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Reversing the Decline : a Review of some Black Grouse Conservation Projects in the United Kingdom (*)

by
D. BAINES [1], K. BLAKE [1] & J. CALLADINE [1]

Key words : *Tetrao tetrix*, Black Grouse, Great Britain, North Pennines, population decline, mortality, habitat improvements, breeding success, predation control, grazing reduction.

SUMMARY

Until the 20th century, the black grouse was widespread across Britain. Today, the estimated 6,500 displaying cocks remaining are restricted to parts of Wales, northern England and Scotland. Factors associated with the decline include habitat loss and degradation, increased predation and collisions with deer fences. Their relative importance varies between different parts of the bird's UK range, hence complicating actions to aid recovery.

Most conservation projects have concentrated on improving black grouse habitat, either in commercial forests by thinning trees and increasing open space, or on moorland edges by reducing sheep or red deer browsing. Limited data from forest based projects in Scotland and Wales suggest that conservation management merely extends the period of forest suitability, does not prevent declines and is usually undertaken at too small a scale. Greater success, measurable in terms of increased spring densities and, in some years, better breeding success, has been achieved through improvements to moorland edge habitats, particularly from grazing reductions. A mean annual increase of 7% in numbers of displaying males has been observed since 1996 on ten sites in the North Pennines, England where sheep numbers have been reduced, set against a regional decline of 5% per annum over the same period. Although broadly encouraging, this trend was not consistent across sites and may only be short-term in nature. Equivalent responses following reductions in red deer density have also occurred, but only in the absence of deer fences. Deer fences are associated with high mortality in all grouse species and this probably out-weighs any likely benefits of improved habitat. An experiment to test this hypothesis has recently been initiated. Perhaps more convincing responses to management have occurred where habitat improvement and predation control have simultaneously been initiated, with two separate, but non-experimental, projects exhibiting ten-fold and four-fold increases in spring male densities since 1992 and 1996 respectively.

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1 *Game Conservancy Trust, The Gillett, Forest-in-Teesdale, Barnard Castle, Co.Durham DL12 0HA, United Kingdom.*

Conservation initiatives for black grouse are currently being focused under a UK Government led Species Action Plan, an integral component of the Biodiversity commitment following on from the 1992 Rio Convention.

Introduction

Until the 20th Century, black grouse *Tetrao tetrix* were widely distributed across much of Britain including large parts of southern England (GLADSTONE 1924). Over the last century, black grouse numbers have declined throughout Britain as part of a wider European decline (SHARROCK 1976, GIBBONS *et al.* 1993, STORCH 2000). Now, they remain only in parts of northern England, Wales and Scotland. The magnitude of the decline is apparent through analysis of sporting gamebag returns which indicate a 90% reduction in the number of birds shot on grouse moors since the early 1900s (BAINES & HUDSON 1995). A recent population estimate indicates the decline is still on-going and may even be increasing, with an estimated population of only 6,510 displaying males (95% confidence limits 5,000 – 8,100) (HANCOCK *et al.* 1999), a massive reduction from 25,000 males (95% c.l. 13,800 – 36,700) in the early 1990s (BAINES & HUDSON 1995). Its range has also contracted, being found in 28% fewer 10 km grid squares in 1988-91 than in 1968-72 (GIBBONS *et al.* 1993).

Comparable declines have occurred across Europe and an analysis of collated data from all published European studies between 1950 and 1990 suggest a general decrease in breeding success of about 60% (BAINES 1991a). The decrease in breeding success appears to be linked to a decline in chick survival. However, on-going studies from different habitats and different geographic areas of Britain suggest that in some areas at least, black grouse would appear to be still breeding well (BAINES 1991b, 1996), indicating that survival of juveniles and adults may be more important in explaining observed declines. The relative importance of different factors and their interactions is likely to change between regions and between different management practices. This serves to complicate the development of widely applicable management prescriptions to restore black grouse numbers. This paper aims to review the factors that are implicated with the decline of the black grouse in Britain and to consider some of the practical conservation projects that are on-going to restore numbers.

Factors associated with the decline

The black grouse is a bird associated with transitional habitats, either spatially in the sense that it occupies ecotones juxtaposed between adjacent habitats that form a mosaic of compositions and structural diversity, or temporally in that it occupies early successional stages in forest development or regeneration (SWENSON & ANGLESTAM 1993). In Britain, black grouse occupy both of these types of transitional habitat. They occur on the edges of native woodlands, either of pine or birch (PICOZZI & HEPBURN 1985), or along the edges

between heather moorland and rough grazing pastures and meadows (BAINES 1994). Temporally changing habitats are provided by afforestation of moorland. Black grouse rapidly colonise areas newly planted with trees, usually, but not exclusively, coniferous stands (CAYFORD 1990), but their numbers decline rapidly as the trees mature.

Perhaps the principal factor associated with the decline in numbers has been the large-scale loss of suitable moorland fringe habitats. In Scotland at least, this has resulted from broad changes in land use, principally losses of heather moorland to agricultural expansion and intensification and to afforestation (ROBERTSON *et al.* 2001). On the remaining moorland, the post-war years have seen a significant increase in numbers of sheep in upland Britain (FULLER 1996). In the Scottish Highlands, there have been comparable increases in red deer *Cervus elaphus* over the last forty years (CALLANDER & MACKENZIE 1991). Such increases have been associated with extensive deterioration of semi-natural habitats including those on the moorland edge and native woodlands (ANDERSON & YALDEN 1981, WATSON 1983). Black grouse prefer tall ground vegetation (PARR & WATSON 1988), but now the ground vegetation on much of the favoured lower moorland and woodland edge has been grazed very short and is often devoid of scrub woodlands of willows eg. *Salix aurita* and birch *Betula* spp. and their associated ericaceous ground layers.

