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Restoration of Moorland Habitat in Northern England : a Conservation Initiative for Black Grouse (*)

by

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Key words : Black Grouse, *Tetrao tetrix*, Great Britain, Pennines, Habitat management, moorland restoration, grazing control.

SUMMARY

Numbers of male black grouse *Tetrao tetrix*, the density of females in summer and their breeding success were monitored at 20 sites on moorland and the moorland fringe in the north of England from 1997 to 2000. At 10 sites under agreements with agri-environment schemes funded by the UK government, the number of grazing animals were restricted two-fold to 1.1 sheep per hectare in summer and three-fold to 0.5 sheep per hectare in winter.

Numbers of displaying males remained stable at sites with low grazing levels, but declined by 7% per annum where grazing remained higher. More broods were reared where grazing was restricted. This was associated with taller vegetation but with similar species composition.

An ongoing conservation initiative encourages uptake of agri-environment schemes to reduce grazing intensity on moorland and the moorland fringe. To date, this initiative has included areas that support over 25% of remaining black grouse in England.

Introduction

Formerly widespread in Britain, numbers of black grouse *Tetrao tetrix* have declined and their range has contracted throughout the 20th century (BAINES and HUDSON 1995). The most recent of two ornithological atlas surveys found them in 28% fewer 10 km squares in 1988-91 than in 1968-72

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(GIBBONS *et al* 1993). The first systematic national census of black grouse in Britain estimated 6,510 displaying males in 1995-96 (95% confidence limits; 5,000 - 8,100) (HANCOCK *et al* 1999). Based on a sample of 31 5-km squares, the latter survey estimated 1700 (800 - 3100) displaying males in the north of England. Counts covering leks known to ourselves, and searches for additional sites based on local knowledge, indicate the estimated population in 1998-99 was at the lower extreme of the given confidence limits, that is about 800 displaying blackcock (unpublished data). Following the extinction of an isolated population in the Peak District (central England) in 1998/99, over 95% of the remaining black grouse in England occur within approximately 2,500 km^2 of the North Pennines between latitudes 54° 10′ N and 55° 0′ N, and also in adjacent parts of Northumberland.

The North Pennines is an upland area of northern England where black grouse occur on moorland and the moorland fringe, using a mosaic of habitats including blanket bog, rough grassland, heather moor, herb-rich meadows and pastures (BAINES 1994). Most black grouse are found between 200 and 650 metres above sea level. Native woodland at this altitude is scarce in the region, but where available, suitable trees and shrubs are used. The principal land uses are the rearing of sheep and sport shooting, notably shooting of red grouse *Lagopus lagopus scoticus*.

Correlative studies suggest reduced population densities of black grouse can be associated with shorter sward heights maintained by higher densities of grazing animals (BAINES 1991, 1996a). In recent decades, the number of sheep grazing in the English uplands has increased (ANDERSON and YALDEN 1981, FULLER 1996), associated with productivity-based financial incentives, and is implicated as an important causal mechanism for the decline of black grouse (HUGHES *et al* 1998). Agri-environment schemes introduced in 1991 by the UK government now offer contractual payments to restrict grazing levels and duration and are being used to encourage prescriptive management as part of a conservation initiative for black grouse in northern England. This paper gives some preliminary results of ongoing work investigating the response by black grouse to reductions in levels of sheep grazing.

Methods

Black grouse numbers and their breeding success were monitored from 1997 to 2000 and the composition and structure of vegetation were measured at twenty sites in the north of England (**Fig. 1**). Each monitored site encompassed between 1.0 and 7.4 km^2 (mean 2.6 km^2) of moorland and moorland fringe and all were occupied by black grouse in 1996. Ten of these areas had agreements to restrict numbers of domestic grazing animals on at least 0.4 km^2 and are referred to as treatment sites. Agreements had been effective for 2 - 5 years before 1997. Such restrictive agreements were not applied on the remaining sites and consequently grazing levels were expected to be comparatively high.

