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Grazing heathland: a guide to impact assessment for insects and reptiles

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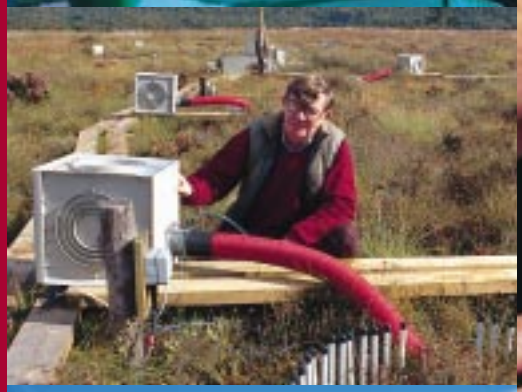

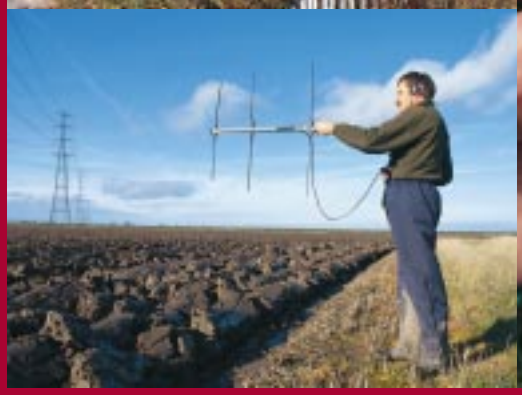

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Grazing Heathland: A guide to impact assessment for insects and reptiles

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Summary and conclusions

- Grazing is now often considered a suitable tool for managing land of conservation interest. Appropriately managed grazing will deliver a variety of benefits for flora and fauna on such sites. However, inappropriate grazing can have serious adverse consequences for such organisms unless their needs are taken into account. This report sets out a process, called Grazing Impact Assessment (GIA), that helps identify and assess potentially adverse impacts of grazing on sensitive fauna.
- The Hampshire Grazing Project hosted a series of meetings beginning in 2001 to discuss concerns expressed by entomologists about the adverse impacts of grazing on insect populations. From these meetings it was clear that there was a need to provide information about the habitat needs of insects to site managers, so they could make more informed decisions. This lead to the initial development of the grazing impact assessment concept. English Nature then supported the further development of the concept using heathland insects and reptiles as test subjects, which is presented in this report.
- The GIA is not a tool for developing a conservation grazing regime from first principles. Guidance for deciding stock rates, timing, intensity and stock characteristics should be sought from alternative sources. However, a site manager wishing to apply the technique will need to have decided upon a grazing regime for delivering their conservation objectives prior to conducting the GIA. The GIA will then identify potentially adverse impacts and thus highlight potential necessary adjustments to the grazing regime.
- The process presented in this report comprises five steps, which begin with the identification of important features on a site and lead to the development of adjustments to the proposed grazing regime. It should be seen as a prototype, which may need further refinement in line with the experience gained in applying it to different situations.
- This GIA has been produced for heathland insects and reptiles. However, the technique could be equally applied to different habitats and other groups with development of additional assessment tables. In the first instance, an impact assessment for insects on key grassland habitats should be considered. Such areas are

commonly subject to grazing management aimed at delivering a particular floristic community potentially at the expense of the insect fauna.

- Training in the technique would help those wishing to apply it to be better able to do so. At a field testing seminar run during this project, participants gained better understanding from guided application of the technique than from previously supplied written material. Furthermore, promotion of the technique to a wider audience is required and it is proposed that an article on Grazing Impact Assessment be submitted to British Wildlife.
- The outputs from the GIA (a list of features at significant risk of adverse impact due to grazing) can potentially be linked into other site management tools, particularly the Countryside Management System (CMS) computer package.
- There is potential for the GIA to be developed into a computer-based (or web-based) tool. This would be a more efficient means of handling the large amounts of data contained within the various tables contained in this report. A web-based package could be flexible, linked to other sources of more detailed information and would, most importantly, be updateable on a regular basis to ensure that the information contained within it is current.
- Grazing Impact Assessment provides a means by which site managers can deliver effective grazing on conservation sites without compromising the requirements of the very species that they are seeking to conserve. It collates for the first time within a single document a large amount of information about the species of insects and reptiles associated with important features on heathland.

We would welcome any comments on the report, including the provision of additional data. This should help to refine the GIA and could be very valuable if the process is expanded to cover other habitats (e.g. grasslands) or other species groups which could be affected by grazing (e.g. birds). Please send your comments to:

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Contents

1. Introduction

Appropriately managed grazing delivers a wide range of conservation benefits and provides more habitat diversity than is generally possible through alternative (manual or mechanized) techniques. However, the activity of grazing animals may also disrupt features upon which certain species or groups depend. Thus grazing like any management activity should be carefully considered, controlled and monitored by the site manager.

During 2001 the Hampshire Grazing Project arranged several technical seminars on integrating the needs of insects with grazing management. Following these the project arranged a series of meetings to identify and discuss the concerns expressed by entomologists about the adverse impacts of grazing on insect populations. It became evident that there was a need to inform site managers about the habitat needs of insects, so they could make more informed management decisions, particularly in respect of grazing. This lead to the initial proposal for the grazing impact assessment concept, which was presented to meeting about grazing of lowland heathlands in Peterborough in April 2002. English Nature then agreed to support the further development of the concept using heathland insects and reptiles as test subjects.

The Grazing Impact Assessment (GIA) that has been developed covering heathland insects and reptiles therefore seeks to address concerns expressed by entomologists and herpetologists about the potential adverse impacts of inappropriate grazing on these groups. The GIA will enable managers to identify key features that should be considered before grazing commences or monitored for disruption as grazing progresses.

The underlying assumption behind the GIA is that grazing provides overall benefits for flora and fauna and that it helps deliver objectives on a conservation site. The GIA can be used to adjust grazing regimes to maximize benefits and minimize undesirable or inadvertent impacts on features of importance for key species of invertebrate and reptile.

2. Terms used in this report

Certain terms are used with specific meanings in this report, as outlined below.

A. **FEATURE:** *Part of a habitat used by an invertebrate or reptile to complete its life cycle.*

Areas of bare, loose sand are 'features' required by sand lizards in which to deposit their eggs.

B. **HAZARD:** *What can happen to disrupt this feature as a result of management (and in turn affects a given species of invertebrate or reptile).*

A feature such as the flowers buds of sallow *Salix cinerea* may be grazed by livestock in early spring thus removing a potential nectar source at a time of year when other sources are very scarce or even absent.