It is estimated that 12-18% of the British uplands are managed for red grouse *Lagopus lagopus scoticus* (BUNCE 1988, HUDSON 1992). Heather is routinely managed by rotational strip burning and predators are controlled by gamekeepers to increase the number of birds available for sport shooting (HUDSON & NEWBORN 1995). Other ground nesting birds appear to benefit from this management (THARME *et al.* 2001), including, in some cases, the black grouse (MARCSTROM *et al.* 1988, BAINES 1991b). Since the Second World War, both the number of gamekeepers and the amount of moorland managed for red grouse has declined (HUDSON 1992). Associated with this, there has been both a loss of moorland habitat (ROBERTSON *et al.* 2001) and increases in some predators which can be legally controlled, particularly the red fox *Vulpes vulpes* (TAPPER 1992) and the carrion crow *Corvus corone* (MARCHANT *et al.* 1990, HOLLOWAY 1996). Similarly, other potential predators of black grouse such as the pine marten *Martes martes,* goshawk *Accipiter gentilis* and peregrine *Falco peregrinus,* which are legally protected, have markedly increased their distribution range and overall abundance (VELANDER 1983, STONE *et al.* 1997, TORNBERG 1997). These increases have followed either extension of woodland habitat through afforestation, often combined with successful re-introductions (MARQUISS 1981, SHAW & LIVINGSTONE 1992), or changes in legislation to provide these predators with full protection and hence relaxed persecution by gamekeepers (TAPPER 1999).

In response to the on-going decline, a series of black grouse management initiatives in northern Britain have commenced in recent years. These are varied in their respective approaches, but generally aim to improve both the

extent and quality of habitat to black grouse, either on moorland or along the forest edge. These initiatives form part of a collaborative programme under the umbrella of a United Kingdom Species Action Plan. The Plan aims to stem the decline in numbers and range by 2005 and to increase the range and abundance over the next 20 years. The Plan is an integral component of the Biodiversity Plan commitment by the UK Government following on from the 1992 Rio Convention. This paper reviews some of the early results from these projects and discusses their relative merits in the recovery programme for black grouse within Britain.

Results

Grazing reductions – sheep on the moorland fringe

Several studies have considered whether reductions in sheep grazing along the moor edge can have beneficial effects for black grouse. BAINES (1996) showed that both breeding densities and breeding success were significantly higher on moors where sheep densities were lower, or where sheep were over-wintered away from the moor (**Table I**). Lower levels of sheep grazing were associated with 41% more invertebrates, particularly amongst key groups selected by chicks such as caterpillars (Lepidoptera and Symphyta) and plant bugs (Hemiptera), and vegetation that was on average a third taller, providing more cover.

Table I. Densities (birds km^{-2}) and breeding success (juveniles hen^{-1}) of black grouse on moors differing in grazing intensity in upland Britain. Density means are based on averages from 10 sites over three years. Breeding success means are based on the number of site years, * P<0.05, ** P<0.01 (from BAINES 1996).

*Densité (oiseaux/km^2) et succès reproducteur (juv./femelle) du tétras lyre sur des landes différant par l'intensité du pâturage en haute Bretagne : Les moyennes de densité sont basées sur les moyennes de 10 sites sur 3 ans. Les moyennes du succès reproducteur sont basées sur le nombre de sites ans, * P<0.05, ** P<0.01*

	Light grazing		Heavy grazing		
	n	mean + SE	n	mean + SE	F
Males (♂)	10	2.1 ± 0.4	10	1.3 ± 0.2	5.45 *
Females (♀)	10	3.2 ± 0.5	10	1.8 ± 0.3	6.51 *
Juveniles hen^{-1}(juv/♀)	29	2.3 ± 0.3	17	1.4 ± 0.3	9.70 **

Results from research on the effects of sheep grazing reduction have been used to design appropriate black grouse management packages. These have been implemented both on a moor in southern Scotland and more generally as part of a «Recovery Project» based in the North Pennines, northern England. At the Scottish moor, numbers of displaying males increased from only two in 1993 to an estimated 25 in 1999 (BAINES *et al.* submitted). Here, sheep reductions coincided with the instigation of predator control to increase red grouse numbers for sport shooting.

Reductions in both numbers of grazing sheep and the period of grazing have been incorporated into management packages implemented at ten moorland edge sites in the North Pennines, often through uptake of UK Government agricultural incentives to reduce sheep numbers. Data from these sites have been compared with those from ten other sites where sheep numbers have largely remained constant. The average response by black grouse to this treatment has been an increase in displaying males of 7% per annum over the period 1996-2000. This is most encouraging compared with a continued decline of 5% per annum on the control sites over the same period (CALLADINE *et al.* (this volume)). However, responses differed between sites, and marked increases in lekking males only occurred at two of the ten management sites. This is highly suggestive that although important, reductions in grazing pressure and their subsequent effects may interact with others factors including scale of management, predation and weather to render overall interpretation more difficult. Similarly, breeding success, as measured by numbers of chicks reared per hen, varied significantly between grazing treatments, with more chicks reared where grazing had been reduced. This factor alone however was a relatively poor predictor of breeding success, suggesting that there are other collectively more important factors operating that remain to be described.