These latter sites were selected as controls and were paired with treatment sites with respect to geographical location. The mean distance between paired sites was 9.5 km (range 5 to 19.5 km). The pairing of monitored sites helped ensure that weather and other regional effects, influenced both treatments within a pair equally. All sites were subject to some degree of predation control. Most were within sporting estates (8 treatment sites and 7 controls) employing full-time game-keepers responsible for restricting numbers of predators. Rough indices of avian predators (numbers of raptors and corvids seen during brood counts described below) suggest low densities (medians of 2.7 corvids and 0 raptors per km^2) which did not differ between the two groups of treatments (paired tests : $Z=0.42$, $P=0.68$ for corvids; $Z=0.45$, $P=0.67$ for raptors). The principal and over-riding difference between treatments was expected to be numbers and duration of grazing sheep. Numbers of sheep on the monitored sites were counted 8 times between 1998 and 2000 to quantify numerical and seasonal differences between treatments. As these were either restricted by agreement or were subject to broader productivity incentives, the two treatments were expected to approximate a series of replicated grazing trials.

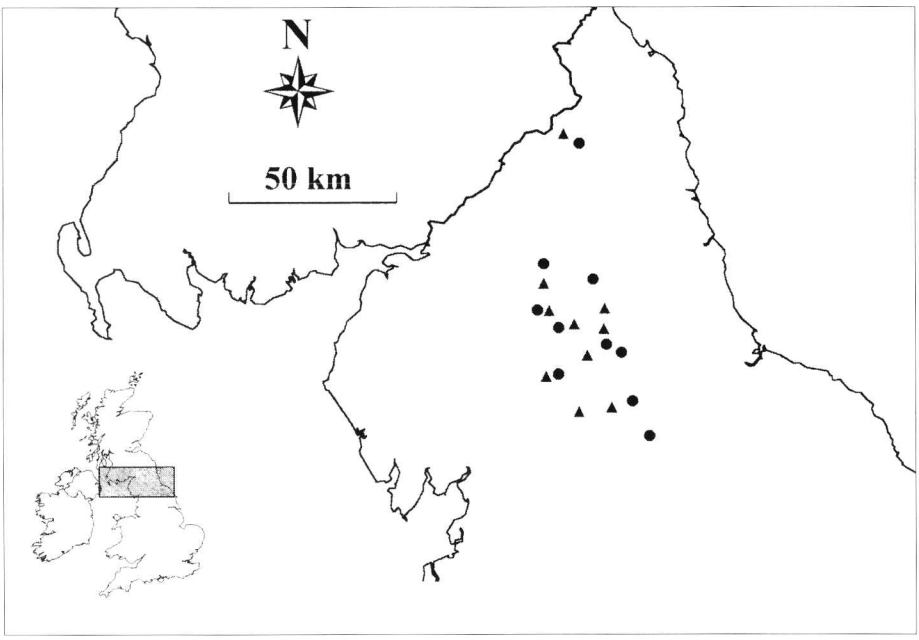

Fig. 1 Location of monitored sites in northern England. Circles represent sites with reduced grazing (treatment sites) and triangles represent control sites.
Localisation des sites sous contrôle dans le Nord de l'Angleterre. Les points noirs représentent les sites où la pression de pâturage a été réduite (sites traités) et les triangles désignent les sites de références non traités.
Untersuchungsgebiete in Nordengland. Flächen mit reduzierter Beweidung sind mit Punkten, Kontrollflächen mit Dreiecken gekennzeichnet.

Bird monitoring

Numbers of displaying males were counted twice at each site within two hours after dawn between early April and late May each year, to coincide with peak and most consistent attendance by males at leks (BAINES 1996b). At least two weeks separated counts at each site, the highest count being that used to estimate the number of males present. Where more than one lek was involved, the maximum combined total in any one visit was used. In 1997, the first year all sites were counted, a total of 110 displaying blackcock were counted on treatment sites (mean = 11, sd = 11.0). At control sites comparable figures were 140 (mean = 14, sd = 5.8). To assess the effect of grazing treatment on the trends in numbers of displaying males in spring, the regression coefficients of log-transformed counts against year for each site were compared using a paired t-test.