C. **RISK:** *The likelihood of associated species being disrupted as a result of disruption of a particular feature through management.*

The extent to which a feature is likely to be affected by grazing stock will depend upon its relative abundance and palatability. For example, pine *Pinus sylvestris* is much less likely to be affected by grazing animals than purple moor-grass *Molinia caerulea*, which will be grazed preferentially in the early part of the year. In addition to the risk to feature itself from grazing stock, the level of risk also incorporates the degree to which dependent species will be disrupted by changes to the feature on which they depend.

D. **IMPACT:** *The effect of the disruption of a feature on a given species or faunal group.*

The depletion of a range of nectar sources from the flowery verges bordering a heathland at key times of year as a result of grazing, is likely to have negative impacts on dependent species and may even result in extinction of those species from a site.

3. Managing for features

3.1 Implications of management decisions

Management decisions result in change, whether as a result of active intervention (e.g. clearing, mowing, burning or scraping) or due to inevitable natural succession where no intervention takes place. Such change will affect the flora and fauna occurring within a particular habitat and may alter the range of species that are able to live there.

While habitat change is often necessary and beneficial, it can also adversely affect species associated with and adapted to particular conditions. This is a particular problem with smaller sites on which it is more difficult to include a full range of successional stages for the habitat. However, short-term change resulting from management is often unavoidable and inherently necessary to maintain the desired habitats in the longer term. The skill of the site manager therefore lies in judging the extent and level of disruption that the fauna can tolerate but that will still secure desired habitat features in the longer-term.

3.2 What we mean by 'heathland'

Heathlands are traditionally defined by the range of plant communities that have developed on suitably infertile acid soils under the influence of a mild oceanic British climate, with local and regional variation governed by factors such as drainage, topography, underlying geology, geographical location and, significantly, past human influence. Typically, heathlands are seen as dwarf shrub communities, dominated by ericaceous shrubs with small lawns of acid grassland. Historically, heathlands are the product of human intervention to provide fuel, wood products and forage for livestock. Thus, the plant and the faunal communities of heathland are, by definition, those that can withstand some grazing pressure.

However, other plant communities and habitats (e.g. bare ground) are commonly associated with the dwarf shrub communities of heathland, including areas of bracken *Pteridium aquilinum*, dense gorse *Ulex* sp), scrub, woodland (edge), and even non-acidic grassland.

These associated habitats are of great importance to the fauna typically found on heathland. For example, the flower-rich verges bordering a heathland can provide nectar sources for heathland insects at times of year when such sources are absent or scarce on the heathland itself.

Heathlands can, alternatively, be defined in terms of the physical environment that they provide; temperature/humidity regimes and/or soil structures that result from their geological origins. However, such physical regimes can be present where 'typical' heathland vegetation is absent. For instance, dunes provide similar physical environments (bare ground, loose sand, warm microclimates) and thus often share similar faunal assemblages to heathland. Furthermore, heathland-type vegetation often develops on established coastal dunes as the calcium in the sand is leached out and many relict inland dune systems (e.g. in the Netherlands and the Brecks of Eastern England) are commonly referred to as 'heathlands'.

As far as insects are concerned, if the reason for their presence on a site stems from the temperature/humidity regimes or physical structure of the soil, it may make very little difference whether 'typical heathland' plants are present or not. Indeed, some heathland insects may utilize more widespread plant species, but only when typical heathland temperature/humidity/soil structure conditions are also present.

Similarly, the great importance of heathland for native British reptiles is primarily a product of the environmental conditions that prevail (which is also linked to the physical structure of various habitats at certain stages of succession), rather than the presence of any particular plant species. Consequently, reptiles such as the sand lizard *Lacerta agilis* and smooth snake *Coronella austriaca*, which are strongly associated with lowland heathland in Britain, thrive in a much wider range of habitats wherever the climate is more favourable elsewhere in Europe.

Heathland is therefore defined in this report in its broadest sense, in landscape and physical terms as well as a series of specific plant communities. This definition not only encompasses the more easily recognised and accepted heathland plant communities themselves (and their various successional stages), but also the other 'peripheral' vegetation types that occur on most sites and, importantly, the specific physical environments and soil structures typical of all these habitats.

3.3 Considering the impacts of grazing

Grazing is generally considered an appropriate tool for managing semi-natural habitats found on sites of nature conservation value and it has received much coverage in the conservation press over recent years. Grazing of heathland can deliver benefits for flora and fauna provided that it is appropriately managed so that adverse impacts are minimised.

Some of the perceived problems associated with grazing livestock on heathland originate from attempting to achieve inappropriate management goals, such as scrub control, through grazing. These have tended to result in overly high stocking rates or long grazing periods that produce excessive disruption to features important for key species such as reptiles and insects.

Grazing can produce substantial change to a habitat and, as we have suggested earlier, such change can be beneficial for some organisms while being detrimental for others. The

photographs in Figure 1, Figure 2 and Figure 3 show how an area of purple moor-grass *Molinia caerulea* dominated grassland has changed due to continuous light grazing over three years. It is evident from these photographs that a substantial change has occurred, particularly in the structure of the habitat. Whether this change is desirable depends upon the conservation objectives that were defined for the site prior to grazing. However, such radical change will undoubtedly have changed the diversity and range of fauna associated with the habitat.

If grazing animals are to be used as management tools in such a situation it is not enough to refer to 'tradition' or 'more natural' as the justification for a particular management regime. We need to be much more scientific in our approach - *what* is it we need to provide in the habitat and *how* may this be achieved?

The tendency within the conservation movement has been to seek extensive grazing solutions for conservation sites, grazing low numbers of animals over large areas in a bid to mimic a 'natural' system. Unlike human intervention, which commonly involves localised, short-term, high-level disruption, grazing under extensive systems produces progressive, often widespread modification of a habitat over a period of days, weeks, months or even years. These latter processes exert a steady pressure on the direction of succession and produce a different result from that provided by so-called non-intervention, or local catastrophes such as ground disturbance, burning or occasional very hard grazing.

Furthermore, extensive systems rarely result in even grazing pressure across a site due to variations in the availability and attractiveness of forage to stock. This variation in grazing pressure can result in detrimental grazing of particular features on a site to an extent that was not previously anticipated.

An alternative to long-term extensive grazing regimes is to see grazing animals as management tools (i.e. biological mowers), and utilise them at high grazing densities over short periods in localised areas to periodically re-set succession. Occasional, localized catastrophic events are more easily borne by populations of most organisms than regular, individually small but widespread, disruptive events, such as those provided by low-density, year-round grazing.

One of the influences of grazing is to open up small patches of bare ground where seeds can germinate, increasing plant diversity. These bare patches also contribute to the maintenance of warm microclimates. Such benefits are often not apparent for insect and spider species until the second year after grazing has ceased in an area, as the insect species will be competing with grazing animals for the same plant resources.

