8. Effects of burning and grazing on the principal invertebrate species of upland blanket bog and wet heath

8.1 Introduction

There has been little work carried out on the impacts of management practices on upland invertebrates which is of direct relevance to this report, although it is possible to speculate to some extent on potential effects from studies in lowland or dry heaths, and from known impacts on vegetation and habitats (see e.g. Usher & Gardner 1988). Specific comments of relevance are outlined below.

Coulson & Butterfield (1986) in examining the spider fauna of upland habitats, found a division into two major habitat types: mineral soils with dominant *Juncus squarrosus*; and peat soils with *Eriophorum vaginatum* and *Calluna vulgaris*. They concluded that the division resulted from differences in plant architecture rather than plant species composition as such. Curtis & Bignal (1980) and Curtis & Stinglhammer (1986) show the importance of vegetation structure in determining the assemblages of spiders, particularly web-spinning species, in peat bogs in Scotland. McCracken (1992) considered that the structure of the vegetation, rather than the basic species composition, influenced the range of ground beetles present on moorland, based on a fuzzy classification of ground beetle and plant communities at Redesdale, Northumberland.

Coulson (1989) emphasizes the differences between blanket bogs and dry heaths and stresses the dangers of assuming similarity between the two. The structural variation, particularly of heather, in blanket bog is inherently greater than that of dry heathland with a long management history – uneven phased stands of heather have greater invertebrate diversity due to the greater range of structure and ages (Coulson, Fielding & Goodyer 1992).

8.2 Burning

Coulson (1988) says of burning "Obviously it has a destructive effect on the invertebrate fauna. The mobility of most invertebrates and the relatively small plots which are burned at any one time raise no major problems for recolonisation by invertebrates. However, it is difficult to separate the direct effects of burning from those associated with loss of food for invertebrates". He thus does not consider possible benefits of burning to some species or the burning of larger stands. On lowland heath and upland dry heath it is established that some species may benefit in the short term from the effects of burning. For example, Merrett (1976) demonstrated such a succession for spiders on Dorset heathland; Usher & Smart (1988) demonstrated a similar succession in upland heathland on Danby Low Moor, Yorkshire, but again in dry heathland.

McFerran, McAdam & Montgomery (1995) examined the impact of burning on ground beetle and spider communities on upland heathland in Co. Antrim. They found clear evidence of successional changes following burning. The beetle *Nebria salina* was most frequent on the most recently burnt plots; the beetles *Carabus problematicus* and *C. glabratus* and the spiders *Lepthyphantes zimmermani* and *Robertus lividus* were most common on unburnt plots, while

the beetles *Pterostichus niger* and *Carabus granulatus*, and the spiders *Ceratinella brevipes* and *Centromerita concinna* were most frequent on plots with heather of intermediate age.

Haysom (1994) recorded Lepidoptera larvae in stands of *Calluna* of different ages in northern heaths managed by rotational burning in Durham, Northumberland and southern Scotland. He found that though Lepidoptera diversity and abundance varied with *Calluna* height, patterns of diversity were not consistent between study sites. He argues for the maintenance of a mosaic of different-aged *Calluna* stands as the best conservation strategy for maintaining Lepidoptera species diversity.

Fishpool & Usher (1989) examined carabid beetle distribution on Danby Low Moor, Yorkshire and Gardner (1991) examined the association between carabid communities and heathland flora at a wider range of sites in the North Yorkshire Moors. Both found that wet heath supported carabid species not found in the drier heathland. Gardner & Usher (1989), examining the effects of burning and cutting on the insects at Danby Low Moor, concluded that insects were able disperse across and recolonise burnt areas, and that burning should be good for the insect community by increasing structural diversity. However, this conclusion was applied over the site as a whole, considering mostly dry heathland; the flush sites were not separately considered.

Usher (1992), considering the spider and beetle fauna of ten heathlands in the North Yorkshire Moors, including wet heathlands, pointed out that some of the nationally rarer species recorded are associated with the open conditions of recently cut or burned heathland, and suggests that the reason for the high invertebrate diversity of heathland may lie in the periodic disturbance provided by "traditional" rotational burning. He does not distinguish between wet and dry heathland in drawing this conclusion. Aked (*in* NYMNP 1986) provides brief details of a preliminary investigation into the relationship between the soil invertebrate fauna and fire-damaged areas on the North York Moors. Springtails and mites were much more abundant on the unburnt than burnt moorland, which was attributed to the destruction of food sources (including litter and fungal mycelia).

