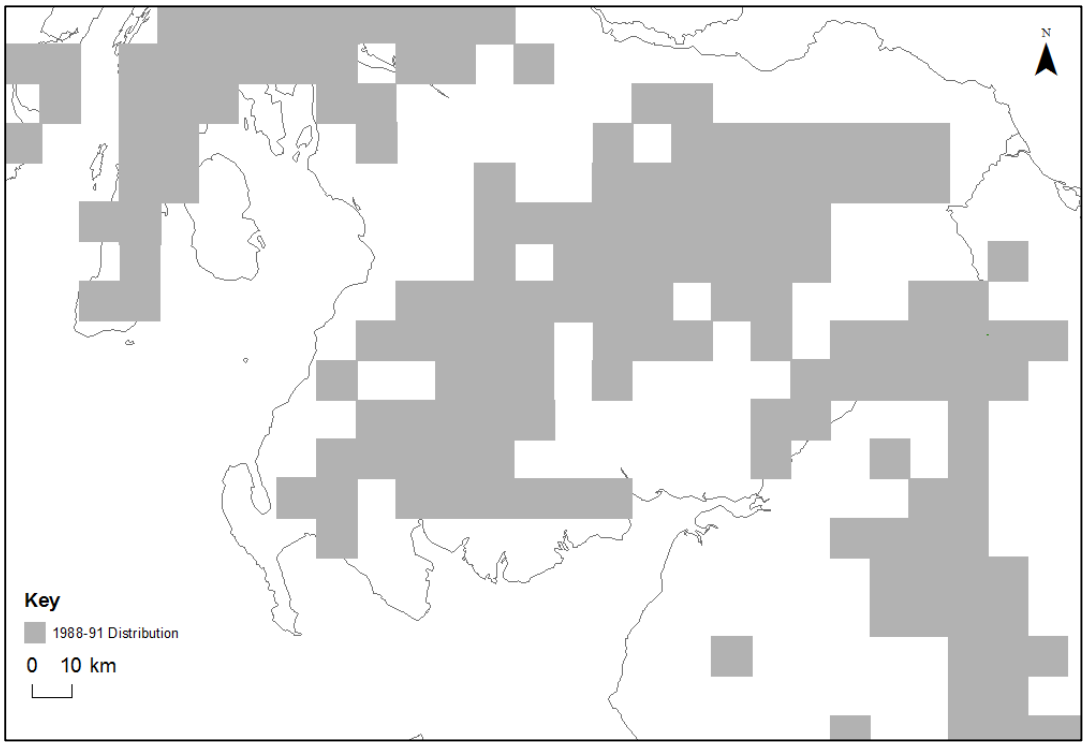
The distribution of black grouse in southern Scotland (occupied 10km grid squares) was quantified through bird atlas surveys in 1968-72 (Sharrock 1976), 1988-91 (Gibbons *et al.* 1993) and in 2007-11 (Balmer *et al*. 2013). In 1968-72 black grouse were widespread occupying 141, 10km grid squares (Figure 1a). Occupied range was contiguous with birds to the north of the central belt in the Scottish Highlands and with those to the south in northern England. However, range has since contracted by 48% to 74 occupied 10km grid squares in 2007-11 (Figure 1c). This has resulted in black grouse in southern Scotland becoming isolated from birds to the north and to the south. By 1988-91 separation from birds to the north and fragmentation with those to the south was evident (Figure 1b). More recently connectivity with black grouse in England has appeared to fragment further. Results from a national survey in England in 2014 reported a 34km gap now existing between populations in southern Scotland and England (Warren *et al*. 2015). Black grouse in southern Scotland may now be considered isolated from other birds to the north in the Scottish Highlands and from those in northern England.

Figure 1. Changes in the distribution of black grouse in southern Scotland from the 1968-72, 1988-91 and 2007-11 atlas surveys

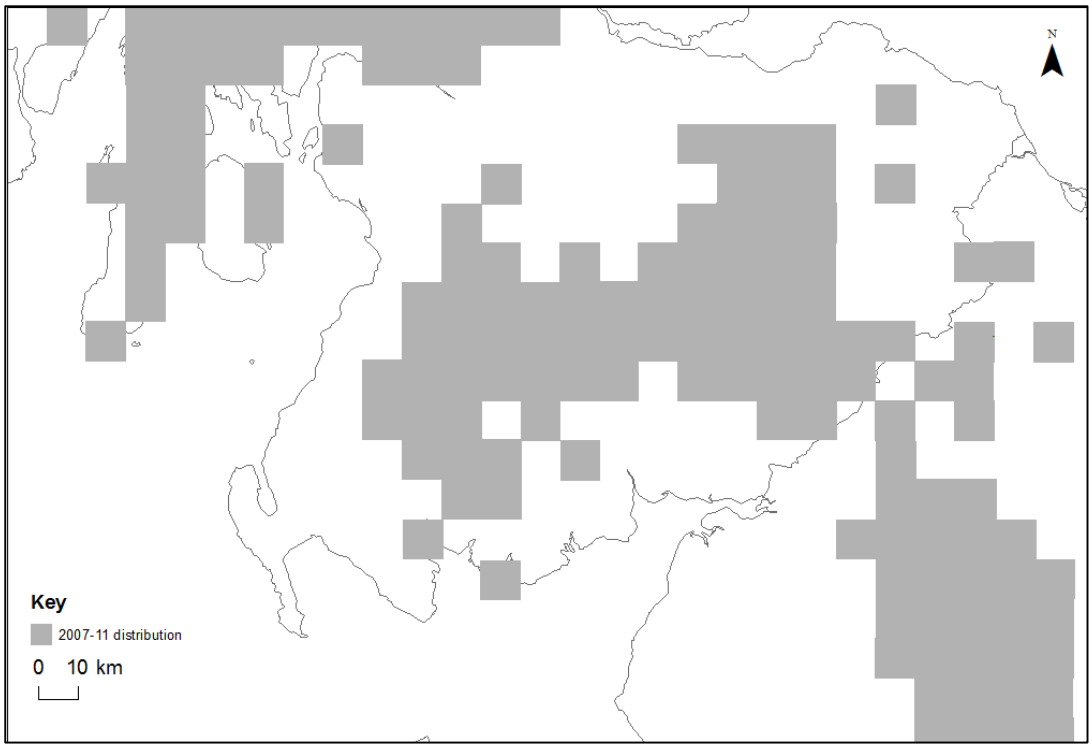
(a) 1968-72



(b) 1988-91



(c) 2007-2011



The numbers of black grouse attending leks in south west and south east Scotland declined by 49% and 69% between national surveys in 1995/6 and 2005 to an estimated 820 males and 257 males respectively (Table 1) (Sim *et al*. 2008). At a sample of leks in the Lammermuir

Hills, Southern Uplands, East Ayrshire and Galloway surveyed in the 1989-99 and 2006-12 periods numbers declined by 64% from 410 to 147 males (Warren *et al*. 2014).

Table 1. Numbers of black grouse in southern Scotland during national surveys in 1995/6 and 2005

Region	Numbers of males (95% Confidence Limits)	
	1995/6	2005
South west Scotland	1586 (1135-2086)	807 (516-1176)
South east Scotland	820 (386-1293)	257 (45-577)

2. CONSERVATION TARGETS

Black grouse in southern Scotland have severely declined in both numbers and range and further declines and range contraction are considered likely. Since 1999 when black grouse were designated as a 'priority species' of the UK government's Biodiversity Action Plan conservation measures have been targeted and implemented across southern Scotland by a range of partners to deliver the initial targets of stopping the decline. Some localised successes have been achieved, but the conservation priority remains to be to stop the decline and limit further range contraction and fragmentation. We therefore recommend the following conservation targets:

Conservation targets

T1: Stop or reverse the decline of black grouse in southern Scotland, in order to hold the population at its current range and extent (2016).

T2: In the long term (20 years) increase range and abundance of black grouse in southern Scotland

2.1 Delivering the conservation targets

To deliver the conservation targets of stopping the decline and increasing numbers and range in southern Scotland we need to:

(1) Increase the breeding productivity and survival rates of the current population to increase numbers and provide recruits for recolonisation. To be achieved through maintaining and enhancing moorland fringe breeding habitats, providing suitable woodland habitats to provided cover from predators and a food source which is particularly important in severe winters.