However, even grazing for short periods can disrupt a feature at a time crucial to an organism's lifecycle. Furthermore, repeated grazing in the same area at the same time of year for a number of years may have serious adverse impacts on the particular organisms. Thus, it is important to consider, not only when grazing should take place during an annual cycle, but also whether it should occur at the same time in the same place from year to year. Grazing rotations may therefore need to be designed over several years, rather than an annual cycle.

Figure 1 - Area of *Molinia caerulea* grassland prior to extensive light grazing.

Figure 2 – Area of *Molinia* grassland after one year of continuous light grazing.

Figure 3 - Area of *Molinia* grassland after two years of continuous light grazing.

Which method, or combination of methods, should be employed in specific situations requires a lot of thought, and probably experimentation, as individual sites will respond differently to management due to local variations in conditions such as topography and hydrology.

3.3.1 Grazing and insects

Through grazing preferentially, animals will remove palatable plants and affect other features thus reducing their availability for associated insect fauna. However, the very plants and/or features, which the insects depend upon, may themselves be reliant on grazing or management to ensure their continued presence on a site over time through the processes such as the control of competitors or encouragement of seed germination through soil disturbance.

Management for conservation normally seeks to maintain and enhance particular habitats and assesses success by the delivery of a floral community typical of that habitat. However, although a characteristic flora is present, this may exist in a form unsuitable for particular species or groups that utilise it. For example:

- grazed gorse *Ulex* sp. has a different form from that of un-grazed gorse and flowering or bud-burst will tend to be later. This can disrupt invertebrate species which have their emergence timed to the normal flowering/leafing period, or which use tall gorse as a scaffolding, such as many spiders;
- fly and beetle species which complete their development in seed heads cannot do so in the absence of these. Some species which use the seed head as a shelter during their vulnerable pupation period require this to be present for up to a year.
- spiders which need tall grasses, including purple moor-grass, from which to hang their webs cannot do so when the tall grass component has been removed by grazing.

To illustrate the complex inter-relationships between insects and the features of heathland that they utilise, two case studies have been provided below. These highlight some of the problems that site managers may encounter while attempting to deliver a range of habitat and species management objectives.

Case Study 1 The pompilid wasp *Homonotus sanguinolentus*

Ecology

In the UK this wasp is totally restricted to heathland in the south. It preys on a specific spider species, *Cheiracanthium eraticum*. The spider lives in the damper parts of heathland (among other habitats) where it preys on woodlice and other ground-dwelling insects. Between late June and August the female spider prepares to lay her eggs. She makes a purse-like web, about 30cm above the ground, by spinning together flowering grass stems, flowering heads of heathers or leaves of small bushes. She lives in this web until she has laid her eggs and the young have hatched. She leaves the web at night in order to forage.

The wasp, which only hunts in warm weather, forces its way into the spider purse-webs. If it finds a female spider, which is ready to lay its eggs, the wasp quickly paralyses it with a sting and lays its own egg on the front of the spider's abdomen. Although the spider apparently revives, it never leaves the web again, nor does it lay any eggs. The wasp larva hatches within three days proceeds to suck the spider dry, finally killing the spider after about ten days and eating the remains (but not the very hard claws or mouth-parts). The wasp larva then spins its cocoon within the spider's web, which needs to remain intact until the following July when the new adult wasp emerges.

Requirements

i) Sufficient prey insects to feed the spider;
ii) A large enough population spiders to supply prey for the wasp; and
iii) A high probability of spider webs surviving, in situ at least until the following spring and, at the least in a dry position, until the following July.

Areas that support the wasp must therefore have a good amount of taller vegetation present during the full twelve-month period. However, as the heather canopy closes over, the microclimate between the taller vegetation becomes colder and less suitable for the spider's prey and hence the spider. The wasp must also be warm in order to subdue its prey quickly: remember the spider is a formidable predator itself.

Management

This is a typical situation where the desired mix of vegetation and physical characteristics is temporary and where appropriately targeted grazing offers can periodically re-set the succession to maintain the desired features.

This might be achieved by:

- rotational localized high density grazing over a span of several years (untried);
- very low density grazing (but note only one part of the whole New Forest area meets this condition of grazing and without control of the stock levels this can be severely compromised); or
- rotational cutting (implemented effectively on Forestry Commission lands);
- intermittent burns (unplanned management, but spider/wasp system still well represented on urban heath within Bournemouth).

Although the latter three techniques are known to provide suitable habitat under specific conditions there is doubtless room for others, hence the inclusion of localized, high density grazing. Whatever management technique is chosen, it is important that dramatic changes to the vegetation structure are not regularly inflicted over the entirety of available habitat at any one time.

Case Study 2 Assemblage of insect species associatd with aspen *Populus tremula* suckers on seepage lines within heathlands

Ecology

Aspen is not a tree only associated with heathlands and many of the nisect species associated with this plant are not restricted solely to heathland either. However, aspen is often found growing in a heathland context in situations that provide ideal conditions for the growth of young suckers extending into warm, open conditions.

This is because

- seepages are frequent in heathland situations;
- aspen is now seen as a weed in commercial forestry and is often systematically removed (this was not always so, it was important for making clogs and arrows); and
- most woodlands have become very dark and overgrown, removing the warmth needed by the associated insects.

As a result, heathland supports a significant contemporary aspen resource and large populations of aspen-associated insects (a very large number, well over 100 species), which are consequently associated with heathland situations.

Implications

Aspen can be very invasive, when conditions are suitable, commonly spreading by suckering at the base of established stands. No heathland manager should tolerate significant losses of overall heathland habitat to this species but it is important to understand that it has a role within the heathland ecosystem.

In any case, as it is the smaller suckers growing in open, warm conditions which are the important insect food resource, management of this feature should aim to restrict the natural transition from suckers to tall, mature trees. However, some examples of this tree component should be allowed to develop within the stand, as these are also an important resource for various insects.

Grazing animals are very fond of aspen leaves and young twigs and will therefore browse suckers heavily. This creates competition for the resource between the grazing animals (management tool) and insects (conservation aim) that also feed upon the aspen.

The site manager therefore needs to understand the way in which this competition is resolved:

1. do the insects lose out to the grazing animals, with a consequent loss of associated insect species? or
2. do the animals lose out to the insects, with an eventual probably loss of insect habitat due to the evolution of tall, dense stands of aspen and a considerable loss of open heathland?

For a site manager employing grazing animals to manage their site, this potential confict needs to be resolved. It may be necessary to adjust the grazing animals' access to the stands of young aspen suckers, so that not all the resource is affected by grazing. alternatively, the area may be excluded fromthe grazing regime entirely and managed through direct intervention by cutting down part of the stand on a regular interval.

Whatever option is chosen, an acceptable balance between the two extremes needs to be attained and under any grazing regime it will be vital that the feature is actively monitored for adverse impacts due to grazing.