The chief advantage perceived by the authors above in rotational burning is in maintaining vegetation structural diversity, but none consider its significance specifically for blanket bog. Some studies on the invertebrates of *Calluna*, though not undertaken in blanket bog, may be of relevance. Barclay-Estrup (1974) examined the numbers of invertebrates associated with individual plants in the four phases of the *Calluna* cycle (see Section 7.3.1), and the species richness of spiders. Both numerical abundance and species richness were greatest in the pioneer and degenerate phases. Gimingham (1985) reports a similar relationship between *Calluna* age and invertebrate diversity as a whole, with the greatest diversity in the pioneer and degenerate phases, explained in terms of heterogeneity and plant diversity.

Anderson (1986) found striking differences in the invertebrate fauna of burnt and unburnt areas of a moorland in the Peak District (including *E. vaginatum*-dominated bog), recorded one and two years after a severe accidental fire. Different groups of species were affected differently, with many more beetles and harvestmen found one year after the fire on the burnt moor than on the unburnt areas, and significantly fewer spiders and 'other' invertebrates. Differences were less pronounced after two years, as the vegetation started to recover, and could be restored to former numbers in 7–10 years. Clearly, the mobility of individual species is an important factor in recolonisation. The implications for the bird fauna of the moors is discussed – the distribution of breeding birds recorded suggested that they were more affected by changes in habitat structure than invertebrate food supply.

8.3 Grazing

Most of the work on blanket bog invertebrates is examining a fauna on sites which have experienced a long period of grazing. The extensive work at Moor House, in particular, has been carried out on land which has been grazed by sheep for at least a thousand years (Coulson & Whittaker 1978).

Coulson (1988) suggests that cessation of sheep grazing would be likely to lead to increased density of above-ground invertebrates because of increased vegetation biomass, but this opinion is apparently based on extrapolation rather than direct observations or experiment.

Coulson, Fielding & Goodyer (1992) state that "It is unlikely that the grazing of domestic vertebrate herbivores would have a direct effect on moorland Lepidoptera . . . Only on the heaviest grazed sites would it seem likely that competition for food would affect the supply of food for Lepidoptera . . . . If grazing reduces the dominance of *Calluna* and encourages alternative foodplants, then this may benefit Lepidoptera species richness."

McFerran, Montgomery & McAdam (1994) examine the effects of different intensities of grazing by sheep on the ground beetle communities on upland heathland in Co. Antrim, Northern Ireland. Different assemblages of ground beetles were found at different grazing intensities. The most frequently recorded species, *Nebria salina*, increased in frequency in trap samples as grazing intensity increased.

Sheep dung supports a significant fauna (Coulson & Whittaker 1978, Nelson 1971, White 1960), contributing up to 10% of the invertebrate fauna of a site (Coulson 1988) (see also Coulson *et al.* 1992).

8.4 Erosion

Several authors have examined the invertebrates of eroding blanket bog. Block (1966a) showed a steady loss of species richness and abundance with progressive erosion, related to changes in the soil moisture and plant cover. Hale (1966) found similar results with the Collembola. However, Cragg (1961), also reporting studies of Collembola and the work of Banage (1960) on nematodes at Moor House, suggests that the drier areas at the lip-zone of peat haggs are "characterised by a special fauna, which though very local may be abundant". Coulson (1990) (*cit.* Coulson, Fielding & Goodyer 1992) found that some species, such as the ground beetle *Nebria gyllenhali*, recorded from blanket bog eroded into haggs and gullies were not present on nearby intact bog. The northern dart *Xestia alpicola*, a nationally scarce species of moth, which feeds on *Empetrum* and possibly *Calluna*, is said to occur preferentially on eroded bog (Coulson, Fielding & Goodyer 1992). Cherrett (1964) found the spider *Meta merianae* to occur on blanket bog at Moor House only where there was a breach in the bog cover, and to be particularly frequent on the underside of eroding peat edges.

9. The effects of burning and grazing on the principal bird species of upland blanket bog and wet heath

9.1 Introduction

There is very little literature specifically concerning the effects of burning blanket bogs or wet heaths on individual bird species, and we found no substantial quantitative studies of the topic for species other than Red Grouse. The majority of references are general or passing references in papers on other subjects and it is often difficult to tell which are anecdotal and which are soundly based on research. As previously noted, another major problem in searching the literature is that papers often refer to "heather moorland" (or even simply 'upland') without giving a clear definition, and it is therefore often not clear whether dry blanket bog dominated by *Calluna* or blanket bog with abundant or co-dominant *Calluna* is included. We concentrated on those studies revealed by the computer key word search and others which appeared to be directly relevant. It is possible that there may be further information and references embedded in some of the papers on the detailed ecology of each species which utilise blanket bog – time constraints did not permit examination of this literature. Ongoing and as yet unpublished work by Mark Whittingham on Golden Plover and Glen Robson on Curlew will provide more detail on the ecology of these two species including their use of recent burn sites (Brown A.F. *pers. comm.* Feb. 1996). See also Robson, Percival & Brown (1993).