(2) Provide the desired network of inter-connected habitats to re-connect existing but fragmented populations in south west and south east Scotland and facilitate recolonisation of formerly occupied areas.

(3) Given the low potential for recolonisation based on the sedentary nature of yearling males, we may need to consider a process of male translocation to habitats pioneered by yearling females out-with the range of males.

3. MECHANISMS TO DELIVER CONSERVATION TARGETS

3.1 Providing suitable habitat networks

Recent experience has shown that restoration of black grouse requires consideration of management at three broad scales: the brood scale, the lek (display site) scale and a wider landscape or population level.

- **Brood scale** – The home range of broods is typically small, in the region of 30ha. The sward structure and composition should be heterogeneous, i.e. have a variety of different heights - tall for nesting and escape cover with shorter areas for foraging and drying out following periods of adverse weather. Favourable brood rearing habitats have abundant invertebrates, notably sawfly larvae (*Symphyta*).

- **Lek scale** – a group of birds centred on a lek requires some 200-700ha of suitable habitat. A mosaic of habitats is needed that contains key foods (shown in brackets) - heath (heather, bilberry (*Vaccinium myrtillus*)), blanket bog or mire (with cotton grass (*Eriophorum vaginatum*)), rough grazing (sawfly larvae / insects), shrubs / trees (berries, buds, catkins in autumn/winter) and where present the management of herb-rich meadows (leaves of herbs, seeds and buds). In good continuous habitat black grouse leks are approximately 2km apart, hence black grouse are generally found up to 1 to 1.5km from the central lek. Therefore suitable habitat needs to be provided at the lek scale.

- **A wider landscape or 'population' level –** dispersal by most, if not all, young females from their natal areas, with an average distance of 9.3km (Warren & Baines 2002), implies that a group of birds centred on a lek, may only be viable in the longer-term if it is within the dispersal range of young females from neighbouring sites. That is, a degree of connectivity between birds from neighbouring leks is essential.

Required mechanisms

- Ensure that habitat improvements are appropriately targeted and delivered in southern Scotland at the brood, lek and landscape scale.

3.2 Increasing breeding productivity

3.2.1 Breeding habitats

Black grouse nest and rear their chicks in variety of moorland and woodland fringe habitats from rough grassland habitats (Baines 1994, Warren & Baines 2004) to eared willow (*Salix aurita*) scrub which supports many moth caterpillars (*Lepidoptera*) (Baines *et al*. 1996). Habitat use by breeding black grouse in southern Scotland is likely to vary from west to east in relation to the availability and type of habitats. Thus, habitat management plans need to be formulated and promoted by specialists on a site by site basis.

Breeding black grouse are attracted to, and breed well within both newly established commercial conifer plantations and native woodlands established on heather moorland and rough grazing. But the resultant canopy closure and the shading out of favoured ground vegetation, can lead to subsequent declines (Cayford 1993, Pearce-Higgins *et al*. 2007). Similar responses have been reported following sheep grazing reductions on moorland

habitats, which temporarily improve breeding success (Calladine *et al.* 2002), but over the longer term the development of rank grass may reduce the initial benefit.

Black grouse respond well initially to these ecological perturbations within the landscape following the exclusion of grazing. However, the value to black grouse declines as vegetation structure changes. In theory, this initial phenomenon could be repeated in a controlled way within already established woodlands and on moorland, by re-instigating management after 5-10 years to recreate the desired conditions for black grouse. Further research is required to quantify the potential mechanisms to recreate these desired conditions, such as through re-instigating a pulse of grazing by cattle or sheep, or direct forest restructuring or vegetation swiping and monitoring the responses by black grouse. This will provide important information to help inform land management practices, particularly with a legacy of moorland agri-environment scheme agreements and newly established woodlands across southern Scotland.

Required mechanism

- Review breeding habitats at all leks in southern Scotland in regards to quality and extent and produce bespoke management plans.
- Initiate a programme of research to investigate the potential to maintain and enhance the value of moorland restoration schemes and newly planted woodlands to black grouse beyond the first years following grazing exclusion, through initiating 'pulse' grazing or other management.

3.2.2 Reducing clutch predation and increasing chick survival

Increasing hatching success and chick survival by control of predators, such as red fox (*Vulpes vulpes*), carrion crow (*Corvus corone*), rat (*Rattus norvegicus*) and stoat (*Mustela erminae*) specifically on the moorland and forest fringe may help to improve breeding success and hence contribute to delivery of conservation objectives. Review current and potential predator control activity on a site by site basis, to (a) maximise efficacy and (b) optimise resource allocation.

Required mechanisms

- Following predator control review, target any additional required predator control effort to black grouse breeding habitats on the moorland and forest fringe.

3.3 Maintain high adult survival rates

Black grouse are a long lived bird and in areas where they are associated with grouse moor management have high adult survival rates (Baines *et al*. 2007) which can be important to maintain population stability and growth. High mortality can be associated with predation by generalist predators such as foxes, stoats and raptors (Baines *et al*. 2007) and with harsh winters when food sources are covered by snow (Warren *et al*. 2013). Black grouse cope with prolonged snow cover throughout their European range, foraging on the buds and fruits of trees such as birch (*Betula* spp.), hawthorn (*Crataegus monogyna*), alder (*Alnus glutinosa*) rowan (*Sorbus aucuparia*) and willows (*Salix* spp.). In areas where tree cover is limited, however, high mortality can occur, e.g. black grouse in northern England declined by 38% following the severe winter of 2009/10 (Warren *et al*. 2013) due to a lack of woodland cover.

In average winter conditions the availability of these food sources do not appear to be limiting, but in severe winters with prolonged snow cover the lack of deciduous woodland as an emergency food source, cover and shelter can be a significant limiting factor.

Required mechanisms

- Ensure presence of pockets of suitable native broadleaved woodlands at all leks in southern Scotland (hawthorn, rowan, birch, alder and willow).
- Following predator control review, target any additional required predator control effort to black grouse lekking groups where no activity is operating.

3.4 Stimulating range recolonisation using translocation

Female black grouse disperse on average 9.3km (Warren & Baines 2002) but can move up to 30km (Caizergues *et al*. 2003). Male dispersal is however more limited with males only moving up to 1km (Warren & Baines 2002). This suggests that yearling females may recolonise areas beyond the fringe of the male range and find no males present. To stimulate range recolonisation, the GWCT has been operating a trial in northern England (2006-2015) to establish new leks beyond the fringe of the male population range by moving males to attract dispersing females (McEwen *et al.* 2009). This has proved successful with males surviving, establishing new leks, attracting wild females which have subsequently bred successfully and re-occupied previously lost range (Warren *et al*. 2015). To help promote range recolonisation in areas of suitable habitat with predator management operating this can be an appropriate tool as long as suitable conditions are present at a sufficient scale. This would be conditional on satisfying IUCN 'Guidelines for Reintroductions and Other Conservation Translocations' (IUCN/SSC 2013) and as laid out in the 'Scottish code for conservation translocations' (National Species Reintroduction Forum 2014a) and 'Best Practice Guidelines for Conservation Translocations in Scotland' (National Species Reintroduction Forum 2014b).

Required mechanisms

- Assess the need and potential for using translocation as a tool to expand the range into previously occupied habitats where conditions have been restored.

3.5 Climate change mitigation

Faced with ongoing climate change, there is a need to understand whether it is possible to increase the resilience of potentially susceptible species such as black grouse to climate change by increasing the availability and spatial composition of suitable habitat within the wider landscape. The RSPB are currently undertaking a 'Black Grouse and Climate Change project' and the results of this will help to guide and assist future appropriate management. Current climate predictions suggest potential for both positive and negative impacts from climate change on black grouse in southern Scotland. Increasing the population size and range would create a larger, interconnected population robust enough to adapt in the face of climate change.

Required mechanisms

- Consider the potential impacts of climate change on black grouse in light of the findings of the RSPB Black Grouse and Climate Change Project.

- Implement management measures to increase population size and range to create a larger, inter-connected resilient population.