Breeding success was estimated by systematically searching monitored sites with pointer dogs for hens and noting number of chicks per brood. Brood searches were undertaken between mid July and mid August each year, when most young were expected to be over 3 weeks old and before the break-up of identifiable broods (BAINES *et al* 1996). Two measures of breeding success were compared between treatments, the ratios of the number of chicks to the number of hens and the number of broods to the number of hens. The mean ratios, weighted by the number of hens found, over the four years for each site were compared between grazing treatments using a paired t-test. Instances when no hens were found are treated as missing data and there were no instances of chicks found without hens. Trends in the numbers of hens found during brood searches were compared using a paired t-test on the regression coefficients of log-transformed counts against year, as for the lek counts.

Vegetation measurements

Point sampling was used to assess vegetation height and the dominant species composition at each study site between mid-June and mid-July in 1999. Dominant species and vegetation height was recorded at 100 points over each monitored site. The points were evenly spaced along transects marked on a map. Typically 1 - 4 transects covered any one site and were evenly spaced where more than two. The number of transects depended on size and shape of the site but aimed to give even coverage. Vegetation height was measured *in situ*, always under dry conditions, to the nearest 5 cm using a vertically held marked cane and is the maximum height of the foliage, or whole plant for dwarf shrubs, at the point touched by the cane. The species recorded was the dominant one within a 2-cm radius of the cane.

For analyses, vegetation was classed into one of six groups, Ericaceous (overwhelmingly *Calluna vulgaris* in the North Pennines), Grass (Gramminacea), *Eriophorum* spp, *Juncus squarrosus*, tall *Juncus* spp. and

'Other'. The latter included herbs, typically *Gallium saxatile*, *Polytrichum* moss and unvegetated soil and peat. Compositional analysis of the log-ratios (AITHCHISON 1986) with, in this case, 'Other' as the denominator and using a paired MANOVA of the log-ratios, determined the significance of any difference in vegetation composition between grazing treatments. A paired t-test was used to assess the significance of differences in mean and variance of vegetation height.

Results

Grazing intensity

Densities of grazing sheep varied both seasonally and between treatments, with greatest densities during the summer and on control sites (**Table I**). In practical terms, for animal husbandry and for implementation of prescriptive management, maximum stock densities give the most useful guidance. In summer, control sites carried a maximum of 2.4 sheep per hectare, just over twice the maximum on treatment sites. In winter, the maximum sheep density was 1.6 per hectare, over three times greater than on treatment sites.

Table I. Density of sheep grazing on monitored sites in the northern England 1998 - 2000.
Densité des moutons pâturant les sites sous contrôle dans le nord de l'Angleterre en 1998-2000.
Schafsdichte auf Kontrollflächen (beweidet/nicht beweidet) in Nordengland 1998-2000.

SEASON STATUS SHEEP PER HECTARE						
		Max	Mean	sd	n	Significance
SUMMER						
	Treatment	1.12	0.48	0.36	10	
	Control	2.40	1.65	0.50	10	$t9 = -7.85$, $P < 0.001$
WINTER						
	Treatment	0.48	0.22	0.18	10	
	Control	1.59	1.02	0.39	10	$t9 = -6.27$, $P < 0.001$

Note: The mean densities are those of the ten sites per treatment derived from the means of four counts per season at each site. The maximum are those of all counts within that treatment and season.

Bird numbers and breeding success

The general trend in numbers of displaying males was for an average increase of 7.4% (SE=7.4%) per year on treatments sites compared to an average annual decline of 6.5% (SE=3.3%) at control sites (**Fig. 2**). The decline at control sites alone approached statistical significance ($F_{1,38} = 3.99$, $P = 0.05$), however the difference in the trend in numbers between treatments was not statistically significant (**Table II**).

The general trend in hen density during the brood-rearing period did not differ from zero (SE=0.1 hens km^2) for treatment sites compared to an average annual decline, the equivalent of 0.4 hens km^2 (SE = 0.2) per year at control sites ($F_{1,38}$ = 5.16, P = 0.03, for control sites). The mean hen density across all sites and years was 1.8 km^2 (SE = 0.3). Again, the difference in the trend in numbers between treatments over the four years of this study was not statistically significant (**Table II**).