3.3.2 Grazing and reptiles

The importance of lowland heathland for British reptiles has long been recognised and some of the earliest conservation-driven management of this habitat was for these species (Webster, 1985). The habitat and management requirements of reptiles on heathland are well documented (e.g. Corbett and Tamarind, 1979; Goddard, 1983; Nature Conservancy Council, 1983; Corbett, 1990; Moulton and Corbett, 1999).

All native reptile species require warm, open habitats that combine a high level of structural diversity (with suitable shelter from inclement weather and predators) and adequate supplies of food. Lowland heathland is the premier reptile habitat in Britain and the only one supporting all six species; over 95% of sand lizards in the country depend on lowland heathland and smooth snake is found nowhere else.

The intimate mosaic of hot basking spots and readily available cool, humid shelter (especially those areas with a deep moss and lichen layer) that can develop on degenerate dry heath provides ideal habitat for all reptiles. Similarly, healthy populations of some reptiles occur in areas of mature purple moor-grass tussocks and rank, tussocky acid grassland with abundant dead plant material and straw.

Reptiles generally prefer habitats that occur during later successional stages of lowland heathland. However, such areas are often the target of management that aims to remove the mature growth and restart the succession. In the past, spatial and temporal availability of such habitats would have varied through natural processes and management by humans. Large herbivores would have played a major role in resetting the succession, thereby allowing reptile habitats to persist in the landscape. Thus reptiles survived in meta-populations with dynamic dispersal and colonisation of newly suitable habitats across space and time.

Habitat fragmentation in the modern countryside has now turned most suitable reptile habitat into virtual islands, in a largely inhospitable landscape. Consequently, dispersal between sites and colonization of new areas of suitable habitat is limited or impossible. Reptiles are thus extremely vulnerable to local extinctions caused by heathland fires, successional change, declines in genetic diversity and inappropriate management. That the best reptile habitats usually only occupy a relatively small proportion of any heathland site, makes them additionally vulnerable to localized disruption.

Inappropriate grazing of heathland, especially on small sites of less than a few dozen hectares, can be highly detrimental to reptile populations in various ways, particularly through a reduction in structural diversity (Edgar, 2003). The importance of structural features to reptiles and the hazards presented by grazing are highlighted in Resource Table 4 on page 56.

Many herpetologists acknowledge the value of grazing for maintaining heathlands and improving overall biodiversity. However, there are concerns about grazing for two main reasons. Firstly, the sheer importance of this habitat for reptiles in Britain, coupled with past experience of grazing on other habitats (reptiles are known to have been eliminated by conservation grazing of chalk grassland) that has clearly been highly detrimental to the more widespread reptile species. Secondly, the severe overgrazing of most upland moorland, although not the result of conservation management, has eradicated reptiles such as adders

Vipera berus and common lizards *Lacerta vivipara* (that would potentially reach very high densities in this habitat) from huge areas of the country.

Conversely, a sensitive grazing regime has benefits for reptiles on most heathland habitats, with the possible exception of degenerate dry heath. As with insects, reptiles benefit most from changes that result from grazing but only become available after the livestock have been removed or reduced in number. On a gross landscape scale, livestock grazing can revert the succession on parts of a heath that, in succeeding years, will by colonised by reptiles from other parts of the same site. On a finer scale, suitable intensity and timing of grazing can enhance the overall structural and biological diversity of many reptile habitats

It is important to note, however, that the smaller the site the harder it becomes to achieve such benefits without damaging the reptile habitat and populations on a site at the same time. Nonetheless, an appropriate grazing regime can be a useful management tool for many heathland sites and one that does not necessarily conflict with the conservation of reptiles.

3.3.3 Prey resources

Up to this point the focus has been very much on effects of grazing on species which feed directly on plants or their products. A further complication arises when we consider the effects of grazing on more common species that in turn support predators and parasites. Although competition from grazing stock may not exterminate herbivorous insects, it may well depress the available prey resource to the extent that species higher in the trophic pyramid are affected.

For example, insects and spiders form a significant proportion of the diet of lizards, while slow worms feed primarily on soft-bodied invertebrates, such as slugs. In the latter instance, both predator and prey require abundant vegetation cover, providing high humidity, which may be disrupted by grazing. Thus even the requirements of common prey species may become a consideration for heathland conservation.

Predatory fauna are often more reliant upon the temperature and physical regimes associated with heathland than herbivorous species. Some predators feed on common prey, but are restricted to heathland/dune situations due to the physical conditions they require.

Many reptiles may be affected by a reduction in prey due to heavy grazing (a notable exception are natterjack toads *Bufo calamita*, which benefit from high levels of grazing and the bare ground this creates). For example, heavy grazing can result in a reduction in amphibian numbers, which reduce available prey for grass snakes *Natrix natrix*. Heavy grazing can also reduce populations of small mammals by removing cover such as grass tussocks and vegetative litter, thus depleting crucial prey for adders and, to a lesser extent, smooth snakes.

A reduction in the abundance of certain preferred prey types may be compensated for by reptiles switching to other species, but only to the extent that these alternative species remain relatively abundant themselves.

However, managing heathland to ensure sufficient structural resources to support viable populations of reptiles and predatory insects, is undoubtedly of greater importance. If this is done, and numbers of reptiles, for example, remain healthy, then the prey resources can be

assumed to be adequate. However since this may not remain the case the issue of prey resources should also be considered when developing a grazing regime and associated monitoring programme.

3.3.4 Interference effects

The presence of large herbivores on heathland may lead to direct disturbance of certain species in particular certain situations. The species and habitats present, the number and type of livestock, the timing of grazing and, especially, the size of the site will have a bearing on the severity or otherwise of any such interference effects.

Basking and foraging reptiles are remarkably tolerant of large animals, including humans, if their behaviour appears benign (witness the numbers of common lizards happily basking on heavily used boardwalks). Additionally, snakes and lizards engaged in courtship and mating are usually too preoccupied to notice much going on around them and are unlikely to be disturbed by livestock.

For mobile species, problems are only likely to arise if they cannot move to safety, and are consequently trodden on. Those sheltering temporarily from inclement weather, or for other reasons, may fall victim to trampling; cases have been reported where reptiles have been killed by livestock treading on survey tins. Hibernating reptiles and insects may be affected if heavy livestock collapse burrows or nest chambers but this is undoubtedly a rare occurrence. Of particular concern is disturbance to female sand lizards prospecting for and digging nests as well as damage to the buried eggs, which are extremely vulnerable for the entire incubation period.

A particular problem can arise where stock are grazing wet site with only a few drier areas. It is highly likely that the animals will tend to utilize such areas for laying up and may thus exert a high level of interference with any insect or reptile species utilizing them.