3.6 Retaining genetic diversity

Black grouse in southern Scotland have become isolated from populations in Highland Scotland and are considered to be genetically part of a demographically independent unit connected with northern England (Höglund *et al*. 2011). Black grouse in southern Scotland/ northern England had lower genetic diversity and showed signs of having lost genetic variability compared to birds in Highland Scotland (Höglund *et al*. 2011). Since 2006, black grouse in southern Scotland have become isolated from those in northern England (Warren *et al.* 2015). There is also evidence to suggest that remaining birds in southern Scotland are splitting into two distinct groups, one to the east centred on the Tweedsmuir Hills and Moorfoot Hills, and the second to the west in the Galloway Forest Park. We need to investigate the degree of genetic variability within black grouse populations in southern Scotland in order to assess the risk of inbreeding depression. Depending upon the results of a genetics study possible management options may need to be considered. For example, as restoring habitat linkages is a long term process, moving birds between sub populations to maintain genetic vigour may need to be considered as a short term measure.

Required mechanisms

- Commission a genetic study to investigate the genetic variability and the degree of isolation of black grouse sub populations in southern Scotland.
- Depending upon the results of a genetics study, identify possible management options.
- Ensure that habitat improvements are appropriately targeted and delivered in southern Scotland at the landscape scale to retain connectivity of moorland habitat networks between birds in the Galloway Forest Park and those to the east in the Tweedsmuir Hills.

4. DEFINING CORE AREAS

The desk study identified the importance of large moorland areas with 90% of all males associated with six large contiguous moorland areas, with two of these, the Moorfoot Hills and Tweedsmuir Hills supporting 62% of all males (Warren *et al*. 2014). To deliver the conservation targets in southern Scotland of stopping the decline, then increasing range and abundance we have identified core management areas. To identify these we evaluated (i) the current distribution of black grouse, (ii) habitat availability, (iii) predator management operating, (iv) the connectivity with other lekking groups, and (v) the potential for further recolonisation.

4.1 Recent abundance and distribution (2011-15)

Black grouse males attending leks have been surveyed across southern Scotland over the past five years to establish their distribution and to monitor responses to management (Table 2). Since, survey effort has varied between years we have used a 5-year average of the numbers of males attending leks for the period 2011-2015 to establish recent occupied range and abundance. We estimated the population in southern Scotland to be 581 males in the 2011-2015 period (Table 3).

Table 2. Years in which black grouse lek surveys were undertaken in the last ten years in southern Scotland by partner organisations

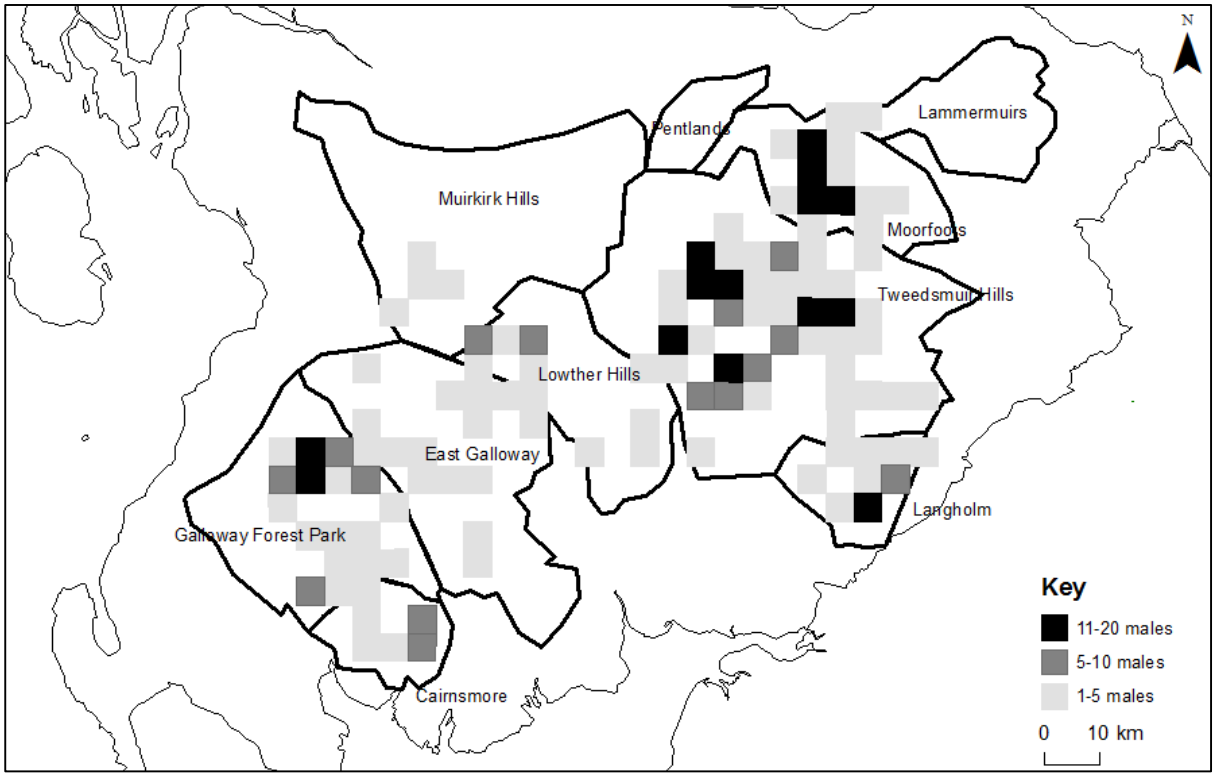
Survey areas (contributing partners)	**Years lek data have been collected**
Southern Uplands (SUP)	2006 - 2007, 2010 – 2015
Lammermuir Hills (Moorland owners)	2009 – 2015
East Ayrshire (SNH & RSPB)	2007, 2013-15
Cheviot Hills (GWCT & SNH)	2011
Dumfries and Galloway	2007 – 2015
Langholm Moor	2008 – 2015

Table 3. Number of males, number of leks and mean lek size in distinct moorland areas of southern Scotland

Moorland area	**Total males**	**Total number of leks (single birds)**	**Mean lek size**
1. Lammermuirs	2	1 (0)	2
2. Moorfoot Hills	130	28 (4)	4.6
3. Langholm Moors	38	15 (7)	2.5
4. Lowther Hills	33	12 (4)	2.8
5. Muirkirk	9	5 (2)	1.8
6. Galloway Forest Park	92	37 (8)	2.5
7. Cairnsmore	20	9 (2)	2.2
8. Tweedsmuir Hills	224	78 (32)	2.9
9. East Galloway	35	20 (10)	1.8
Total	581	205 (69)	2.8

The Tweedsmuir Hills, Moorfoot Hills and Langholm Moors in the south east support 67% of all males (Figure 2). In the south west, the Galloway Forest Park is the stronghold, supporting 16% of all males. The population is still considered connected from west to east but with a 'bottleneck' being the Lowther Hills (Figure 2). Low numbers and fragmentation of lekking groups in the Lowther Hills and adjoining East Galloway mean, however, that the population may be showing evidence of splitting into at least two distinct sub populations, one to west centred on the Galloway Forest Park, and the other to the east centred on the Tweedsmuir Hills and the Moorfoot Hills (Figure 2). N.B. monitoring effort is low in much of the Muirkirk Hills and not comprehensive in the Lowther Hills.

Figure 2. The distribution of black grouse in southern Scotland (2011-2015) and total numbers of males per 5 x 5km grid squares



4.2 Habitat

Black grouse require a mosaic of habitats which contain heather, cotton grass, the leaves, flowers and seeds of grasses and herbs, and the buds and berries of various broad-leaved trees and shrubs, plus insect rich areas for foraging chicks (Baines 1994, Beeston *et al.* 2005). In good continuous habitats, black grouse leks are distributed at 2-3km intervals, hence most birds attending leks are found within 1.5km radius of the lek. Therefore suitable habitat needs to be provided within this area of 200-700ha.