The general habitat requirements of the principal bird species of upland blanket bog and wet heath are reviewed well in Cadbury (1992) and Coulson *et al.* (1992). A review of the relationships between grazing and birds in the uplands is in preparation by R. Fuller (see Appendix 1). This section therefore concentrates on those aspects of particular relevance to blanket bog and wet heath, highlighting the potential implications of burning for characteristic upland bird species. It also reviews the available studies of associations between breeding birds and blanket bog.

Many birds may be able to avoid the direct effects of burning by flying away, but fire may destroy less mobile animals, such as breeding birds or chicks. The main impacts are likely to be indirect, through changes in physical habitat characteristics (see 4.2) and plant species composition (Section 7), the latter affecting both food sources and vegetation structure (see below). It should also be borne in mind that the effects of burning will frequently be exacerbated by grazing (see Section 6). Thompson & Miles (1995) provide a diagram of a simple linear avian moorland food chain under three wet or dry heath regimes (on acid brown earths, humus iron podzols or shallow blanket peat) that shift either to grassland under heavy grazing pressure (or drainage) or through to scrub/woodland where grazing and burning are prevented or greatly reduced (see Figure 9.1).

Since many areas of blanket bog are recognised as being of international importance for their breeding birds (e.g. much of the proposed Peak District and Southern Pennines SPA is blanket bog), it is obviously important to be clear about the potential impact of burning which is still a widespread management practice on many areas of this habitat. In general, there seems to be a presumption against burning blanket bog; for example, Bates, Cole & Tew (1993) suggest that in order to benefit many upland bird populations, burning of blanket bog

should cease throughout upland Wales, or where this is not possible, there should be a minimum rotation of 20 years.

9.2 Indirect effects

9.2.1 Vegetation

Vegetation structure

The principal influence of burning on birds appears to be through altering the structural characteristics of the vegetation, which will affect the suitability of the vegetation for breeding, roosting and foraging by birds. The exact effects will in practice vary according to the frequency and intensity of burning, and the detailed burning pattern on each individual moor/blanket bog (see 4.4). Thus, species such as Dunlin, Golden Plover and Curlew, which 'prefer' short vegetation are likely to benefit from burning (these species are unable to walk and feed in rank heather (Bibby 1988), while others, such as Merlin, Hen Harrier and Short-eared Owl, which favour rank heather for breeding or roosting, may be adversely affected. While the maintenance of some 'mature' heather stands for the latter species may, in theory, increase their populations, Bates *et al.* (1993) point out that it is not clear to what extent, if any, these species are currently restricted by nest-site availability, and in fact mature heather stands may support fewer prey.

There appears to be little research on the impact of the size and pattern of burns on bird species other than red grouse (9.4.4).

Vegetation composition

Another effect of burning, if it is carried out too frequently, is a shift in dominance of the vegetation away from *Calluna* towards *Eriophorum* spp. (4.4.3). This, in turn, is likely to affect the nature of the available vegetable and invertebrate food, but also will have an effect on the structural characteristics of the vegetation (as above) and thereby may affect its suitability for nesting or foraging. The effects of this shift on birds does not appear to have been documented.

Nutritional value of vegetation

The increased nutritional value of young *Calluna* following fire is beneficial to Red Grouse (Watson in Lack 1986). We did not find any references to the effect of this on other birds species.

9.2.2 Soil physical characteristics

Any alteration to the soil structure, especially its permeability (see 4.2), could affect probing species of birds such as Snipe. We found no studies of this topic on blanket bog.

Burning may also cause the drying out of bogs which could affect species such as Dunlin which are particularly associated with wetter areas of bogs and associated pools. Yalden (1974) found that Dunlin avoided the drier blanket bog situations in the Peak District.