The potential for eutrophication of water bodies through the deposition of dung and the consequent loss of important plant species should be noted; as should the potential for increases in turbidity due to stock entering margins of water bodies. This may affect both the plant-associated insect fauna through loss of plant species and the predatory ones, as visual hunting is greatly curtailed in turbid water.

Thus, there is some potential for livestock to interfere directly with insects and reptiles on heathland, which site managers should take into account when preparing management plans and monitoring programmes.

3.3.5 Dung resources

Dung provides protein and carbohydrate supply for certain adult and larval insects. It also attracts predatory species by concentrating numbers of their prey species.

The amount of dung available to insects will be increased through the presence of grazing animals on a conservation site. However, the dung resource provided by livestock may have adverse impacts on insects if the stock concerned have been treated with worming agents. These agents will pass into the dung of treated stock and have the potential to adversely affect

the invertebrate fauna utilizing the dung resource. Of particular concern are chemical boluses for cattle that release a steady amount of controlling agent over a period of months.

The easiest solution to this problem is to ensure that such boluses are not used for animals grazing conservation land. Furthermore any required worming treatment should be carried out on pasture of low conservation interest where the stock can be kept for a period of 2-4 weeks while the chemical flushes through their systems before they return to more sensitive land.

4. Grazing impact assessment

This section introduces the structure of the assessment process and explains how the information has been provided in the various tables. It also lays out the procedure for undertaking the assessment in a series of five steps.

A suitable compartment within Hazeley Heath, a large heathland site in North Hampshire, has been selected to be used as a worked example for the process. This compartment comprises a diverse mix of dry/humid/wet heath with a mix of heather, gorse and purple moor-grass with extensive transition zones. The worked example is presented alongside the main text in shaded text boxes, one for each stage of the assessment process. In addition, information gathered for Hazeley Heath, such as the Feature Recording Sheets has also been included.

4.1 Where the impact assessments fit

The Grazing Impact Assessment should be seen as a tool to be used when planning (and undertaking) the management of a conservation site. The assessment can only be applied once objectives have been determined and it is evident that grazing provides a potential mechanism for delivery. The flow chart in Figure , illustrates how Impact Assessment fits into the site management process. Ideally, an Impact Assessment would be conducted for all of the management operations under consideration on a given site and for the potential impacts on a range of flora and fauna. However, that is beyond the scope of this study, which focuses purely upon an impact assessment for grazing in relation to insects and reptiles in a heathland context.

The Grazing Impact Assessment will not serve as a tool for developing a grazing regime from scratch on heathland. Such a regime should be developed using guidance provided elsewhere (see Lake *et al.*, 2001; Bacon, 1998; Gimingham 1992; Tolhurst & Oates, 2001, and Webb, 1998). Once the initial grazing regime has been specified the Grazing Impact Assessment provides a means to highlight any potential problems and thus introduce adjustments.

The Grazing Impact Assessment identifies features on a site and the species of invertebrate and reptile associated with these. It seeks to assist site managers in making adjustments to grazing regimes, so that disruptions to such features are avoided or minimized. This will enable the delivery of management objectives through grazing without inadvertently jeopardizing features important for insects and reptiles.

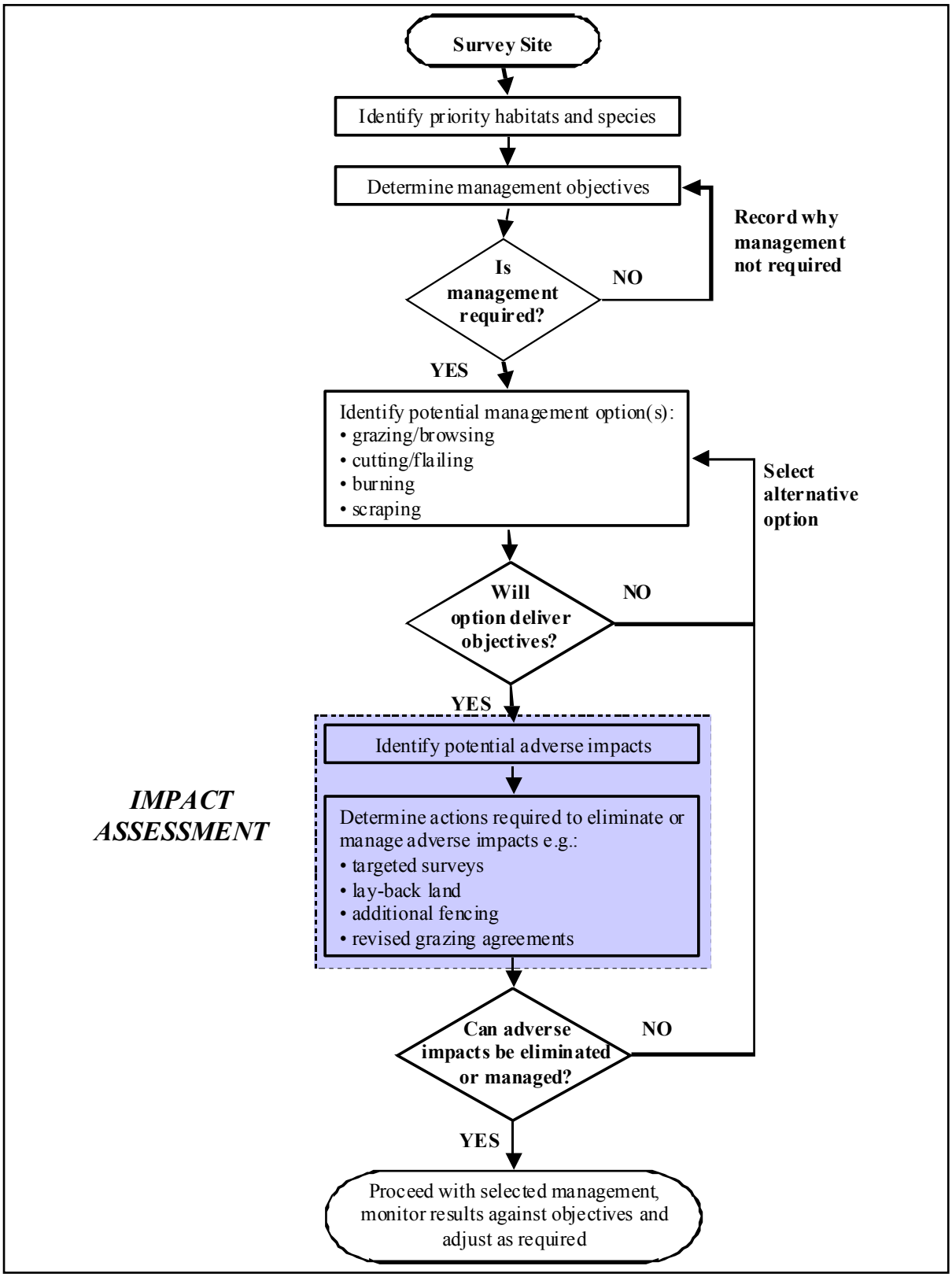

Figure 4 - Where impact assessments fit when selecting management options

Worked Example - Hazeley Heath (abridged from Edgar, 2002)