Analyses of black grouse data from six pairs of adjacent plots (10-200 ha in size) within northern England that differed in grazing regime, showed higher densities of breeding hens, estimated from counts using pointer dogs in August, where grazing had been reduced. Here, a mean of 6.0 hens km^{-2} were found (95% CL 2.7-13.3) compared with 3.5 hens km^{-2} (95% CL 1.9-6.8) on grazed control plots. However when changes in density were considered through time, densities in plots where sheep had been reduced showed a progressive decline over time relative to the control plots ($r_5 = -0.82$, $P<0.05$) **(Fig. 1a)**.

After seven years, densities in the plots with reduced grazing were lower than those in the control plots. Such data are difficult to interpret, but may reflect a preference by breeding hens for areas that contain a more diverse assemblage of cover heights and types, especially when rearing chicks. Grazing reductions typically result in a more homogenous sward in terms of vegetation structure that comprises more heathy vegetation (ericaceous species and *Eriophorum* spp.), both in terms of height and composition **(Table II)**, which may restrict chick mobility and foraging efficiency. This reduction in density on the plots with restricted grazing occurred despite increases in invertebrate abundance, both in this study (BAINES in prep.) and other published studies (BAINES *et al.* 1994, BAINES 1996). Indeed, differences in hen densities between the paired plots were negatively correlated with structural diversity (co-efficient of variation of vegetation height) of the vegetation ($r_5 = -0.90$, $P<0.01$) **(Fig. 1b)**, and were not related to the abundance of any of the invertebrate taxa preferred by chicks. Although hens within the study were both long-lived and tended to be breeding site faithful (WARREN & BAINES submitted), habitat change may have promoted a local redistribution of breeding hens, with relatively more hens occupying areas outside of grazing agreements with increasing time since sheep reduction.

Fig. 1a. Changes in the density of breeding hens (birds km^{-2}) in August in six paired grazing plots in the North Pennines, England, where one of the pair had reduced sheep grazing (treatment) and the second had normal grazing regimes (control). Densities are expressed as the ratio of treatment : control in relation to:
a) the number of years since grazing was reduced.
Variation de la densité de poules nicheuses (oiseaux/km^2) au mois d'août dans 6 couples de parcelles pâturées dans le Nord des Pennines Angleterre, oüune parcelle du couple avait un régime de pâturage normal (contrôle). Les densités sont exprimées selon le taux de traitement: contrôle en rapport avec :
a) le nombre d'années depuis que le pâturage a été réduit.

Table II. Vegetation composition and structure within nine paired plots differing in grazing treatment, either grazing reduced (exclosure) or not reduced (grazed). Values are means with standard deviations. Structure index = sd/mean of vegetation height.
Heath = ericaceous shrubs + *Eriophorum* spp.
Composition et structure de la végétation au sein de 9 couples de parcelles différant par le régime de pâturage, soit pâturage réduit («exclosure»), soit non réduit («grazed»). Les valeurs sont les moyennes avec les déviations standards. L'index de structure = surface/hauteur de végétation moyenne «health» (bruyère) = buissons d'éricacées + Eriophorum spp.

Vegetation	Exclosure	Grazed	paired « t »	P
Grass	62 ± 21	53 ± 19	0.64	0.54
Rushes (*Juncus*)	12 ± 9	29 ± 18	-1.04	0.33
Heath	13 ± 18	0	3.22	0.01
Other	12 ± 12	17 ± 8	0.02	0.98
Height (cm)	39 ± 10	35 ± 7	0.68	0.51
Structure index	0.44 ± 0.13	0.64 ± 0.13	-4.2	0.003

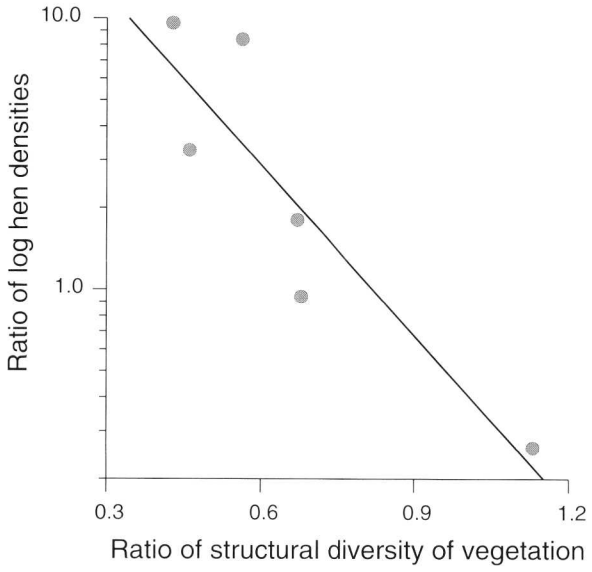

Fig. 1b. Changes in the density of breeding hens (birds km^{-2}) in August in six paired grazing plots in the North Pennines, England, where one of the pair had reduced sheep grazing (treatment) and the second had normal grazing regimes (control). Densities are expressed as the ratio of treatment : control in relation to:
b) between plot changes (treatment : control) in the structural diversity (sd/mean of vegetation height) of the sward.
Variation de la densité de poules nicheuses (oiseaux/km^{2}) au mois d'aoüt dans 6 couples de parcelles pâturées dans le Nord des Pennines Angleterre, oùune parcelle du couple avait un régime de pâturage normal (contrôle). Les densités sont exprimées selon le taux de traitement: contrôle en rapport avec :
b) les changements entre parcelles (traitement/contrôle) dans la divbersité de structure de la pelouse (surface/hauteur de végétation moyenne.