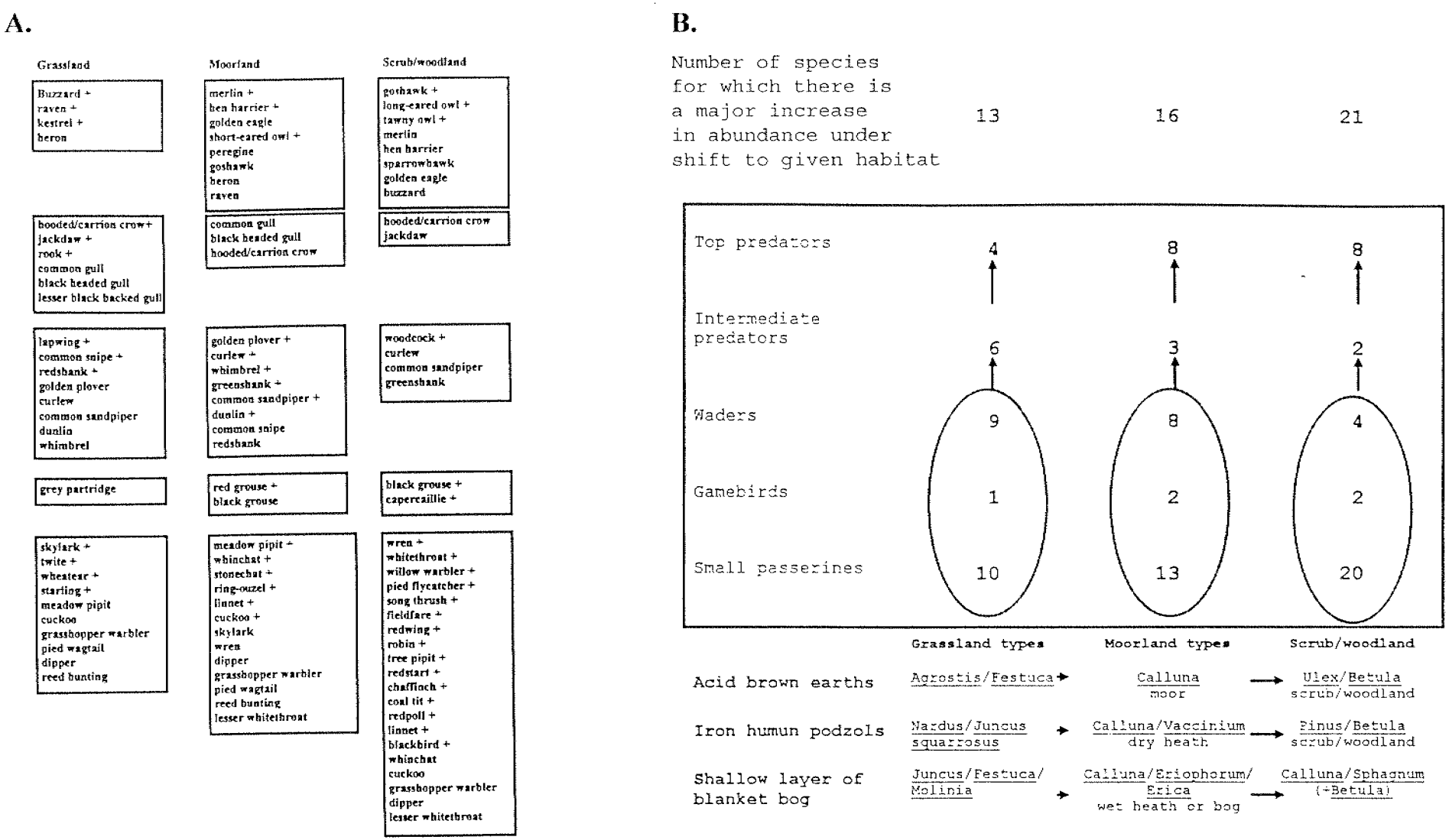

Figure 9.1 Simple linear avian moorland food chain for three wet or dry heath regimes, with change in grazing / burning pressure.
Correspond to shifts either to grassland under heavy burning/grazing pressure, or to early succesional woodland (scrub) where grazing or burning are prevented or reduced.
(From Thompson & Miles 1995: Crown copyright is reproduced with the permission of the Controller of HMSO)

9.2.3 Invertebrate populations

Burning is known to affect the invertebrates of blanket bog (8.2). It is however unclear how much this affects breeding birds. Anderson (1986) concluded that changes in vegetation structure had a far greater impact on the distribution of breeding birds following severe accidental fire on blanket peat than fluctuations in invertebrate populations (see above).

9.3 Accidental summer fires

The effects of accidental spring and summer fires will depend on their size and intensity, which in turn depends on the weather and the original condition of the vegetation (4.5). They can radically affect the habitat for birds. Anderson (1986) studied the effects of a severe accidental fire in Spring 1980 on Harrop Moss/Torside in the Peak District. She found that the extensive areas of burnt heather were mostly avoided by all species except golden plover. Territories of other species were clustered around small pockets of vegetation which had escaped the fire or on the cotton grass which recovered more quickly. It was concluded that it was the change in habitat structure which affected the distribution of breeding birds rather than the fluctuations in invertebrate populations.

In one instance in the Peak District, at Burbage Moor, the bare peat and mineral soils resulting from a severe accidental summer fire attracted Dotterel *Charadrius morinellus* to the site during passage and there were indications of prospecting for territories. Presumably this was because the conditions were mimicking those of their favoured montane heath breeding habitat.

9.4 Species accounts

9.4.1 Introduction

For the purposes of this review we have concentrated on the species which these studies showed to be reasonably strongly associated with blanket bogs. Each of the species accounts given below begins with a summary of what appears to be known about the degree of association of that species with blanket bogs. It then goes on to review what is known about the breeding and feeding requirements of the species on blanket bog. Where specific studies of requirements or detailed habitat use of blanket bog are not available, an attempt has been made to summarise what is known about the requirements of that species in relation particularly to the structure of the vegetation and the nature of the substratum in similar moorland or heathland habitats. This may give a clue to the potential impact of burning of blanket bogs on the species. Any winter usage of blanket bog habitat is also noted. Each account concludes with a summary of what the potential impact of burning blanket may be on the species.