Hazeley Heath is one of the largest remaining heathlands (approximately 175 ha.) in the Thames Basin of north Hampshire. Hart District Council own and manage 51ha of the heath and the Timpany Trust own the majority of the remainder (120ha). Hazeley Heath is a Site of Special Scientific Interest (SSSI) due to its size and range of heathland flora and fauna. It has also been proposed as a Special Protection Area (pSPA) for its heathland bird interest. Hazeley Heath comprises a wide range of heathland and associated communities:

- Dry Heath, Humid Heath, Wet Heath
- Acid Grassland, Disturbed Grassland
- Gorse, Bracken
- Secondary Woodland
- Wet flushes

At least 220 plant species have been recorded, many of which are locally or nationally rare. Most of the latter are declining in the absence of appropriate grazing. The site also supports good communities of bryohpytes and lichens. It has a varied invertebrate fauna including Red Data Book and Nationally Notable species, although many typical heathland rarities have not been found. Hazeley Heath is currently considered unsuitable for sand lizards. Smooth snakes have not been recorded since before the war. However, they may have been overlooked, as has been the case elsewhere in north-east Hampshire

Hart District Council and the Timpany Trust have commissioned a management plan for the site. The draft for this plan suggests that one management option is grazing. Hazeley Heath therefore provides an appropriate example of a site for Grazing Impact Assessment.

Figure 5 - View of the compartment of Hazeley Heath used as a worked example

4.2 Initial grazing regime

Before commencing the assessment you will need to have worked out a basic grazing regime for your site, which will include a preliminary idea of:

- Livestock Type (Species, Breed, Age, Sex).
- Timing and Duration (e.g. May – July, 1–31 August).
- Stock Numbers/Intensity (number of animals or Livestock Units (LU) per hectare).
- Frequency (annual, every other year, one year in three etc.)

The impact assessment can then be used to help adjust the grazing regime in order to prevent adverse impacts on key features. It can even be repeated several times, adjusting the proposed regime slightly on each occasion until the 'best' solution has been found (see Figure 6 on page 25).

For the worked example, a simple baseline grazing regime has been selected for Hazeley Heath, which is given in the shaded text box below.

Worked Example – Proposed Grazing Regime, Hazeley Heath

For the purposes of this worked example, it is proposed that the following be considered as the baseline grazing regime for the compartment under consideration:

Stock:	Highland Cattle – mature cows or steers
Density:	1 LU per 5 ha (low intensity grazing)
Period:	May – September
Frequency:	Annual (exclusion of grazing for at least one year in five).

The above regime will introduce a low level of grazing pressure upon the area during the summer period. Given the time of year, it is most likely that the stock will focus predominantly upon grass and associated herbaceous plants. Some light browsing of heather and scrub may occur (e.g. sallow and sapling pine or birch growing within the grass sward).

4.3 Impact assessment tables

The Impact Assessment has been developed into a series of linked tables: a Feature Recording Sheet**,** a set of four Resource Tables and a set of five Species Associations Tables. These tables provide information about important features, the species associated with them, the nature of these species' associations and potential hazards presented by grazing. Finally, there is an Assessment Summary Table, that can be used to record the results of the assessment.

4.3.1 Feature recording sheet

The features from the Resource Tables have been extracted into a Feature Recording Sheet (see **Error! Reference source not found.** on page **Error! Bookmark not defined.**), to facilitate easy recording of key features and their relative abundance on a site prior to the more detailed assessment using the other tables. The Feature Recording Sheet can be completed in the field or using previously recorded site information (e.g. management plans or surveys).

However, one purpose of the Grazing Impact Assessment is to encourage site managers to look at their sites differently; in terms of the particular features and their importance for insects and reptiles. For this reason, a field assessment at the start of the process is highly recommended.

4.3.2 Resource tables

The Resource tables are designed to allow the findings of the Assessment and related observations to be recorded, in order to provide a written record of the assessment process for future reference.

For each of the features listed within the Resource tables, information is provided about the hazards presented by grazing, the potential impacts on associated fauna and the organisms associated with the feature. The examples of faunal groups, which are likely to be affected are not exhaustive or likely to be relevant to all sites but should be used by site managers primarily for guidance. The four Resource Tables have been developed to cover specific issues, as explained below.

Table 1 - Nectar and pollen resources

Nectar and pollen provide protein and carbohydrate supply for many insects. Both adult and larval insects may be affected by the availability of these resources. Some insect species are specialists on a particular plant species, or a small group of species, while others are opportunistic.

Table 2 - Seed & fruit resources

Seed and fruit provide protein and carbohydrate supply for many insects. Both adult and larval insects are affected by the availability of the resource. Some insect species are specialists on a particular plant species, or a small group of species, while others are opportunistic.

Table 3 - Foliage resources

Foliage provides protein and carbohydrate supply for many insects. Both adult and larval insects are affected by the availability of the resources. Some insect species are specialists on a particular plant species, or small group of species, while others are more opportunistic.

Complete loss of this resource will lead to the loss of a wider range of resources, such as roots and woody stems, than occasioned solely by reduction in plant size. Many of the plant eating invertebrate species are prey resources for other predatory/parasitic insects and spiders (see Section 3.3.3). Additionally, the plants themselves may provide structural resources used by organisms such as spiders and reptiles (see Table 4 - Structural resources).

Table 4 - Structural resources

Variation in structural features, often small-scale, is extremely important to insects and spiders. Rapid changes to, or total loss of, structural features (e.g. removing flowering stems of grasses through grazing) can be very detrimental to some species. Likewise, constant

disturbance can lead to the disruption of fragile or annual plant communities, compaction of short turf and degradation of bare ground, which can be highly detrimental for reptiles.

Species associations tables

The Species Associations Tables provide further explanation of the nature of the associations between the fauna and the features to which they are linked. They contain extensive details of the groups and species associated with the features listed in the Resource Tables. There are separate associations tables for reptiles and insects in order to avoid confusion.