We conclude that reductions in sheep grazing, probably through changing the structure and composition of the moor edge habitats, can result in marked and sometimes rapid increases in both numbers and breeding success of black grouse. There are however suggestive data, which indicate that any initial benefits may only be short-term in nature and may subsequently diminish in relation to vegetation succession and associated reductions in structure and diversity of fine-scale mosaic. On-going studies suggest that grazing reductions over areas between 40 and 100 ha may be necessary to promote the most appropriate scale of favoured habitat mosaics, particularly for rearing chicks. This needs to be addressed through more flexible longer- term grazing prescriptions within government agri-environment prescriptions.

Grazing reductions – red deer in forests

Several native forests in the Scottish Highlands have failed to regenerate within the last 200 years (WATSON 1983). Consequently, to conserve the habitat of forest grouse, regeneration schemes are often necessary. This is achievable only through reductions in grazing pressure of red deer. Grazing reductions can be accomplished either through increasing deer culls (eg. BEAUMONT *et al.* 1995), or by fencing to exclude deer. Either method may have beneficial effects for black grouse in the short-term through increasing ericaceous food plants and insects important to chicks (BAINES *et al.* 1994), which in turn may lead to higher breeding success (BAINES 1996). At Abernethy Forest in the Scottish Highlands, a reduction in red deer numbers from 900 in 1988/89 to 300-400 in 1995-98 by increased culling was associated with an increase in lekking males from almost 50 to just under 200 (HUGHES *et al.* 1999). However, the reduction in deer numbers coincided with other changes in management, which included removal of deer fences and, in some years, control of predators. This did not permit estimation of the relative contribution of each management component to the observed increase in lekking males. A similar pattern has however been observed at a second site in the Scottish Highlands. Here, reductions in red deer and sheep have resulted in woodland regeneration (RAMSAY 1996) and an associated increase in lekking males from 29 in 1994 to 57 in 1998 (D. BAINES, unpublished), whilst other management variables have remained at broadly equivalent levels. Over the last three years, despite maintenance of reduced deer densities, black grouse numbers have shown a progressive annual decline at Abernethy (D. DUGAN pers. comm.). This perhaps indicates that deer numbers may now be too few and, similar to the response to reduced sheep grazing described in northern England, the forest floor vegetation may now be too dense for successful chick rearing.

Problems of using fencing to improve habitat

Although forest regeneration by culling deer may be preferable, many land owners and managers consider that in some forests successful tree regeneration and retention of sufficient deer for sporting purposes can only simultaneously occur through fencing. Recently, it has been shown that wire mesh and multiple-line wire fences, erected to exclude domestic stock and deer from young conifer plantations and regenerating native woodlands, kill both black grouse and capercaillie *T. urogallus* in Scotland (CATT *et al.* 1994, BAINES & SUMMERS 1997). CATT *et al.* (1994) reported mean collision rates for black grouse of 0.4 km^{-1} $annum^{-1}$, whilst BAINES & SUMMERS (1997) from a more extensive sample of forests recorded 0.6 collisions km^{-1} $annum^{-1}$.

Given the recently expanded deer population in the Scottish Highlands (CALLANDER & MACKENZIE 1991), fences have been increasingly used to exclude deer to permit forest regeneration. To this end, there are an estimated 1,925 km of deer fencing in and around native pinewoods and forestry plantations

in the Moray and Dee areas of the Scottish Highlands alone (SUMMERS 1998), both areas within the core black grouse range. Hence fences may be a serious problem to forest grouse. Furthermore, any benefits of reduced grazing, either in the short-term by providing better habitat, or in the longer term by providing more habitat, may be outweighed, or at least compromised, by increased bird mortality from collisions with fences.

The impact of deer fences on black grouse and capercaillie can be reduced by marking particularly hazardous sections of fence. In an experimental trial, two strips of orange plastic netting, each of 25 cm depth and mesh size 9 x 3.5 cm, were attached to each of ten fences. Marking was associated with a 91% (95% CL: 67 - 98%) reduction in black grouse collision rates (BAINES & ANDREW in press). A further large-scale experiment involving fence marking is being conducted to consider the role of fence deaths in the decline of black grouse in the Scottish Highlands. All deer fences within a 1 km radius of six black grouse leks were marked in winter 1998/99, while at a further six leks deer fences were left unmarked. Numbers of males attending each lek were recorded from 1997 to 2000. An index of the success of marking for each site was derived from the mean number of males after fence marking (1999 and 2000) divided by the mean number of males prior to marking (1997 and 1998). Interim results suggest that marking fences was associated with an average 9% increase in lekking males (± 9% S.E.), whereas unmarked fences showed a 15% decline in males (± 4% S.E.) (t_{11} = 2.44, P<0.05) **(Fig. 2)**. The experiment will be conducted over a further two years before firm conclusions are drawn.