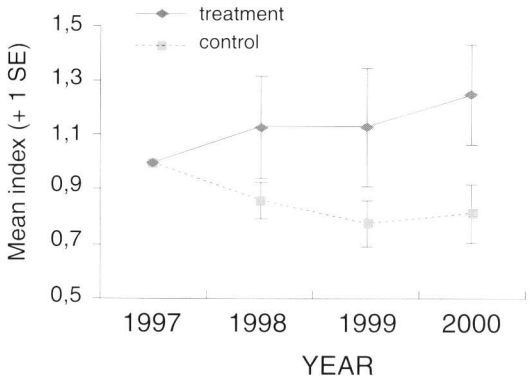

Fig. 2 Relative changes in numbers of displaying blackcock at sites with reduced grazing (treatment, n=10) and control sites (n=10) in northern England, 1997 - 2000. Indices are based on counts in 1997 (=1), the first year when all sites were counted.
Changements respectifs des effectifs des Tétras lyres mâles en parade sur les sites bénéficiant d'un allègement de la pression de pâturage (sites traités, n=10) et sur les sites de référence (n=10) dans le Nord de l'Angleterre de 1997 à 2000. Les indices sont basés sur des comptages réalisés en 1997 (=1), la première année où tous les sites ont fait l'objet de comptages.
Relative Änderungen in der Anzahl balzender Birkhähne auf Flächen mit reduzierter Beweidung (n=10) und Kontrollflächen (n=10) in Nordengland, 1997-2000. Die Indizes wurden auf das erste Jahr der Zählung (1997) (=1) bezogen.

Table II. Comparison of trends in numbers of displaying male black grouse in spring and hens in summer, 1997 - 2000.
Comparaison des tendances quant aux effectifs des mâles en parade au printemps et de ceux des poules en été pendant la période 1997 à 2000.
Vergleich der Bestandsentwicklung balzender Birkhähne im Frühling und von Birkhennen im Sommer, 1997 -2000.

Count		Regression coefficient			Significance (paired test)
		Mean	SE	n	
Displaying males					
	Treatment		0.04	0.05	10
	Control	-0.05	0.03	10	t9 = -1.45, P = 0.18
Hens in summer					
	Treatment		-0.06	0.06	10
	Control	-0.15	0.06	10	t9 = 1.29, P = 0.23

Note: The regression coefficients are those of counts (log-transformed) against year for each site over four years, the means and standard errors shown are of the coefficients within each grazing treatment.

One measure of breeding success, the brood to hen ratio differed significantly between treatments with, on average, 40% fewer hens found with broods at control sites than at treatment sites (**Fig. 3.**). The difference in the chick to hen ratios between grazing treatments showed a close to significant tendency for more chicks to be reared at sites with reduced grazing with an average 1.3 chicks per hen compared to an average 0.7 chicks per hen at control sites (**Table III**).

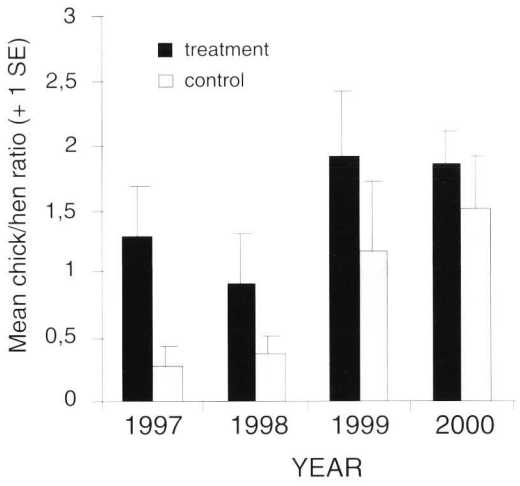

Fig. 3. Breeding success of black grouse at sites with reduced grazing (treatment, n=10) and control sites (n=10) in northern England, 1997-2000.
Succès reproducteurs des Tétras lyres, respectivement sur les sites bénéficiant d'une pression de pâturage réduite (sites traités, n=10) et sur les sites de contrôle (n=10) dans le Nord de l'Angleterre, 1997-2000.
Bruterfolg von Birkhühner auf Flächen mit reduzierter Beweidung (n=10) und Kontrollflächen (n=10) in Nordengland, 1997-2000.