The associations tables are structured differently to the Resource Tables. They are ordered by **Feature Groups** and then **Specific Features**, which are broken into **Resource Types** (opposite to the Resource Tables, which are ordered by **Resource Type** and then **Feature**):

Table A - Vegetative Features: Scrub, Trees and Shrubs
Table B - Vegetative Features: Herbaceous Plants (Not Grasses)
Table C - Vegetative Features: Grasses, Sedges and Rushes
Table D - Vegetative Features: Lower Plants
Table E - Structural Features

Within the associations tables, the plants are listed alphabetically under each category. It is possible for a **Specific Feature** to be listed in different sections of the Species Associations Tables. For example, Bilberry provides multiple resources and has entries under three categories: **Flowers**, **Fruit and Seeds** AND **Foliage**.

Where an insect is restricted to or dependent upon a particular species of plant this is highlighted in **bold** in the tables to make location easier.

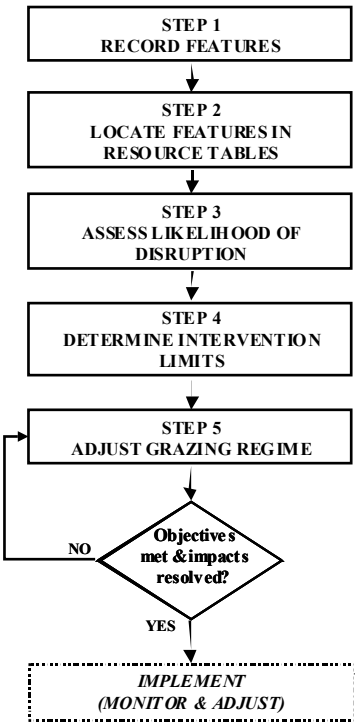

Figure 6 - Grazing impact assessment process

4.4 Assessment procedure

Before conducting the assessment you will need some prior knowledge of the site's habitats, flora and fauna, either from first-hand field visits or survey information. It may be necessary to visit the site at different time during the flowering season to ensure that features of importance are not overlooked. Initially, it is recommended that a field assessment should be conducted at least twice: once in spring (April/May) and once in summer (June/July).

To undertake the assessment it is suggested that you use the approach detailed below and illustrated in Figure 6 above.

4.4.1 Step 1 – Record features

Use the Feature Recording Sheet (see **Error! Reference source not found.**) to note the presence of relevant features. For vegetative features record your findings in the left-hand four columns on the first page. Findings for non-vegetative features should be recorded in the three right-hand columns on the second page.

You should also attempt to record the relative abundance of each feature using following scale:

Dominant (occurs over whole site as the dominant vegetation)
Abundant (occurs across the whole site but not as dominant vegetation OR in dense stands in many locations)
Frequent (scattered over the whole site OR in a few dense stands)
Occasional (a few stands)
Rare (at most a few individual examples)

As plant communities tend to be patchy, it may be necessary to qualify the **DAFOR** assessment using an **L** to denote Locally. Thus species may be denoted as **OLF** (Occasional Locally Frequent) or **ALD** (Abundant Locally Dominant), which makes more sense on the ground.

Alternatively you may wish to record the actual extent of particular features on the site in hectares or percentages of the total site area. Recording relative abundance will assist with assessing the extent to which grazing poses a risk to a feature. For example, a feature that is likely to be grazed but is abundant on a site is likely to be less at risk of serious disruption than one that is occasional or rare.

You should also record relevant comments about the features, such as specific location, condition etc. These comments can later used to assist with the Impact Assessment.

Worked Example: Step 1 – Record features

An initial assessment of the compartment was made to identify relevant features through a field visit using the Feature Recording Sheets to record the sorts of features shown in Figure 7 and Figure 8. Rough estimates of abundance were recorded on the forms along with comments about features where necessary. Copies of the completed Feature Recording Sheets are show in Figure 9 and

Other comments/observations

Figure 10 on pages 30 and 31 respectively. A summary of the features recorded is given in the table below.

Where particular species were not present but related ones were, a note was made of these (e.g. Meadow thistle (*Cirsium dissectum*)was recorded instead of knapweed (*Centaurea* sp.) and devil's-bit (*Succisa pratensis*) was recorded instead of Sheep's-bit (*Jasione montana*)).

Table 1 - Features Recorded on Hazeley Heath

Feature	Abundance DAFOR	Comment
Scrub, trees and shrubs		
Alder buckthorn	VR	
Birch	O	Some mature and young scattered trees
Bramble	R	
Broom	VR	Also Petty Whin
Gorse	LF	Western Gorse in association with heather
Hawthorn	R	On woodland edges
Heather	LA	
Pine	O/R	Some large trees and occasional young shoots
Sallow	R-LA	Some clumps in wet flushes

Herbaceous Flowers		
Heath bedstraw	LA	
~~*Knapweeds*~~ *Meadow thistle*	LF	
Legumes	O	Greater Bird's-foot Trefoil
~~*Sheep's bit*~~ *Devil's- bit*	LF	
Yellow composites	R	
Grasses, Rushes and Sedges		
Deschampsia cespitosa	ALD	
Festuca ovina	R(LA)	
Molinia caerulea	ALD	
Non-vegetative Resources		
Molinia litter and tussocks on humid or wet heath	ALD	
Heather-grass interface	F	
Dry areas with bare ground and early successional vegetation	R	Around military workings on hill
Wet, bare ground, margins of ponds including draw-down zones	R	Along stream, flush edges
Dry heath – wet heath interface	R	Humid heath
Bare soil/sand	R(LA)	
Short vegetation	R	