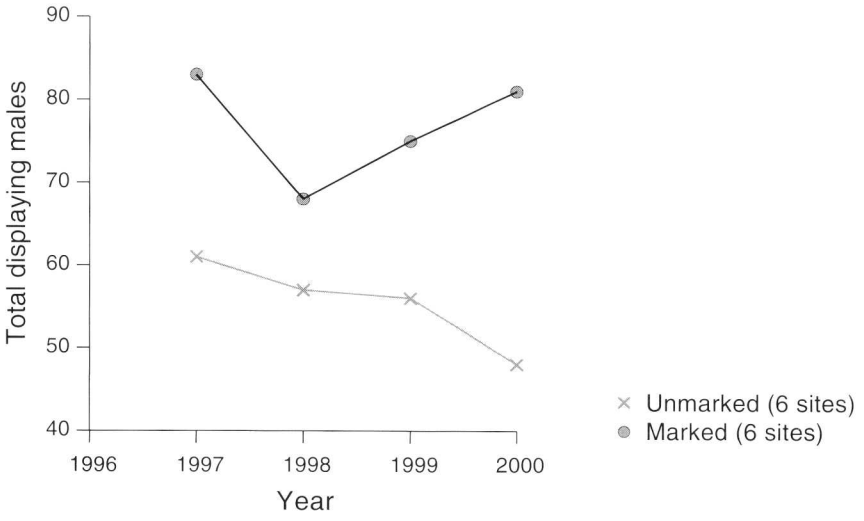

Fig. 2. Changes in the total number of displaying males at six leks where deer fences were visibly marked to help reduce collisions in relation to changes at six leks where deer fences were not marked. Fences were marked in winter 1998/99.
Changements dans le nombre total de mâles paradant sur 6 arènes où les clôtures à cervidés étaient visiblement marquées pour aider à réduire les collisions, par rapport aux changements sur 6 arènes où les clôtures n'étaient pas marquées. Les clôtures ont été marquées durant l'hiver 1998-1999.

Forest maturation

Afforestation occurred over large areas of the British uplands between 1950 and 1980, usually aided by the UK Government through subsidies and tax incentives. These commercial plantations were often planted on, and therefore replaced, heather moorland and rough grazing habitats frequented by black grouse. In their early developmental phases, these plantations, usually of mixed species conifers dominated by sitka spruce *Picea stitchensis* and lodgepole pine *Pinus contorta*, provided appropriate habitat for black grouse (CAYFORD 1990). The young conifers provided a scrub woodland habitat that had probably been more frequent on moorland edges prior to increased browsing from large herbivores such as sheep and deer. Consequently, black grouse often thrived in such plantations and rapid increases in densities were observed (THOM 1986).

Repeated counts with pointer dogs through the first 14 years after planting in four sitka spruce plantations in Perthshire, Scotland showed a rapid increase in numbers. This was particularly the case for hens, probably post-dispersal first breeders, with densities averaging 10 hens km^{-2} four years after planting **(Fig. 3)**.

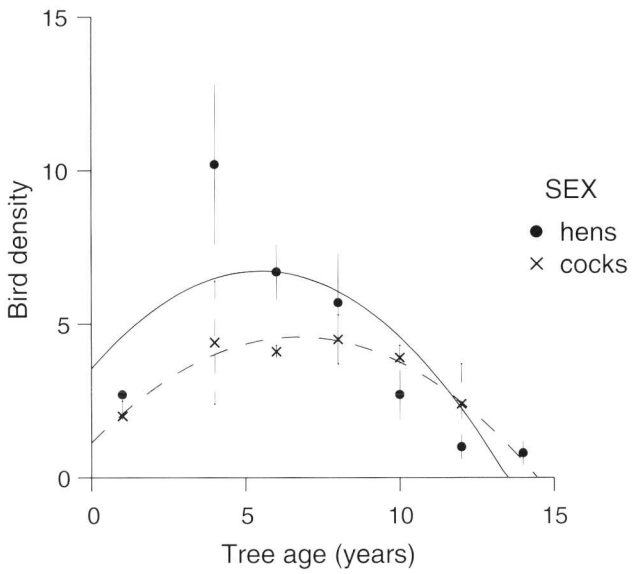

Fig. 3. Changes in the density of male and female black grouse (birds km^{-2}) in August in four spruce and pine dominated plantation forests in Perthshire, Scotland in relation to years since planting. Data presented are means ± SE with a quadratic smoothing curve fitted between the points.
Changements dans la densité des tétras lyres mâles et femelles (oiseaux/km^2) en août dans 4 plantations forestières dominées par l'épicéa et le pin dans la Perthshire, Ecosse par rapport aux années depuis la plantation. Les données présentées sont des moyennes +/- écart type avec une courbe quadratique lissée ajustée entre les points.

Trees within plantation forests are planted at close and regular spacings, typically every 1.5 metres, resulting in approximately 2,000 trees ha^{-1}. Given this regular close spacing, and the necessity to plant high densities to obtain government grants, the tree canopy usually closes after 10 to 15 years. Given that the unplanted area within the timber crop rarely exceeds 5 to 10%, canopy closure results in the virtual loss of ericaceous species growing on the forest floor and black grouse numbers rapidly decline thereafter. Breeding success however did not diminish over time in relation to increasing tree age **(Fig. 4)**, indicating that maturing forests are still capable of supporting successfully breeding greyhens, albeit perhaps confined to areas of crop failure, limited unplanted areas on steep rocky slopes or along rides and stream edges. These residual areas are of limited availability and accordingly the forest supports fewer breeding greyhens and may be less attractive to yearling hens when choosing sites in which to settle and breed.