The composition of habitat mosaics within a 1km radius of 197 lek locations from Galloway and the Southern Uplands were determined through the desk study (Warren *et al*. 2014). In the Southern Uplands lek ranges were dominated by acid grassland which comprised 55% of all habitats (Table 4). Heather moorland was the second most abundant habitat type (22%). Heather moorland and acid grassland were found within all lek ranges (Table 5). Similarly in Galloway, acid grassland 29% and heather moorland 32% were the most important

components, but lek ranges had more woodland cover, particularly conifer woodland which was present with 92% of all lek ranges. This association of black grouse leks with heather moorland and acid grassland habitats in southern Scotland is illustrated in Figure 3.

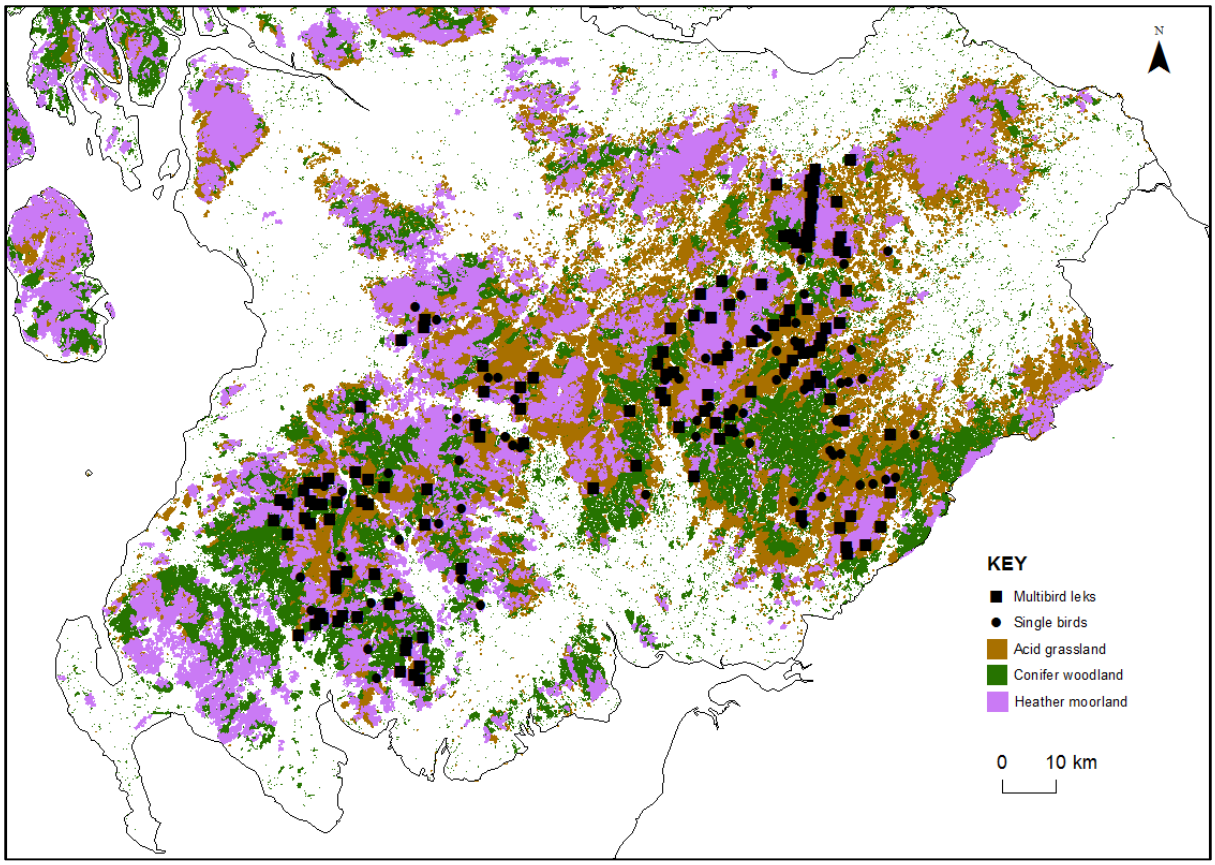
Table 4. Habitat composition within a 1km radius of leks in Galloway and the Southern Uplands

Percentage habitat composition within a 1km radius of leks (±1se)		
Habitat	**Southern Uplands (112 leks)**	**Galloway (85 leks)**
Heather moorland	22.4 ± 1.9	32.6 ± 2.5
Acid grassland	55.2 ± 2.1	29.1 ± 2.6
Farmland	8.1 ± 1.0	2.1 ± 0.6
Broad-leaved woodland	3.2 ± 0.4	0.9 ± 0.2
Conifer woodland	5.9 ± 1.0	27.4 ± 2.5
Felled woodland	0.2 ± 0.1	3.5 ± 0.8
New woodland	3.0 ± 0.4	0 ± 0.0
Other	2.0 ± 0.6	4.3 ± 1.0

Table 5. Presence (%) of habitat types within a 1km radius of leks in Galloway and the Southern Uplands where habitat composition at leks was assessed

Habitat	**Southern Uplands (112 leks)**	**Galloway (85 leks)**
Heather moorland	100	100
Acid grassland	100	99
Farmland	84	41
Broad-leaved woodland	88	40
Conifer woodland	63	92
Felled woodland	16	56
New woodland	77	0
Other	41	48

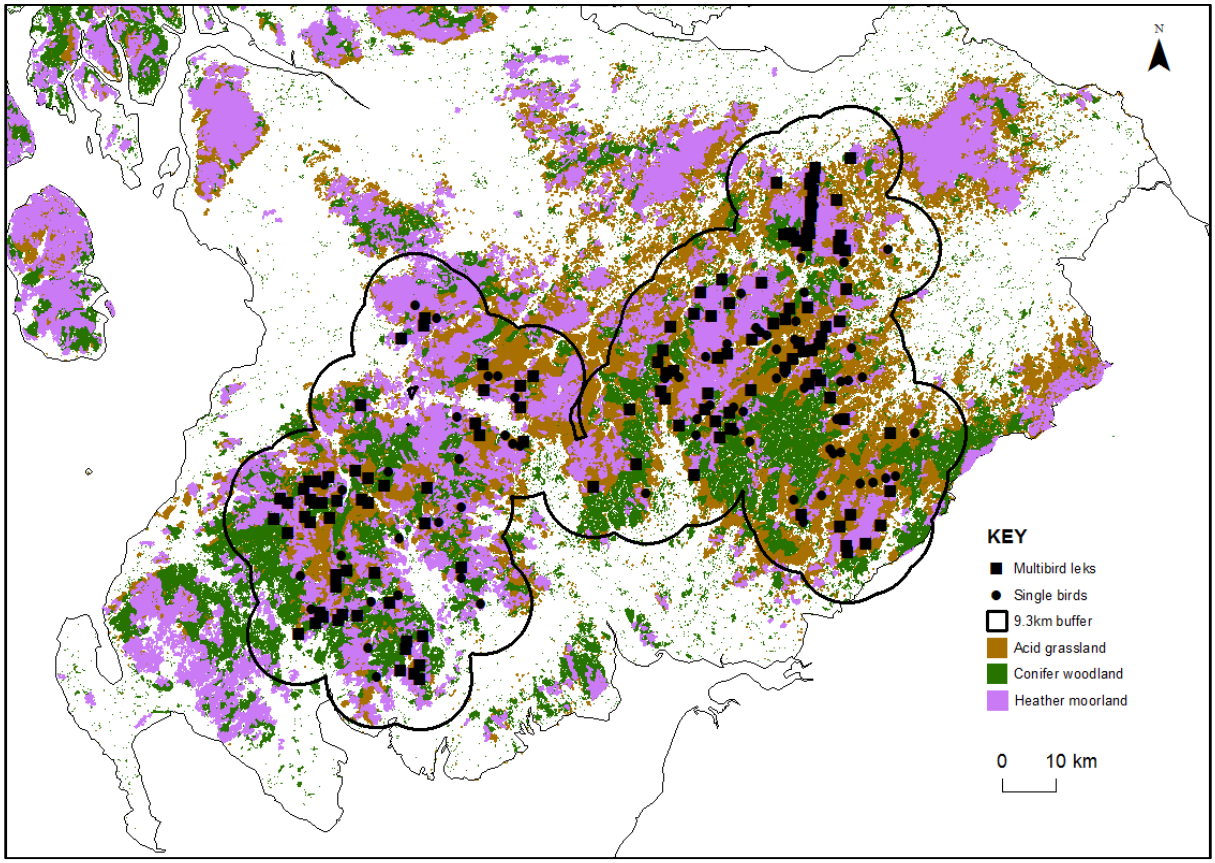
Figure 3. The distribution of black grouse leks (n=136) and single displaying males (n=69) between 2011-15 in relation to the distribution of heather moorland (blanket bog and heather), acid grassland and coniferous woodland habitats in southern Scotland



4.3 Population connectivity

Most young females disperse from their natal areas, with a mean distance of 9.3km (Warren & Baines 2002), whereas males and adult females hardly move at all. This implies that a group of birds centred on a lek, may only be viable in the long term if they are within the dispersal range of young females from neighbouring leks. In good habitats, leks are found 2-3km apart (Figure 4) and this degree of connectivity between birds from neighbouring leks is essential to maintain genetic diversity and to prevent inbreeding through fragmentation of social structure, gene pool and habitat.