Ratio		Mean	SE	n	Significance (paired test)
Chicks per hen					
	Treatment		1.27	0.24	8
	Control	0.73	0.20	10	t7 = -2.24, P = 0.06
Broods per hen					
	Treatment		0.50	0.08	8
	Control	0.30	0.06	10	t7 = -3.59, P = 0.01
Note: No hens were found in any year at two of the treatment sites.					

Table III. Comparison of breeding success (mean ratios across the four years, weighted by the number of hens) between grazing treatments, 1997 - 2000.
Comparaison du succès reproducteur (taux moyens calculés sur les 4 années, évalués d'après le nombre des femelles) selon les traitements de pâturage, 1997-2000.
Vergleich des Bruterfolgs zwischen versschiedenen Beweidungsarten, 1997-2000.

Vegetation

The composition of dominant vegetation types did not differ significantly between treatments ($\Lambda = 0.67$, $P = 0.28$) (**Table IV**). However, the vegetation in June was on average 50% taller at treatment than at control sites with a significant trend for increased heterogeneity in structure (as indicated by variance of vegetation height measures taken) at treatment sites (**Table IV**).

a) Composition (% cover)

	treatment		control	
	mean	SE	mean	SE
Ericaceous	18.2	4.5	18.1	7.0
Grass	47.7	5.0	42.5	7.5
Eriophorum spp.	15.7	3.5	11.9	3.8
Tall Juncus spp.	11.2	1.9	13.1	2.3
Juncus squarrosus	2.9	1.3	13.3	4.1
Other	7.8	1.7	9.5	2.1

Paired MANOVA of log-ratios: L = 0.67, P = 0.28

b) Height (cm)

	treatment		control		Difference
	mean	SE	mean	SE	
Mean per site	33.6	1.6	21.5	1.6	t9 = -6.00, P <0.001
Variance per site	558	92	289	43	t9 = -2.62, P = 0.03

Table IV. The composition (a) and height (b) of vegetation at monitored sites in the northern England in June-July 1999.
Composition (a) et hauteur (b) de la végétation aux sites contrôlés dans le Nord de l'Angleterre en Juin-Juillet 1999.
Zusammensetzung (a) und Höhe (b) der Vegetation auf Kontrollflächen in Nordengland im Juni/Juli 1999.

Discussion

The initial results of this study suggest that reductions in grazing pressure can contribute towards maintaining the status of black grouse in the north of England. Taller swards, maintained by relatively low levels of grazing, can provide better feeding and chick rearing opportunities associated with vegetative food availability and invertebrate abundance (BAINES 1996a). In this study, no significant difference in the composition of vegetation was detected between the two grazing treatments, but the presence of taller and perhaps more heterogeneous swards is likely to have been a factor influencing black grouse, per-

haps through improving the ability to rear broods.

Factors other than grazing which have been implicated in influencing black grouse abundance include weather (MOSS 1986, LONEUX *et al* 1997), predation (KAHAULA 2000), availability of suitable woodland cover (PARR and WATSON 1988) and disturbance (MULLER 1982). Although a significant decline in summer hen densities was noted at control sites during the four-year study, with a similar trend for displaying males in spring, the difference between paired treatments was not significant. The greater variation in trends within the treatment sites (for example, see **Fig 2**) suggests factors in addition to, or interacting with, the grazing treatment are also likely to be significant determinants in black grouse status. The area contained within a restrictive grazing agreement and its position within a mosaic of habitats and vegetation structures could also be significant. Further work will assess the influence of some of these factors and their interactions.