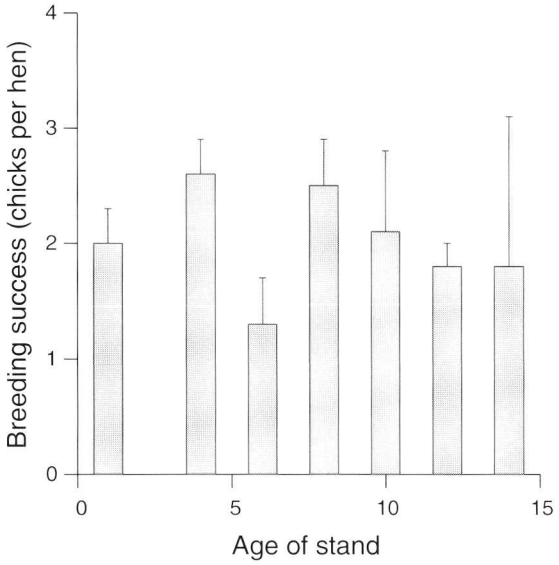

Fig. 4. Breeding success (chicks per hen) in August in four Scottish forests in relation to years (age of stand) since planting. Data presented are means + SE.
Succès reproducteur (poussins par poule) en août dans 4 forêts écossaises par rapport aux années depuis la plantation (âge du peuplement). Les données présentées sont des moyennes + écart-type.

Varying open space within forests

A comparison of changes in hen densities over time in two Scottish forests differing in the amounts of open space supports the above hypothesis. The first forest had < 10% open space within the crop and showed a peak of 4 hens km^{-2} six years after planting **(Fig. 5)**. The second forest, with 35% open space, reached a peak of 11 hens km^{-2} some 12 years after planting, but this density had declined to 4 hens km^{-2} after 16 years. Hence it would appear that forests with a greater allocation of open space support higher densities of hens, have a later peak in densities and overall have an extended period of suitability for black grouse.

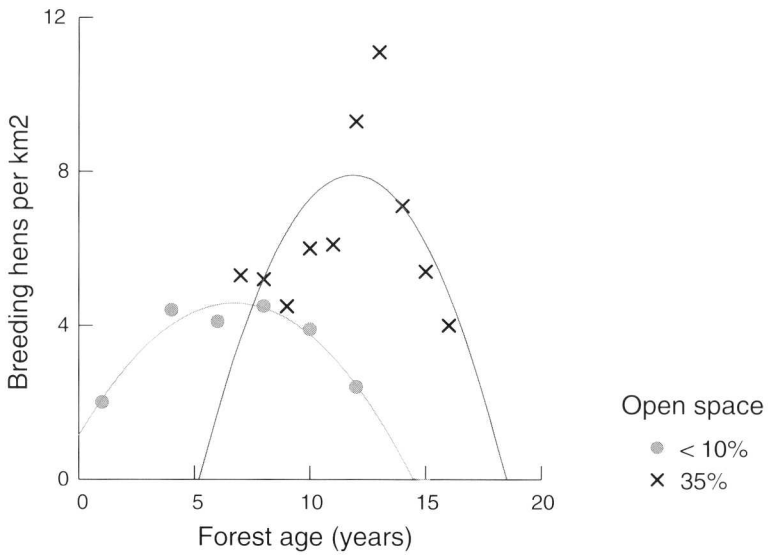

Fig. 5. Changes in breeding hen densities (birds km^{-2}) in relation to the number of years since planting for two Scottish forests differing in the extent of open, unplanted space within the forest.
Changements dans la densité de poules nicheuses (oiseaux/km²) par rapport au nombre d'années depuis la plantation pour deux forêts écossaise différant par l'étendue des zones ouvertes non plantées au sein de la forêt.

Few management trials have been conducted to establish the critical amount of open space to provide, or to establish whether progressive selective tree removal at or prior the pre-thicket stage and canopy closure can extend the period of forest suitability for breeding black grouse. One trial in Perthshire, Highland Scotland in the mid 1990s increased the amount of open space within the forest from 7% to 21%. However, this alone proved insufficient to prevent a reduction in displaying males from 12 to 1 over three years. Establishing replicated trials that manipulate both the amount of open space and its position in relation to the forest edge will be a focus for future research initiatives.

Perhaps the best opportunity for establishing scales of suitable forest management for black grouse occurs when the forest is clear-felled and areas of it are replanted (restocks). Considering black grouse occupancy rates in relation to the sizes of restock patches provides an indication of the spatial requirements of a lekking group of males. Analysis of data from some 60 leks in Argyll showed that forests being planted with their second crop of trees (second rotation) were similarly attractive to black grouse as during the first rotation, ie. when initially afforested. The occupancy rate of pre-thicket patches of second rotation forest was significantly related to two variables; the size of the patch and the variability of tree age within that patch. Together these two variables accounted for some 40% of the variation in patch occupancy rates (S. HAYSOM unpublished). Modelling the relationship between the second rotation patch size within first rotation forests and the chance of a lek occurring within that patch suggested a linear relationship (line forced through the origin) between occu-

pancy and patch size up to 200 ha, when all patches were occupied. 100 ha patches had a 50% chance of containing a lek. Hence larger clearfell patches had a greater chance of containing a black grouse lek, up to a maximum of 200 ha.

Predator management

Several of the studies that considered the effects of habitat manipulations on black grouse were conducted on sites where predators were simultaneously controlled, particularly where red grouse shooting was a primary land use.