Figure 4. Connectivity of black grouse lekking groups in southern Scotland illustrated through a 9.3 km buffer representing mean dispersal distances of juvenile females



4.4 Infrastructure of predator control

We found in the desk study that the numbers of males attending leks were twice as large where gamekeepers were employed and driven red grouse *Lagopus lagopus scotica* shooting practised on heather moorland (Warren *et al.* 2014). This combined with other evidence that populations of ground nesting birds, including black grouse, are more likely to be limited by predation than other groups (Gibbons *et al*. 2007, Fletcher *et al*. 2010) means that predator management may help deliver conservation objectives. However, predator management in isolation may not prevent further declines without the provision and maintenance of suitable habitats (Baines, 1996). This is evident in southern Scotland, where keepered grouse moors in the Moorfoot Hills and Tweedsmuir Hills all still support black grouse, but on keepered grouse moors in the Pentlands and Lammermuirs numbers have recently dwindled. In the Pentlands and Lammermuirs, the loss and fragmentation of grass moor, rough grazing habitats and scrubby woodlands adjoining the heather moorland probably explains the reduction in numbers.

This means that the conservation programme may benefit from incorporating the existing predator control infrastructure, as habitat improvements may have more 'net' gain in areas where gamekeepers are currently operating in relation to areas where there are none.

5. CORE MANAGEMENT AREAS FOR DELIVERING CONSERVATION OBJECTIVES

Through this process we have identified eleven geographically distinct black grouse management areas (Figure 5). The mechanisms required to deliver the conservation targets are discussed in further detail for these key areas and summarised in Table 6.

5.1 South east Scotland

5.1.1 Tweedsmuir Hills

The Tweedsmuir Hills support 39% of all males and 38% of all leks in southern Scotland. However, black grouse are widely distributed and in general leks are small with 41% of known sites occupied by single males (Table 3). This could be evidence of range expansion or retraction, but in light of recent declines (Warren *et al*. 2014) it is more likely that declines are still occurring. Therefore, leks occupied by single males are considered at a high risk of extinction. There has been a decline in moorland management for red grouse in this area in recent decades, with only one estate now employing a moorland gamekeeper to produce red grouse for driven shooting. This one estate hosts 16% of remaining males.

In the Tweedsmuir Hills management needs to be targeted at existing leks to increase numbers through appropriate habitat improvements and predator control. We recommend forming a black grouse moorland management cluster which includes all estates (Figure 6) on or adjacent to the Tweedsmuir Hills and Moffat Hills SSSIs which support 30% of birds. This could also include Talla-Wild land opportunities, the Borders Forest Trust (Carrifran, Corehead and Devils Beef Tub, Talla and Gameshope) properties, Scottish Water and Wemyss and March estates. Wind farm developments, if inappropriately sited, may pose a risk to black grouse populations; however, they may also offer opportunities through Habitat Management Plans (HMPs) and biodiversity offsets. These include the Clyde Wind Farm and Clyde extension in the South Lanarkshire Hills and Glenkerie wind farm in Borders. Biodiversity offset schemes associated with Langhope Rig and Toddleburn wind farms have delivered black grouse habitat measures in the Tweedsmuir Hills core area. Further opportunities for targeted HMPs and biodiversity offsets may arise associated with wind farms, Flood Protections Schemes or other development opportunities.

Black grouse in the Tweedsmuir Hills are connected with birds to the south at Langholm through a habitat corridor which runs to the east of Craik Forest. Here, it is important that this open corridor is maintained and habitat enhancements targeted to maintain a heathland network through this corridor.

Required Mechanisms

- Increase breeding productivity and the survival of the resident population (see section 3.2 & 3.3).
- Ensure that agri-environment schemes to maintain and enhance moorland and acid grassland habitats are appropriately targeted to existing lekking groups and to areas that promote further infill within the range.
- Create a black grouse management cluster on and around the Tweedsmuir Hills and Moffatt Hills SSSIs formed by moorland estates and the Borders Forest Trust holdings. Draw up estate specific black grouse management plans for these to help ensure SRDP scheme applications are appropriate and correctly targeted.

- Target habitat improvements to maintain and improve connectivity with the satellite black grouse population to the south at Langholm.

5.1.2 The Moorfoot Hills

The Moorfoot Hills support 22% of the remaining black grouse in southern Scotland and lek sizes here are the highest at an average 4.6 males per lek. The primary management of this area is for red grouse shooting with five estates forming a distinct management cluster supporting 80% of males. The core heather moorland area has statutory protection provided by the Moorfoot Hills SAC, SSSI, with 67% of lekking males in the Moofoot Hills on or within 1km of the boundary of this designated site. Commercial forestry is restricted to the Glentress forest in the western section. Black grouse were present within this forest until canopy closure. Opportunities to recreate habitats suitable for black grouse on the fringe of this forest should be explored in future design plans when the existing crop is harvested.

The main objective here is to improve conditions to increase productivity and provide recruits to recolonise adjacent habitats to the east in the Lammermuir Hills and to the north into the Pentlands. SRDP provides a funding mechanism, but other opportunities through natural flood management associated with Flood Protection Schemes (e.g. Galashiels, Peebles) and future wind farm developments and their HMPs and biodiversity offsets should be considered.

Required Mechanisms

- Increase breeding productivity and survival of resident population (see section 3.2 & 3.3). To provide recruits to re-colonise neighbouring areas to the north in the Pentlands and east into the Lammermuirs.
- Ensure that agri-environment schemes to maintain and enhance moorland and acid grassland habitats are appropriately targeted to existing lekking groups and to areas that promote further infill within the range.
- Create a black grouse management cluster here of the six moorland estates and tenant farms. Draw up estate specific black grouse management plans for the six moorland estates and Glentress forest to help ensure SRDP scheme and forest grant applications are appropriate and correctly targeted.