9.4.2 Waders

Curlew *Numenius arquata*

Breeding in the S. Pennines is not strongly associated with blanket bogs (e.g. Stillman & Brown 1994) but strongly associated with high plateaux (Haworth & Thompson 1990). In the E. Highlands of Scotland, Brown & Stillman (1993) found the occurrence of curlew to be negatively related to the cover of bog.

The exact conditions in which Curlews may nest on blanket bogs do not appear to be well documented. It may however be reasonable to infer that fresh burns might be suitable on drier blanket bogs from the findings that on dry moorland they generally breed on fresh burns (Baxter & Rintoul 1953; Blair 1961; Brown 1995a). They often avoid *Calluna*-dominated areas (Grant: *cit.* Gibbons, Reid & Chapman 1993). According to Cadbury (1992), however, they nest in taller vegetation (70–80 cm).

Wet marshy ground is selected for feeding (Coulson *et al.* 1992). Chicks feed in damp areas with short vegetation (Cadbury 1992). Nearby pastures and other cultivated habitats appear to be important for feeding (Cadbury 1992; Gibbons *et al.* 1993).

We could find nothing in the literature specifically about the effects of burning blanket bog on this species. However, from the above it might be reasonable to infer that burning may be beneficial for this species, especially near the edge of blanket bogs. An English Nature-supported PhD study (researcher: Glen Robson) is currently in progress on the breeding ecology of curlew, which should provide some useful information.

Dunlin *Calidris alpina*

Typical breeding habitat in Britain is poorly drained upland moors (up to 1,000 m altitude) with small scattered pools (Sharrock 1976). 39% of the British breeding population occurs in the Flow Country where they show a preference for *Calluna–Eriophorum* mires with an abundance of dubh lochans (Stroud *et al.* 1987). Haworth & Thompson (1990) and Stillman & Brown (1994) found that Dunlin favoured the high plateaux and *Eriophorum* bog in the S. Pennines. Yalden (1974) found that drier areas of eroded peat-hagg and moors without pools tend to be unsuitable.

Nests are usually concealed in *Eriophorum* tussocks (Cadbury 1992).

Feed mainly on *Chironomidae* and *Tipulidae* larvae occurring in wet pools and *Sphagnum* hollows (Holmes 1966).

We were unable to find any specific references to the effects of burning. However since burning can lead to drying of blanket bogs this may well be detrimental to Dunlin (see Yalden 1974).

Golden Plover *Pluvialis apricaria*

Stillman & Brown (1994) showed that Golden Plover are positively associated with blanket bog in S. Pennines. In the same area Haworth and Thompson (1990) showed them to be positively associated with high plateaux and *Eriophorum* and *Calluna /Eriophorum*. Yalden (1974) reported that in the Peak District, Golden Plover breed in wet and dry *Eriophorum*-dominated blanket bog and the closely associated *Empetrum–Vaccinium* heath, preferring to use areas which have been recently burnt or with short turf. 18% of British breeding population occur in the Flow Country (Stroud *et al.* 1987) where they show preference for breeding in *Calluna–Eriophorum* mire communities. Golden Plover on Islay also showed a preference for bog vegetation-types (Bignal, Curtis & Matthews 1988).

Ratcliffe (1976) states that Golden Plovers prefer to breed on flat or gently sloping ground (<10%), in vegetation <15 cm tall, and they favour the intermediate phases of heather re-growth after fire in preference to very early stages, usually breeding on sites which have been burnt within the last 8 years. Cadbury (1992) states that birds nest in very short vegetation (< 15 cm) and bare areas where the bird has good all round visibility and the chicks can feed.

Anderson (1986) found some evidence that Golden Plover benefited from the short vegetation created by the accidental fire on Torside (Peak District).

Very wet areas are avoided as nest sites (Coulson *et al.* 1992).

Golden Plover require short vegetation for feeding (Cadbury 1992). It is unclear from the literature how important recent burns on blanket bog are for feeding. The majority of adult feeding occurs off the moor, although unpublished work by Mark O'Connell apparently indicates that during chick rearing one bird stays close to the chicks whilst the other is feeding within sight on the moor (Derek Yalden *pers. comm.*). Flushes are important feeding areas especially later in the season when the spring invertebrate peak on blanket bogs has declined (Parr 1980; Coulson *et al.* 1992). Nearby base-rich soils and grasslands are also particularly important feeding areas (Coulson *et al.* 1992).