Table III. Estimates of black grouse mean brood size (an index of chick survival) and breeding success (chicks fledged per hen) in relation to management of predators. Sites classified as receiving predator control are denoted "a", those without "b". Values are means ± SE.
Calculs de la taille moyenne de la nichée (index de la survie des poussins) et du succès reproducteur (poussins à l'envol par poule) selon la gestion des prédateurs. Les sites classés comme soumis à un contrôle des prédateurs sont notés «a», ceux sans contrôle sont notés «b». Les valeurs sont les moyennes +/- écart type.

Predators Study remaining	Chick Study area survival	Years of Breeding study success	Predators removed
Baines 1991b	Scottish Highlands	1989-90	[a] *Vulpes vulpes*, *Corvus corone*
Felis sylvestris, *Martes martes*	3.4 ± 0.5	2.6 ± 0.5	
	Scottish Highlands	1989-90	[b] none
all	2.7 ± 0.5	1.6 ± 0.3	
Calladine *et al.*2001	various, N.Pennines	1996-00	[a] *Vulpes vulpes*, *Corvus corone*,
Mustela erminea	some *Mustela erminea* 2.8 ± 0.3		1.4 ± 0.2
	various, N.Pennines	1996-00	[b] some *Vulpes vulpes*, *Corvus corone*
Mustela erminea, some *Vulpes vulpes*	2.7 ± 0.6	1.0 ± 0.4	
Hughes *et al.* 1999	Inverness-shire, Scotland	1994-96	[a] *Corvus corone*
Vulpes vulpes, *Martes martes*	3.9 ± 0.5	3.5 ± 0.6	
	Inverness-shire, Scotland	1989-93, 97-98	[b] none
Vulpes vulpes, crow, *Martes martes*	3.2 ± 0.6	1.9 ± 0.6	
Baines 1996	various, N.Britain	1991-93	[a] keeper present
	3.3 ± 0.3	1.9 ± 0.3	
	various, N.Britain	1991-93	[b] keeper absent
	3.0 ± 0.2	1.8 ± 0.3	
GCT unpubl.	Pale Moor, N.Wales	1996-00	[a] *Vulpes vulpes*, *Corvus corone*, *Mustela erminea*
	4.1 ± 0.4	3.6 ± 0.3	
RSPB unpubl	Various, N.Wales	1997-00	[b] none
Vulpes vulpes, *Corvus corone*, mustelids	2.6 ± 0.3	1.4 ± 0.3	

Within Britain, effects of predator control on black grouse numbers and breeding success have not been estimated experimentally. There are however correlative data from several studies, which use sites that differ in their degree of predator management. Each of five studies where black grouse breeding success was compared between sites where predators were controlled and those where they were not showed better breeding success where predators were controlled by gamekeepers **(Table III)** (BAINES *et al.* submitted). Combining data from all five studies showed that each female black grouse on average reared 2.6 (± 0.4 SE) chicks where predators were controlled, compared to 1.5 (± 0.4 SE) on sites without or with only limited predator control. A similar effect was found for mean brood size, an index of chick survival, with 3.5 (± 0.3 SE) chicks where predators were controlled, compared to 2.8 (± 0.3 SE) where they were not.

Conclusions

Management schemes that have endeavoured to mimic natural conditions of seral vegetation successions, that both provide and maintain appropriate transitional stage habitats preferred by black grouse, have met with some success. Examples of this within semi-natural habitats have been grazing reductions of both sheep and red deer to promote development of ericaceous moorland edge habitats and scrubby margins along the edges of native woodlands. Within commercial conifer plantations, the creation of internal edge by selective felling to increase open space or the clear-felling of entire patches has mirrored naturally occurring transitional stages of woodland edge, perhaps akin to the Fennoscandian forest bog systems (ANGELSTAM 1983). Key factors that probably play a large part in determining the degree of success of such operations are the adoption of correct spatial and temporal scales. Trial and error involving spatial comparisons has produced some approximations of the scales of operation necessary and their timings in relation to habitat development and succession. However these need to be supported by the implementation of replicated experimental management trials, particularly those that manipulate spatial factors and their interaction with adjoining habitats within mosaics of perceived importance. Providing these mosaics of habitat through management at the correct scale, and thereby mimicking traditional natural habitat systems, is likely to be the key to success in restoring black grouse numbers in the United Kingdom. However, given that utopian habitats of optimal quality and extent are long gone and have been reduced to highly degraded, fragmented patches, habitat manipulation approaches alone may be insufficient to stem the decline of the black grouse. Most work programmes that have demonstrated increases in black grouse have been associated with simultaneous programmes of predator reduction. Poor quality habitats, limited in their extent and dominated by edge, may give unquantified advantages to generalist predators within predator-prey relationships. Should this be the case, then predator management may, alongside habitat improvement, be an essential component of successful black grouse recovery schemes.

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RESUME : Renverser le déclin : aperçu des projets de conservation du tétras-lyre au Royaume-Uni

Jusqu'au siècle dernier, le tétras-lyre était répandu dans tout le Royaume-Uni. Aujourd'hui, on estime qu'il reste 6 500 coqs sur les sites de parade, dans des contrées restreintes du Pays de Galles, du nord de l'Angleterre et de l'Ecosse. Les facteurs associés au déclin comprennent la perte et la dégradation de l'habitat, une prédation accrue et les collisions avec les clôtures anti-cervidés. Leur importance relative varie avec les différents habitats de l'oiseau au Royaume-Uni, ce qui complique les efforts de rétablissement.