Figure 5. The core black grouse management areas in southern Scotland

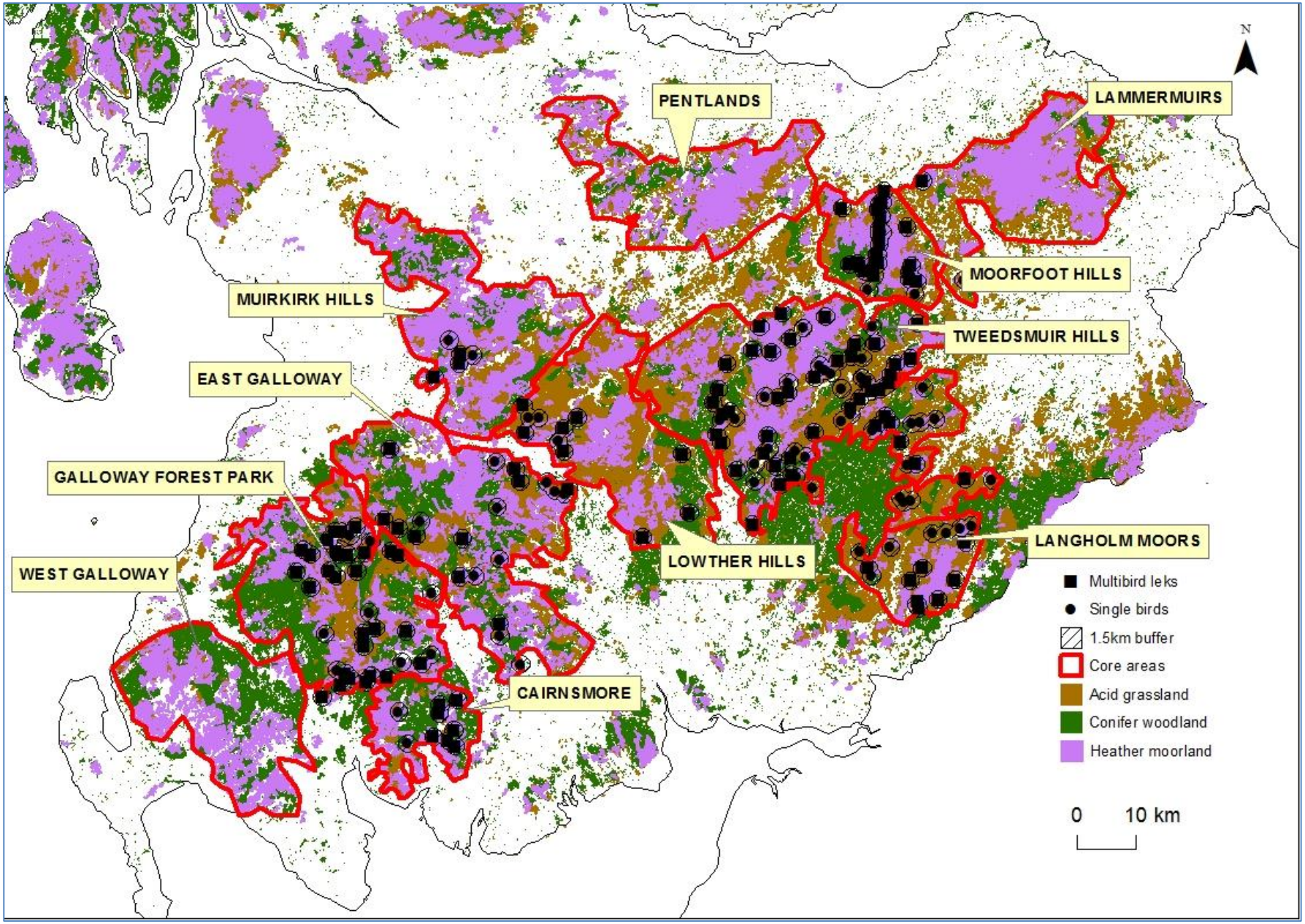
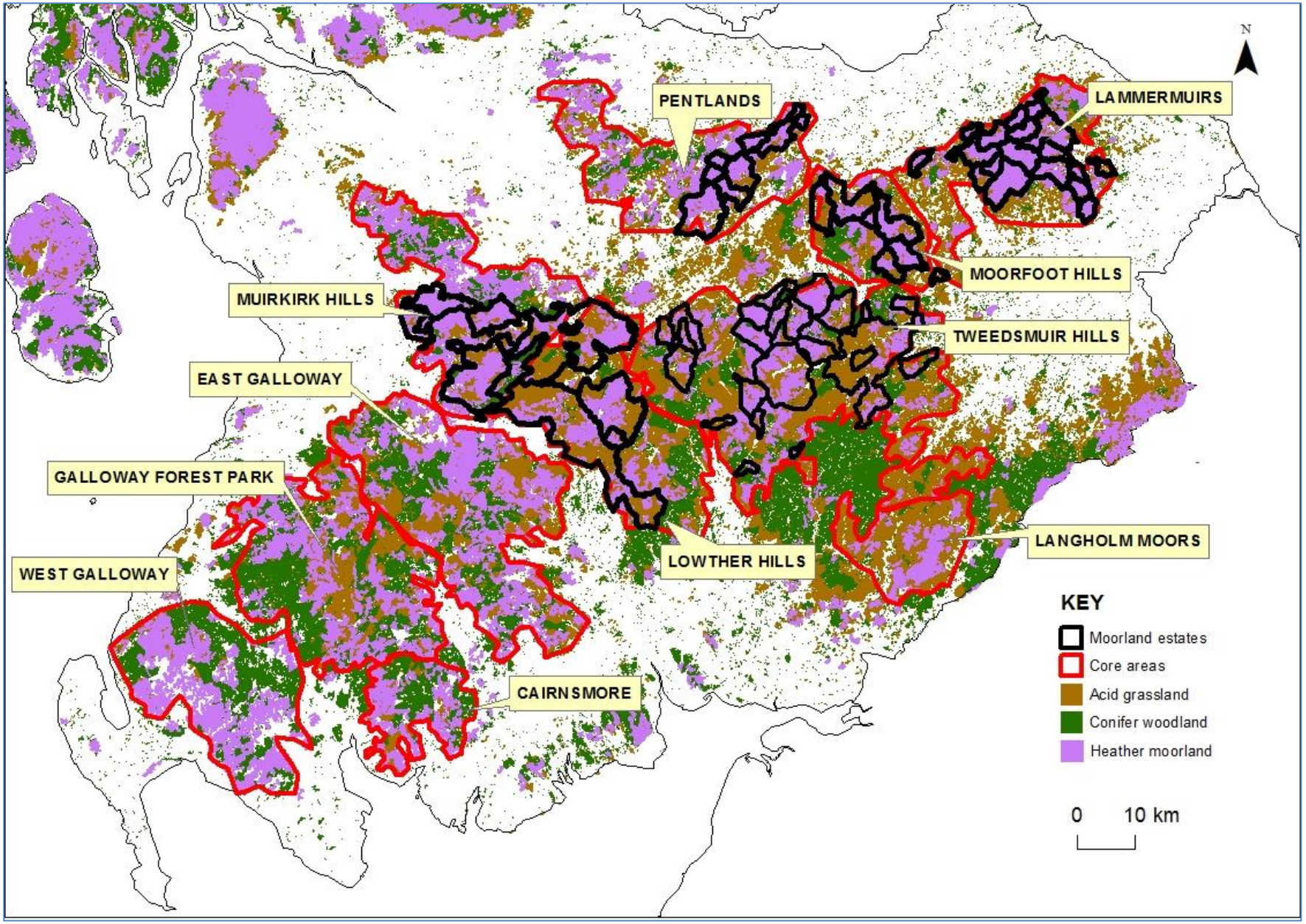


Table 6. Numbers of displaying males, numbers protected by statutory designation and moorland gamekeepers, and summarised management actions within core management areas in southern Scotland

Moorland area	Total males (leks)	Numbers (leks) protected by statutory habitat designation	Numbers (leks) protected by full-time moorland gamekeepers	Management area	Action
1. Tweedsmuir Hills	224 (78)	68 (12)	35 (2)	CORE	Implement conservation measures to increase breeding success and overwinter survival to consolidate populations and provide recruits to recolonise neighbouring areas.
2. Moorfoot Hills	130 (28)	87 (15)	104 (21)	CORE	Implement conservation measures to increase breeding success and overwinter survival to increase numbers to provide recruits to recolonise neighbouring Lammermuirs and Pentland Hills.
3. Langholm Moors	38 (15)	27 (6)	27 (6)	SATELLITE	Implement conservation measures to increase numbers. Maintain and enhance moorland habitat corridor to the east of Craik Forest to maintain connectivity with birds in the Tweedsmuir Hills
4. Lammermuirs	2 (1)	0	0	RECOLONISATION ZONE	Restore moor fringe habitats and functional habitat links with neighbouring Moorfoot Hills. Consider a translocation programme to stimulate range expansion.
5. Pentlands	0	0	0	RECOLONISATION ZONE	Restore moor fringe habitats and functional habitat links with neighbouring Moorfoot Hills. Consider a translocation programme to stimulate range expansion.
6. Galloway Forest Park	92 (37)	11 (4)	0	CORE	Implement conservation measures to increase breeding success and overwinter survival to consolidate populations and provide recruits to re-colonise neighbouring areas.
7. Cairnsmore	20 (9)	20 (9)	0	SATELLITE	Implement conservation measures to increase breeding success and overwinter survival. Investigate mechanisms to enhance connectivity of moorland habitats with birds in the Galloway Forest Park.
8. East Galloway	35 (20)	0	0	CONNECTIVITY	Implement immediate conservation management measures to secure remnant populations and retain connectivity with neighbouring groups
9. West Galloway	0	0	0	SATELLITE	Complete surveys to assess presence and numbers. Restore functional habitat links with the Galloway Forest Park.
10. Lowther Hills	33 (12)	16 (5)	4 (1)	CONNECTIVITY	Implement immediate conservation management measures to secure remnant population and retain connectivity with neighbouring groups
11. Muirkirk Hills	9 (5)	9 (5)	6 (4)	CONNECTIVITY	Implement immediate conservation management measures to secure remnant population and retain connectivity with neighbouring groups
Total	**581 (205)**	**238 (56)**	**176 (34)**		