The benefits of grouse moor management (including burning) for Golden Plover are disputed. Brown & Stillman (1993) state that there do not appear to be quantitative data to support the belief that Golden Plover are associated with management for red grouse. Haworth & Thompson (1990) found no association between Golden Plover and *Calluna* moorland. Thompson & Boobyer (*in* Gibbons *et al.* 1993) state that many grouse moors have few Golden Plovers. Thompson & Boobyer also state however, that breeding densities are generally high (>10 pairs per km^2) on heather-dominated, short rotation burned moors, especially those juxtaposed with pasture land!

The abandonment of controlled burning on heather moors may have contributed to a 50 % reduction in Golden Plovers on the northern foothills of the Cairngorms since 1960 (Cadbury 1992). Harding, Green & Summers (1994) amongst others, postulate that Golden Plover would be adversely affected by a reduction or cessation of burning of heather moorland (NB. Again it is unclear whether they include heather-dominated blanket bog). On the North York Moors, there was some evidence that the distribution of Golden Plovers was influenced by the availability of short vegetation for nesting, and thus indirectly by the effects of fire (NYMNP 1986).

English Nature are currently supporting a study on the breeding ecology of Golden Plover (researcher: Mark Whittingham).

Greenshank *Tringa nebularia*

In Britain, Greenshank mainly breed in the pool-dominated and boulder-strewn blanket bogs of the NW and central Highlands of Scotland, usually nesting beside a rock. Highest densities occur where feeding habitats (pool complexes and rivers) are densely packed. On grouse moors and drier bogs, densities are lower (Gibbons *et al.* 1993).

Greenshanks require short vegetation and the cessation of muirburn can lead to their demise (Nethersole-Thompson & Nethersole-Thompson 1979).

Greater detail of breeding biology can be found in Thompson & Thompson (1991).

Lapwing *Vanellus vanellus*

This is predominantly a grassland species and blanket bog does not appear to support significant populations (Gibbons *et al.* 1993). Brown & Shepherd (1991) found that where lapwing occurs on moorland in the South Pennines, it is usually near the moorland fringe. Stroud *et al.* (1987) state that in the Flow Country it is mainly a species of grassland and

arable land and not strictly a peatland wader, although they found the site with highest breeding density (1.92 pairs km^{-2}) was on a peatland site.

Cadbury (1992) states that those that do nest on unenclosed moorland tend to do so on heavily grazed commons, grazed fringes of heather moor and where limestone outcrops produce 'islands' of heavily-grazed grassland on otherwise acidic peatland. Coulson *et al.* (1992) state that on blanket bog and heath, Lapwing tend to be associated with patches of well-grazed grassland on mineral soils where rocks outcrop along stream sides. They also state that they sometimes breed on patches of recently burned heather moor but as earthworms are an important component of the diet, nearby mineral grasslands are important for feeding.

From the available literature, the burning of blanket bog does not appear to be a particularly significant factor for this species.

Redshank *Tringa totanus*

Inland, Redshank breed primarily on wet grassland (Gibbons *et al.* 1993). Blanket bog does not appear to be a particularly important habitat for this species. Even in the Flow Country breeding Redshank are decidedly sparse: 0.2 pairs km^{-2} and less (Reed, Langslow & Symonds 1983).

Haworth & Thompson (1990) however found that redshank were closely associated with *Eriophorum* bog in their study area in the S. Pennines.

Those Redshank that breed on moorland appear to favour mosaics of short heather, flushes and turf (Reed 1985).

We found no specific comments about the effects of burning blanket bog on this species in the literature.

Snipe *Gallinago gallinago*

Gibbons *et al.* (1993) quote Snipe as breeding widely on moorland bogs (type not defined). However, Stillman & Brown (1994) found them to be negatively associated with bog in the S. Pennines. In the Eastern Highlands of Scotland these authors found no significant relationship with any habitat features (Brown & Stillman 1993). In Caithness and Sutherland their breeding distribution was strongly determined by the distribution of feeding habitat (Stroud *et al*, 1987) i.e. wet, rank flushes with abundant cover of *Juncus*.

Snipe nests are usually well concealed among tussocks and coarse grasses including *Eriophorum* spp. (Cadbury 1992). Nests are particularly associated with dense stands of *Juncus* (Baines 1988).

Wetness of the soil is important during the breeding season since they probe for food (earthworms and tipulid larvae) with their bills (Cadbury 1992). Most feeding localities have sparse vegetation 10–30 cm high (Coulson *et al.* 1992).

We found no mention of the effects of burning of blanket bog on this species.

It may be reasonable to assume that Snipe would be adversely affected by burning either where it leads to the drying out of blanket bog or where severe fires have caused the removal of the acrotelm and the formation of a surface layer of algal origin with low permeability (Conway & Millar 1960; McVean & Lockie 1969: both *cit.* Coulson *et al.* 1992).