With evidence for a contribution of grazing restriction to the conservation of black grouse, it is encouraging to report a substantial uptake of agri-environment schemes within their range in the north of England. By the end of 2000, it is expected that over 100 km^2 of habitat will be subject to grazing agreements comparable with the treatment sites monitored. This area will host at least 25% of black grouse in England. Associated with increased funding, the number of agreements, and therefore the proportion of black grouse influenced, is expected to increase over the next few years. It therefore becomes increasingly important for a critical assessment of the contribution of a mosaic of vegetation structures at both the field and landscape levels for effective targeted prescriptive management for black grouse.

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ZUSAMENFASSUNG : Moorland Restauration in Nordengland : eine Initiative zur Erhaltung der Birkhuhns.

Anzahl und Bruterfolg von Birkhuhns wurden an 20 Stellen Moor- und Moorrandgebieten in Nordengland von 1996 bis 2000 gemessen. Mit der Zulassung von Agrar-Umwelt-Projekten wurde in 10 Gebieten eine reduzierte Begrasung durch Schafe erlaubt. In weiteren (Kontroll-) Gebieten fand eine intensievere Schafbeweidung statt, wie es für die Gegend typisch ist. Andere großere Herbivore waren in allen Fällen nicht vorhanden, Bäumeund Sträucher waren selten, und es gab nur wenige Jäger, sodass eine Serie gleichartiger Versuchsbedingungen gegeben war. In Gebieten mit reduzierter Begrasung nahm die Anzahl balzender Männchen um 6% pro Jahr zu, während diese Zahl im selben Untersuchungszeitraum in Kontrollgebieten um 4% pro Jahr abnahm. Bruterfolge waren in Kontrollgebieten während generell schlechter Jahre vermindert, im

Vergleich zu Gebieten mit reduzierter Begrasung. Gebiete mit geringerer Begrasung waren durch hehr wachsende Vegetation gekennzeichnet, und mit ähnlichem Artenreichtum jedoch größerer Anzahl von Invertebraten.

Eine andauemde Initiative zur Erhaltung der Birkhuhns sollte zum Einsatz von Agra-Umwelt-Projekten ermutigen, um die Begrasung von Moor- und Moorrandgebieten zu reduzieren. Es wird erwartet, daß diese Initiative bis heute mehr als 25% der noch existierenden Birkhuhns Englands geholfen hat.

Schlüsselwörter: Birkhuhn, *Tetrao tetrix*, Pennines, Habitat Management Moor

RESUME : La restauration des landes dans le nord de l'Angleterre : une initiative de conservation en faveur du Tétras lyre.

Les effectifs et le succès reproducteur des Tétras lyres ont été suivis de 1996 à 2000 sur 20 sites dans et en bordure des habitats de bruyères et de landes dans le nord de l'Angleterre. Des niveaux relativement faibles de pâturage par des ovins ont été maintenus sur 10 sites, conformément à des projets agro-environnementaux. Sur le reste (sites de contrôles), on a maintenu des niveaux relativement élevés de charge de moutons, typiques de la région. Dans un cas comme dans l'autre, les autres grands herbivores étaient quasi absents, les arbres et les buissons étaient rares et une série limitée seulement de prédateurs étaient présents, conditions garantes d'une série de tests répétés sur l'effet du pâturage. Les nombres des coqs en parade ont augmenté de 6 % en moyenne annuellement sur les sites à faible niveau de pâturage. Pendant la même période, on a noté une diminution annuelle moyenne de 4 % sur les sites de contrôle. Le succès reproducteur sur ces deniers était plus sévèrement déprimé durant les saisons globalement pauvres en comparaison des sites à faible taux de pâturage. Ceux-ci étaient caractérisés par une végétation plus élevée, mais de composition floristique identique, et par une plus grande abondance d'invertébrés.

Une initiative de conservation en cours encourage la conception de programmes agro-environnementaux visant à réduire la pression de pâturage dans et en bordure des landes. Présentement, on espère que 25 % des Tétras lyres subsistant en Angleterre bénéficieront de cette initiative.

Mots-clés : *Tetrao tetrix*, Tétras lyre, Grande Bretagne, Pennines, gestion de l'habitat, restauration des landes, contrôle du pâturage.

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