La plupart des travaux de conservation ciblent l'amélioration de l'habitat du tétras-lyre, soit en éclaircissant des forêts exploitées et en accroissant les espaces ouverts, soit en réduisant l'impact de l'abroutissement des moutons et des cerfs en bordure des landes. Des données limitées, en provenance de travaux dans des forêts d'Ecosse et du Pays de Galles, suggèrent que cette gestion ne fait que prolonger la période pendant laquelle la forêt convient aux tétras, qu'elle n'empêche pas les déclins et est généralement entreprise à trop petite échelle. L'amélioration des habitats en bordure de landes, notamment par la réduction du pâturage ovin, conduit à un plus grand succès, mesurable par des densités printanières accrues et, certaines années, un meilleur succès de reproduction. Une augmentation annuelle moyenne de 6% (mâles en parade) a été observée depuis 1996 sur dix sites du nord des Pennines, Angleterre, après une réduction du nombre de moutons, contre un déclin annuel régional de 5% durant la même période. Bien qu' encourageante, cette tendance n'était pas constante sur tous les sites et pourrait n'être qu'éphémère. On a noté des résultats semblables suite à une réduction du nombre de cerfs, mais seulement en l'absence de clôtures anti-cervidés. Ces clôtures occasionnent une mortalité importante pour toutes les espèces de tétras et cela contrecarre probablement toute amélioration due à la gestion de l'habitat. Cette hypothèse est testée expérimentalement en ce moment. Des résultats plus convaincants ont été notés quand l'amélioration de l'habitat et le contrôle légal des prédateurs sont entrepris simultanément: deux projets distincts, mais non-expérimentaux, montrent une augmentation de facteurs dix et quatre pour la densité printanière des mâles depuis 1992 et 1996 respectivement.

Les initiatives de conservation du tétras-lyre se déroulent présentement dans le cadre d'un Plan d'Action d'Espèce, mis en place par le gouvernement britannique suite à son engagement en faveur de la biodiversité résultant de la Convention de Rio en 1992.

Mots-clés : *Tetrao tetrix* , Tétras lyre, Grande Bretagne, Nord des Pennines , déclin des populations, mortalité, succès reproducteur, restauration des habitats, contrôle de la prédation, limitation du pâturage.

ZUSAMENFASSUNG : Den Rückgang umdrehen – Übersicht der Projekte zur Erhaltung des Birkhuhns in Großbritannien.

Bis zum letzten Jahrhundert war das Birkhuhn über ganz Großbritannien verbreitet. Heute zählt man noch 6500 Hähne in begrenzten Gebieten von Wales, Nordengland und Schottland. Mehrere Faktoren dürften zu dem Rückgang beigetragen haben, vor allem Verlust und Degradierung des Habitats, erhöhter Predatorendruck und Unfälle an Wildzäunen. Ihre relative Bedeutung variiert zwischen den verschiedenen Teilgebieten des Vogels in Großbritannien, was die Schutzbemühungen erschwert. Die Mehrzahl der Schutzprojekte konzentrierten sich auf Habitatverbessung ; in forstlich genutzten Gebieten durch Durchforstungen und Schaffung offener Flächen und entlang der Ränder der Moore und Heiden durch die Verringerung der Schaf- oder Hirschbelastung. Begrenzten Daten aus Projekten zur Habitatverbesserung in Waldgebieten lassen vermuten, dass die Maßnahmen lediglich die Zeitspanne verlängern, in der sich die Wälder für Birkhühner eignen, dass sie jedoch deren Niedergang nicht verhindern und im allgemeinen in unzureichendem Umfang unternommen werden. Erfolgreicher, messbar an erhöhten Frühjahrsdichten und, in manchen Jahren, an größerem Reproduktionserfolg, waren Maßnahmen zur Verbesserung des Habitats am Rand der Heiden, vor allem durch Verringerung der Beweidung. Eine jährliche Steigerung von 20 % (balzende Hähne) wurde seit 1996 beobachtet, in sechs Gebieten im Norden der Pennines (England), wo die Anzahl Schafe verringert wurde, gegenüber einem regionalen jährlichen Rückgang von 5 % während der selben Zeitspanne. Obwohl ermutigend, ist diese Tendenz jedoch nicht in allen Gebieten übereinstimmend und könnte auch nur von vorübergehender Dauer sein. Ähnliche Ergebnisse wurden auch durch die Reduktion der Rothirschzahlen erreicht, jedoch nur in ungezäunten Gebieten. Hirschzäune verursachen eine hohe Sterberate bei allen Rauhfußhuhnarten und machen wahrscheinlich die Effekte jeglicher Habitatverbesserung zunichte. Diese Hypothese wird zur Zeit experimentell überprüft. Überzeugender waren wohl die Ergebnisse wo Habitatverbesserung und Predatorenkontrolle gleichzeitig unternommen wurden ; zwei nicht- experimentelle Projekten ergaben eine zehn bzw. Vierfache Steigerung in der Dichte der Hähne im Frühjahr seit 1992 bzw. 1996.

Initiativen zum Schutz des Birkhuhns werden derzeit in einem Artenschutz-Aktionsplan gebündelt als integraler Bestandteil des Engagements der britische Regierung zugunsten der Biodiversität im Rahmen der Vereinbarung von Rio im Jahr 1992.

Schlüsselwörter : *Tetrao tetrix,* Birkhuhn, GroßBritania, Nordpennine Population Rückgang, Sterblichkeit, Habitat Verbesserung, Bruterfolg, Predatorkontrolle.