9.4.3 Raptors

Merlin *Falco columbarius*

Ground nesting Merlin prefer dry, steeply-sloping areas of heather moors and bracken beds (Haworth & Thompson 1990). A few Merlins nest on level flow ground in Caithness and Sutherland (Ratcliffe 1990).

They require open ground for hunting (English Nature 1994c) which may well include blanket bog adjacent to their preferred drier heather moorland (Ratcliffe 1990, for instance, quotes them as often seen on the Flow Country of Caithness and Sutherland).

In winter, Merlin use roost sites in rank vegetation (Cramp & Simmons 1980). It is unclear from the literature whether or not this includes any blanket bog sites.

Burning of blanket bog is therefore unlikely to be a significant issue for this species except on drier sloping ground, or in as far as it may affect the populations of its main prey the Meadow Pipit or the availability of rank vegetation.

Short-eared Owl *Asio flammeus*

Heather moorland is the main habitat for this species (Gibbons *et al.* 1993). It is unclear from the literature to what degree they use blanket bog. Stroud *et al.* (1987) recorded several pairs breeding in the Flow Country, although Haworth & Thompson (1990) found that in the S. Pennines they avoided using blanket bog for breeding.

Like other raptors they will hunt over blanket bog (Ratcliffe 1990). It is not clear from the literature what effect the burning of blanket bogs has on its main prey species, the field vole.

Hen Harrier *Circus cyaneus*

Has a strong breeding preference for undulating moorland usually below 500 m. They apparently avoid extensive mires (Gibbons *et al.* 1993). English Nature (1994b) however states that they breed principally in long rotation dry heath and unmanaged blanket bog, preferring old deep heather (35–60 cm deep) for their nest sites (see also Bignal, Curtis & Matthews 1988). In some situations, this could lead to a conflict in conservation objectives, for example, in sites where suitable habitat has developed as a result of degradation.

Hen Harriers prefer large open areas for hunting (Clarke in Lack 1986). As with many other raptors there are often several distinct habitat types within a single hunting territory (Cramp & Simmons 1980). Thus birds nesting on dry moorland may feed on the edges of adjacent blanket bog (Ratcliffe 1990).

Harding, Green & Summers (1994) postulate that reducing heather burning is likely to be beneficial to breeding Hen Harriers. Thus, on drier blanket bogs with abundant heather, a decrease in burning may benefit Hen Harriers and an increase may be detrimental to them.

Low altitude dry blanket bog with old leggy heather in the Peak District is used by Hen Harriers for winter roosting. It is unclear to what degree burning may affect the suitability of these types of sites, but it could be detrimental.

Other raptors

Other species which do not nest or roost on the ground such as Peregrine *Falco peregrinus*, and in Scotland, Golden Eagle *Aquila chrysaetos*, hunt over blanket bog (Ratcliffe 1990). We

did not find anything in the literature on the effects of burning blanket bog on the feeding success of these species. It seems unlikely however that 'normal' moor burning will have a significant impact on either of these species.

9.4.4 Game birds

Black Grouse *Tetrao tetrix*

Depends on a mosaic of habitats on the edge of moorland. Stroud *et al.* (1987) report that Black Grouse are not an important component of the peatland bird fauna in Caithness and Sutherland.

In the uplands, the flowers of cotton grass are frequently taken by females prior to laying and incubation (Cadbury 1992; Gibbons *et al.* 1993). Blanket bogs are therefore an important component of the habitat mosaic upon which many populations of Black Grouse depend. However, English Nature (1994a) states that the chicks seem to avoid areas of heather and blanket bog, presumably as they lack high densities of sawflies (which provide a food source).

Burning of blanket bog/heath has long been used by farmers in order to stimulate a flush of new growth and a greater flowering of cotton grass. This may be of benefit to Black Grouse as well as Red Grouse (see below) especially near to woodland (Harding, Green & Summers, 1994) and near the edges of blanket bog.

Red Grouse *Lagopus lagopus scoticus*

Due to its economic importance, the detailed ecology and management requirements of Red Grouse and its relationship with burning are very well documented elsewhere (e.g. Watson & Miller 1976; Hudson 1986, 1992; Hudson & Newborn 1995). This material is summarised only briefly here. Lawton (1990) provides a detailed summary of the issues surrounding the dynamics of red grouse populations and moorland management. Iason (*in* Whitby & Grant 1990) reviews the ecological interactions between sheep and red grouse on grouse moors.

Grouse are most abundant on the more productive, drier moors of the east – in the west, heather grows more sparsely. Red grouse are widespread throughout the peatlands of Caithness and Sutherland (Stroud *et al.* 1987). Breeding Red Grouse did not show a significant correlation with bogs in either the S. Pennines (Stillman & Brown 1994) or the Eastern Highlands of Scotland (Brown & Stillman 1993) although it is not clear in either of these studies whether dry blanket bog is included in their classification of bog.