Figure 6. Map illustrating the core management areas and potential moorland estate clusters to deliver conservation objectives



5.1.3 Langholm Moors

The Langholm moors support a small population of 38 males of which the majority are associated with the Langholm Moor Demonstration Project Area which encompasses the Langholm - Newcastleton Hills Special Protection Area (SPA). This population is small and isolated and its longevity is dependent on retaining and enhancing connectivity with populations to the north in the Tweedsmuir Hills through a corridor to the east of Craik Forest and possibility through Eskdalemuir. Here it is important that habitat improvements are targeted to existing lekking groups whilst maintaining and enhancing the corridor to the north. Opportunities to deliver habitat improvements in addition to SRDP may arise through Natural Flood Management (NFM) connected to the Hawick Flood Protection Scheme. Wind farm developments may also provide opportunities through HMPs to deliver habitat enhancements.

Required Mechanisms

- Increase breeding productivity and survival of resident population (see section 3.2 & 3.3).
- Undertake black grouse surveys of suitable habitat in currently un-surveyed areas to north-west (Eskdalemuir) in order to inform management targeting.
- Target habitat improvements to existing populations on and directly adjacent to the Langholm - Newcastleton Hills SPA. Maintain and enhance habitat connections with populations to the north, through the habitat corridor to the east of Craik Forest.
- Within future forest design plans for Craik forest utilise opportunities to restore moorland habitats along the eastern edge which adjoins existing open moorland habitats.

5.1.4 Lammermuir Hills

Black grouse were common in the Lammermuir Hills up until recently, but numbers have dwindled with now only occasional records reported. This area has the potential for recolonisation due to its proximity to the neighbouring Moorfoot Hills population, which has the largest leks in southern Scotland providing potential recruits. Range recolonisation is achievable here as highly connected keepered grouse moors are present. Potentially suitable habitats are present within the linkage zone between the Moorfoot Hills and Lammermuir Hills through the Fala Moor area. Here, habitat improvements have been implemented through agri-environment and wind farm mitigation schemes (Dunlaw extension and Toddleburn wind farms). Other habitat improvements, including the establishment of low density native woodlands were undertaken under biodiversity offset schemes associated with Crystal Rig 2 and Fallago Rig wind farms. We recommend that a translocation project to initiate re-colonisation in the Lammermuir Hills may need to be considered, subject to compliance with IUCN and Scottish guidelines and a detailed assessment to consider further habitat improvements required. A black grouse moorland management cluster is already operating here and we recommend developing specific black grouse management plans for all moorland estates.

Required Mechanisms

- Ensure that agri-environment schemes are appropriately targeted to the recolonisation zone east from the Moorfoot Hills through the Fala Moor area to provide the desired conditions for range recolonisation.
- Conduct a study to assess the need and potential feasibility for using translocation as a tool to stimulate range recolonisation in this area.
- Support the existing black grouse management cluster here. Draw up estate specific black grouse management plans for all moorland estates to help ensure SRDP schemes applications are appropriate and correctly targeted.

5.1.5 Pentlands

Black grouse were lost from the Pentlands in the early 1990s. Moorland habitats in the southern section are connected to the Moorfoot Hills to the south and provide the potential for future range recolonisation. Range expansion may be limited in the short term by the low dispersal capacity of males, therefore we recommend considering translocation. To deliver this we recommend a detailed assessment to consider further habitat improvements required to support this. A moorland management cluster of moors is present here (Figure 6) and we recommend developing specific black grouse management plans for all moorland estates.

Required Mechanisms

- Ensure that agri-environment scheme applications are appropriately targeted to the recolonisation zone north from the Moorfoots to provide the desired conditions for range expansion.
- Conduct a feasibility study to assess the need and potential for using translocation as a tool to stimulate range expansion in this area.
- Create a black grouse management cluster here. Draw up estate specific black grouse management plans for all moorland estates to help ensure SRDP scheme applications are appropriate and correctly targeted.

5.2 South west Scotland

5.2.1 Galloway Forest Park

The core area in south west Scotland is the Galloway Forest Park, owned and managed by Forest Enterprise Scotland which supports 16% of remaining birds in southern Scotland and half of the remaining birds in south west Scotland. Significant habitat improvements have been implemented in this area, through bog restoration, woodland fringe planting and forest edge restructuring. Predator management is conducted in the northern section covering a third of known lekking males. Black grouse in the Galloway Forest Park are connected with birds to the south at Cairnsmore, and to the east through East Galloway and the Lowther Hills to those in the Tweedsmuir Hills. The historic connectivity with moorland habitats to the west appears to have been effectively 'blocked' by commercial afforestation. However, ongoing forest restructuring, felling and restoration of open habitats for wind farms and increasing riparian zones in this area may, in the longer term, restore connectivity of open moorland habitats to West Galloway.

Required Mechanisms

- Increase breeding productivity and survival of the resident population (see section 3.2 & 3.3).
- Maintain existing predator control operating on the key black grouse habitats in the Galloway Forest Park. Continue to collect lek data in order to assess the effects of predator management, review findings, and explore future opportunities and mechanisms to extend this to cover other lekking groups.
- Review current black grouse conservation management plans for the Galloway Forest Park to assess opportunities to increase numbers and occupied range.
- Investigate opportunities for enhancing management for black grouse presented by the Galloway Glens and Biosphere initiatives.
- Assess the feasibility of improving and enhancing habitat connections with populations in East Galloway, West Galloway and Cairnsmore.

5.2.2 Cairnsmore

A small satellite population of 20 males attending seven known leks are found associated with the Cairnsmore of Fleet and Laughenghie and Airie Hills SSSIs moorland areas. Birds here appear isolated from the core Galloway Forest Park population to the north by conifer afforestation. The remaining moorland habitat patches are fragmented and no predator management is operating in this area. To safeguard the population here it is important that habitat improvements and predator management are targeted to known lekking groups whilst assessing the opportunities for restoring and enhancing connectivity with birds to the north in the Galloway Forest Park.

Required Mechanisms

- Increase breeding productivity and survival of the resident population (see section 3.2 & 3.3).
- Target habitat improvements and implement predator management at all existing lekking groups on and directly adjacent to the Cairnsmore of Fleet and Laughenghie and Airie Hills SSSIs.
- Assess the feasibility of restoring functional moorland habitat networks with neighbouring populations to the north in the Galloway Forest Park.
- Create a black grouse management cluster here. Draw up estate specific black grouse management plans for all moorland and forest areas to help ensure SRDP scheme applications are appropriate and correctly targeted.

5.2.3 East Galloway

Black grouse in this area are dispersed and fragmented, with 35 displaying males recorded attending 20 known leks. Suitable moorland habitats are fragmented by commercial afforestation with no predator control operating and no protection via statutory designation. This is an important area for black grouse as it provides a link between populations in the Galloway Forest Park and those in the Tweedsmuir Hills. To safeguard the remaining population we recommend that immediate conservation measures are implemented and targeted at existing lekking groups. We recommend a feasibility study to assess the potential for restoring habitat corridors through this zone to maintain and enhance connectivity of populations from east to west. We also recommend forming a black grouse moorland

management cluster here, which incorporates small farms and existing and future wind farm developments.