Grouse prefer a patchy mosaic of heather of different ages, to provide both food and shelter in close proximity – these mosaics are created by careful use of patch burning, often coupled with some grazing. Grouse need some old *Calluna* for cover and shelter. Sheep, cattle or deer can graze tall heather so severely that it becomes very short over a large area, having the same effect on grouse as a big fire: none will settle to breed. However, they will colonise within 2 or 3 years of fences being erected (e.g. for new forestry). Grouse are often more abundant where hillocks and peat haggs break up the ground than in featureless places. Anderson (1986) found that following a severe accidental fire on blanket bog, Red Grouse either nested in adjacent unburnt heather or in areas of cottongrass or mixed moor which recovered their structure more quickly after the fire.

Wet areas including blanket bogs are important parts of the red grouse habitat, particularly for feeding (Cadbury 1992); diet depends on the availability of different food sources. Grouse

feed largely on the shoots and flowers of *Calluna* (preferably 2–6 yrs old) which makes up nearly all their diet in winter and most of it in summer. They also eat smaller amounts of e.g. stalks & leaves of *Vaccinium myrtillus*, flowers & shoots of *E. vaginatum* and seeds of *Juncus squarrosus*. The flowers of *Eriophorum* spp. form a highly nutritious source of protein utilised by female grouse in early spring during egg formation and laying (Hudson 1992). The insect food available in bog flushes and damp areas with plenty of *Sphagnum* in spring and early summer is important for Grouse chicks (Hudson 1983). Insects, particularly craneflies, are also an important source of nutrients for adults on blanket bog moors (Butterfield and Coulson 1975), and the chicks eat insects in their first few weeks.

Although the practice is widespread, Hobbs (1984) found that the burning of blanket bog does not lead to an increase in grouse populations in the same way as it does on dry heather moorland. Hobbs & Gimingham (1987) attribute this to the associated decline in *Calluna* cover.

Although Red Grouse remain on moorland throughout the year, *The Atlas of Wintering Birds* (Lack 1986) does not specifically mention blanket bogs.

The effects of burning blanket bog *per se* on Red Grouse are therefore somewhat unclear – some work is in progress which should provide some elucidation (see Section 11).

9.4.5 Other characteristic species

Meadow Pipits *Anthus pratensis*

Meadow Pipit is the most numerous of the small passerines on the blanket bog of the Flow Country (Stroud *et al.* 1987) being particularly associated with *Calluna*-dominated heaths. Brown & Stillman (1993) found no significant association with any form of vegetation in the Eastern Highlands of Scotland.

Meadow Pipits usually nest in tussocky vegetation and on blanket bog they tend to nest at the interface between heather and mineral grasslands (Coulson *et al.* 1992), 86% of food for the first brood coming from the blanket bog and 65% of the food for the second brood coming from the grassland (Coulson 1956).

Anderson (1986) found no preference for burnt or unburnt sites following severe accidental fire. We found no other references to the impact of burning on Meadow Pipit.

Skylark *Alauda arvensis*

Brown & Stillman (1993) found a positive correlation between Skylark and flush / bog mosaics in the Eastern Highlands of Scotland. Stroud *et al.* (1987) found Skylarks to be the second most common breeding passerine on the blanket bogs of the Flow Country; they also found a positive association between Skylarks and grass-dominated areas. Fuller (1982) states that Skylarks prefer to nest in grassland and avoid heather and bilberry except when grazed.

Skylark nest more frequently on thicker grass than short turf (Coulson *et al.* 1992).

Anderson (1986) found no preference for burnt or unburnt sites following severe accidental fire. We found no other references to the impact of burning on skylark.

Twite *Carduelis flavirostris*

There appears to be little in the literature linking Twite with blanket bogs, although they can be found breeding on moorland edges and are often associated with steep slopes (see e.g. Haworth & Thompson 1990; Stillman & Brown 1994). Cadbury (1992) implies that blanket bogs are of minor importance for nesting, brooding or roosting although tussocks of *Eriophorum vaginatum* are frequent nest sites in some areas of the Pennines. McGhie *et al.* (1994) showed that in the south Pennines, whilst there was a strong selection of long heather and bracken for nesting, the main Twite food sources were dandelion and sorrel from enclosed farmland.

English Nature is currently supporting work on the breeding ecology of Twite.

Gulls

A noteworthy feature of blanket bogs is the occurrence of sizeable gull colonies (Ratcliffe 1990) in several areas. Colonies of black headed, common, lesser black-backed, herring and greater black-backed gulls occur in different locations. By far the largest, on the Bowland Fells, occurs mainly on degraded and eroded blanket bog. Large colonies of breeding gulls on blanket bog can cause substantial damage and enrichment (Lindsay *et al.* 1988).

It is unclear from the literature we have searched whether burning has any significance in relation to these colonies.