Required Mechanisms

- Implement immediate conservation measures to safeguard remaining lekking groups and increase numbers (section 3.2 & 3.3).
- Assess the feasibility of restoring functional moorland habitat networks with neighbouring populations to the west in the Galloway Forest Park with those to the east in the Lowther Hills.
- Assess the potential for developing a black grouse management cluster here. Draw up specific black grouse management plans to help ensure SRDP scheme applications are appropriate and correctly targeted.

5.2.4 West Galloway

This area is currently considered under surveyed for black grouse, with no formal black grouse survey data available for this area. However, two birds were reported in this area in 2014 (Chambers & Henderson 2014). Suitable moorland habitats are present but are isolated from populations in the Galloway Forest Park to the west by commercial forestry. On-going forest restructuring within the Galloway Forest Park and increasing more favourable habitats in riparian zones may, in the longer term, restore this connectivity. Wind farm developments, if inappropriately sited, may pose a risk to black grouse populations. However, they may also offer opportunities through HMPs and biodiversity offsets to restore moorland habitats.

Required Mechanisms

- Liaise with local land managers to assess whether black grouse are still present. If thought to be present, undertake follow up lek surveys in April and May to confirm numbers and distribution.
- If birds are present implement immediate conservation measures to safeguard remaining lekking groups and increase numbers (section 3.2 & 3.3).
- Assess the feasibility of restoring functional moorland habitat networks with neighbouring populations to the east in the Galloway Forest Park.
- Assess the potential for developing a black grouse management cluster here. Draw up estate specific black grouse management plans for all moorland estates to help ensure SRDP scheme applications are appropriate and correctly targeted.

5.2.5 Lowther Hills

Black grouse leks in the Lowther Hills are dispersed and fragmented with 33 males attending 12 leks. This area can be considered the 'bottleneck' between populations to the west and east. There is clear evidence of fragmentation in the Lowther Hills with a 20km gap between existing lekking groups (Figure 4.). Moorland management for red grouse shooting has declined in recent years, with only 12% of displaying black grouse males found associated with this management. Here, it is important that management is targeted to maintain and increase numbers at existing leks whilst restoring a network of suitable habitats. We recommend forming a black grouse moorland management cluster here, which incorporates the main moorland estates (Figure 6) and existing and future wind farm developments.

Required Mechanisms

- Implement immediate conservation measures to safeguard remaining lekking groups and increase numbers on the Lowther Hills (section 3.2 & 3.3).
- Undertake black grouse surveys of suitable habitat in currently un-surveyed areas with a view to assisting with management targeting.
- Ensure habitat improvements are targeted to existing lekking groups and assess the feasibility of restoring habitat connectivity with the neighbouring East Galloway, Tweedsmuir Hills and Muirkirk Hills moorland areas.
- Create a black grouse management cluster here. Draw up estate specific black grouse management plans for all moorland estates to help ensure SRDP scheme applications are appropriate and correctly targeted.

5.2.6 Muirkirk Hills

Black grouse numbers here appear to have collapsed and only nine males remain occupying three known leks. The known leks are all associated with the Muirkirk and North Lowther Uplands SPA. Much of the area is un-surveyed in recent years and extensive habitat recovery has occurred within the SPA as a result of sheep grazing reductions, thus more males may be present. Management for red grouse here has recently declined with only one estate still known to employ a moorland gamekeeper. The remaining black grouse may be isolated from birds in neighbouring populations in East Galloway (13km) and the Lowther Hills (12km). Urgent conservation action is required to implement management to prevent local extinction, together with undertaking surveys of some areas where habitat has recently improved. We recommend forming a black grouse moorland management cluster which is based on all the moorland estates (Figure 6) on or adjacent to the Muirkirk Hills and North Lowther Uplands SPA which supports all remaining birds. This cluster could include Forest Enterprise, all private estates and wind farms.

Required Mechanisms

- Implement immediate conservation action to retain existing lekking groups, through increasing breeding productivity and the survival of resident population (see section 3.2 & 3.3).
- Undertake black grouse surveys of suitable habitat in currently un-surveyed areas with a view to assisting with management targeting.
- Ensure that agri-environment schemes to maintain and enhance moorland and acid grassland habitats and predator management are appropriately targeted to existing lekking groups.
- Create a black grouse management cluster on and around the Muirkirk Hills and North Lowther Uplands SPA. Draw up estate specific black grouse management plans for these moorland estates to help ensure SRDP scheme applications are appropriate and correctly targeted.

6. EVALUATING PROGRESS AGAINST TARGETS

We recommend the establishment of a rigorous monitoring regime to assess progress against the target of stopping the decline in numbers and occupied range. To achieve this we recommend the continuation of already established annual lek monitoring in southern Scotland. In the south west, black grouse attending leks in the Galloway Forest Park are surveyed annually by Forest Enterprise Scotland and the RSPB. In the south east in the Tweedsmuir Hills the Southern Uplands Partnership conducts counts at core areas in the Tweedsmuir Hills and Moorfoot Hills to assess annual trends. We recommend that this monitoring effort is maintained and that currently under-surveyed areas in the Muirkirk Hills and Lowther Hills are surveyed. Monitoring of habitat changes in responses to management should also be considered.

7. NEXT STEPS

Once this strategy and priorities for action have been agreed by partners, we recommend sourcing funding to undertake an implementation phase. This will be developed in partnership with the key stakeholders. The Environmental Co-operation Action Fund (ECAF) within SRDP provides a potentially suitable mechanism for delivering landscape scale habitat improvements.

8. SUMMARY

To deliver the conservation target of stopping the decline of black grouse in southern Scotland a conservation programme is required which (a) increases the breeding productivity and overwinter survival of the current population, (b) provides the desired network of inter-connected habitats to re-connect existing but fragmented populations in south west and south east Scotland and (c) facilitates recolonisation of former areas in the Lammermuir Hills and Pentlands, potentially through conducting a feasibility study to assess the need and potential for using translocation.

Recent declines in the Muirkirk Hills, Lowther Hills and East Galloway have left these populations at critically low levels with some isolated populations potentially heading for local extirpation. Attention should be focussed on maintaining remaining populations through continued habitat improvements and targeted predator control. However, if birds are lost from these areas, natural recolonisation, even if conditions were improved, would be slow due to the lack of connectivity and recruits from core populations in the Galloway Forest Park and Tweedsmuir Hills.

To deliver the conservation targets in southern Scotland the following priority actions have been identified:

Short term

- Increase breeding productivity and over-winter survival of black grouse within the core identified populations in the Tweedsmuir Hills and Moorfoot Hills in south east Scotland and the Galloway Forest Park in south west Scotland to provide recruits to re-colonise neighbouring areas. To be achieved through targeted habitat enhancements on the moor fringe implemented through agri-environment/ woodland scheme applications and forest management, in combination with targeted predator management.

- Implement a robust surveying and monitoring strategy to establish locations of unknown leks and to monitor black grouse populations and thereby the success of management work promoted by this project.

Medium term

- Implement immediate conservation measures to safeguard small remnant populations in the Muirkirk Hills, East Galloway and Lowther Hills. Specifically, retain and consolidate connectivity between black grouse populations in the west (Galloway Forest Park) with those to the east (Tweedsmuir Hills and Moorfoot Hills) through restoring and enhancing moorland habitat networks, forest restructuring and targeted broadleaf planting.

- Promote range recolonisation into the Lammermuir Hills and Pentland Hills from the Moorfoot Hills. Target habitat enhancements through agri-environment/woodland scheme applications on the fringes of heather moorland with full-time gamekeepers operating. Assess the need and potential for using translocation as a tool to expand the range into previously occupied habitats where conditions have been restored. All conditional on satisfying IUCN guidelines on translocations and as laid out in the 'Scottish code for conservation translocations'.

Long term

- Retain and enhance population connectivity of the small satellite Langholm metapopulation with the Tweedsmuir Hills to the north through retaining and enhancing a heathland network east of Craik Forest. Investigate potential for similar linkage through Eskdalemuir to the north-east.

- Restore functional habitat links to enhance population connectivity between black grouse in the Galloway Forest Park with those to the south at Cairnsmore to create a larger more robust core population.

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