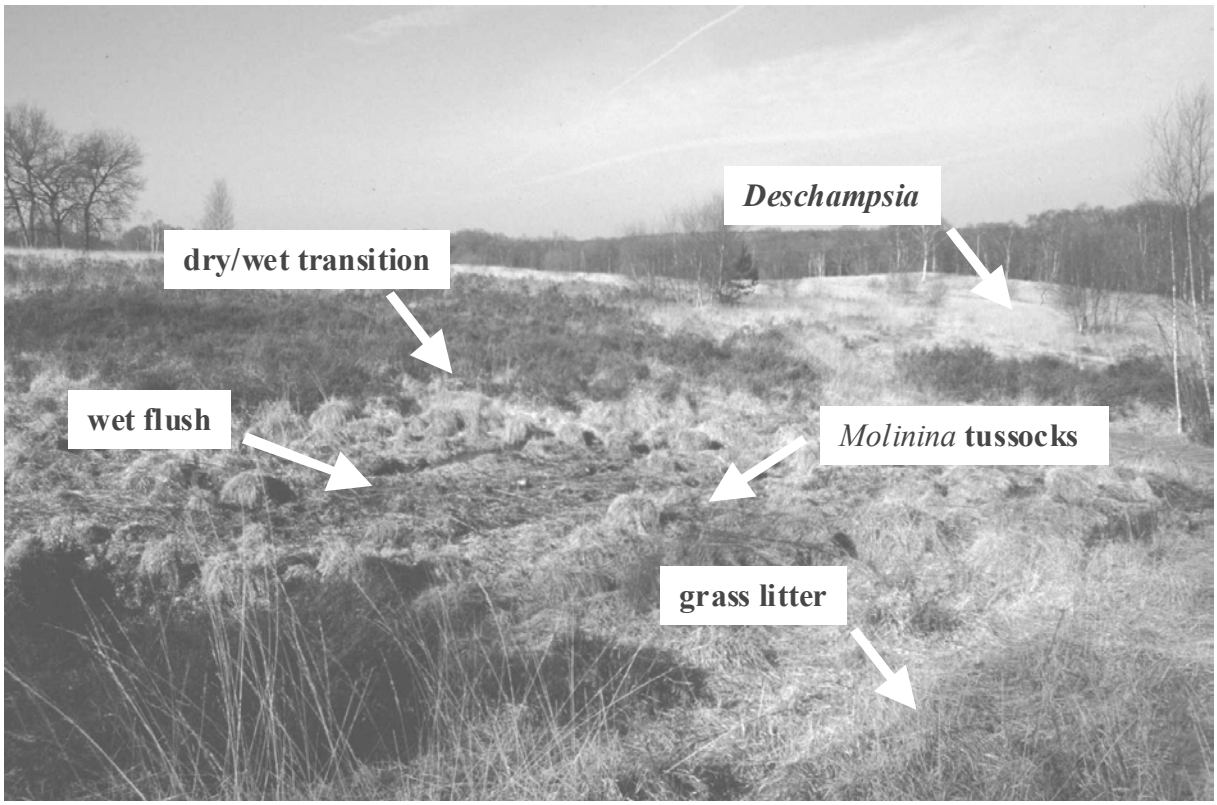

Figure 7 - Hazeley Heath - Wet flush, *Molinia caerulea* tussocks and transition zones

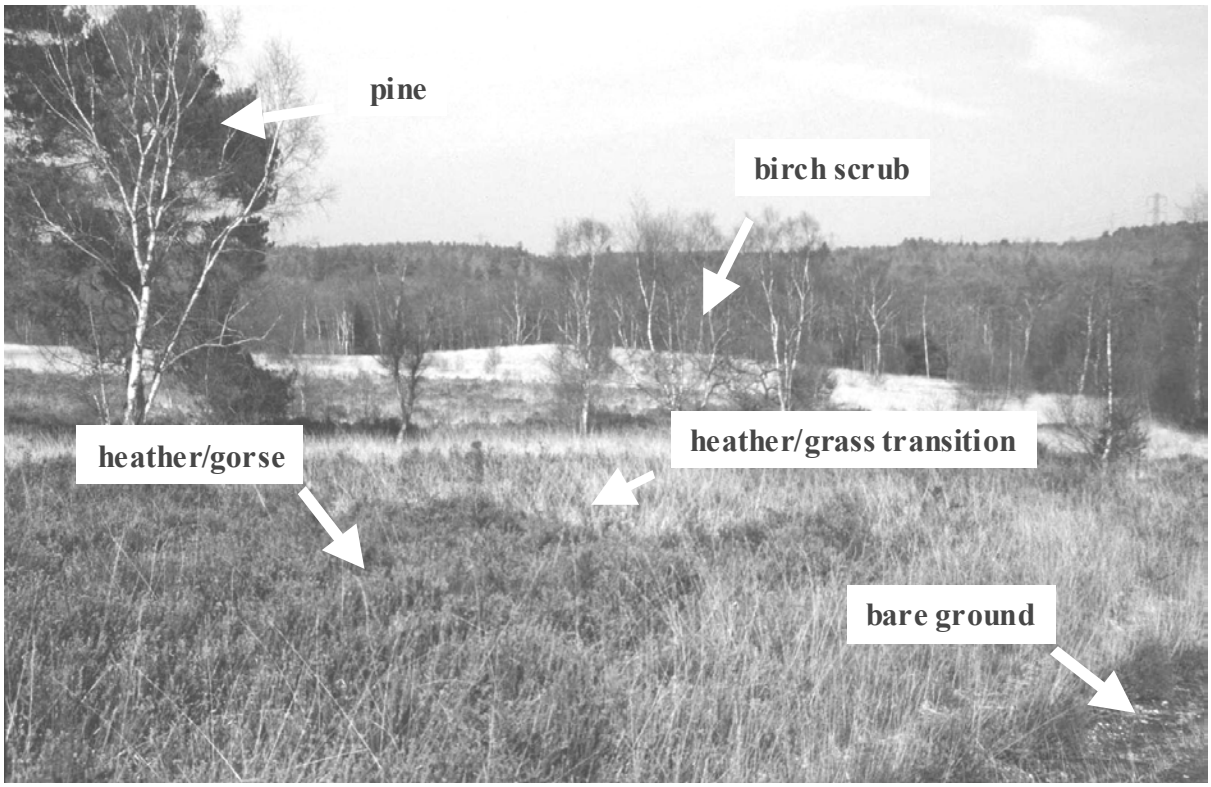

Figure 8 - Hazeley Heath – Heather (*Calluna vulgaris*, *Erica sp.)* with western gorse *Ulex gallii* and birch *Betula sp.* scrub

RECORD PRESENCE OF FEATURES BELOW				Vegetative Resources				
				1 - Nectar and pollen			*2 - Seed & Fruit*	*3 - Foli-age*
Feature	☑	**Abund-ance DAFOR**	**Comments (e.g. very localised, only occurs in block a)**	*Mar – Apr*	*May – Jun*	*Jul – Aug*		
Scrub trees and shrubs								
Apple	☐							
Alder buckthorn	☑	VR	Odd plant					
Aspen	☐							
Bilberry	☐							
Birch	☑	O	Some mature and young scattered trees					
Blackthorn	☐							
Bramble	☑	R	Some on edges of woodland					
Broom	☑	VR	**PETTY WHIN**					
Gorse	☑	F						
Hawthorn	☑	R	Along woodland edge					
Heather	☑	LA	Extensive tracts of low-growing *Calluna* and					
Holly	☐		and some *Erica tetralix*					
Pine	☑	O/R	Large trees and occasional saplings					
Rose	☐							
Rowan	☐		Clumps around wet flushes and along					
Sallow	☑	R(LA)	streams					
Herbaceous Flowers								
Campions	☐							
Harebell	☐							
Heath bedstraw	☑	LA	Common among heather areas					
Knapweeds	☑	LF	**MEADOW THISTLE** – clumps					
Legumes	☑	R	**GTR BIRD'S-FOOT TREFOIL**					
Sheep's-bit	☑	LF	**DEVIL'S-BIT** – local dense groups					
Sheep's sorrel	☐							
Spurreys	☐							
St. John's wort	☐							
Umbellifers	☐							
White bryony	☐							
Wood sage	☐							
Yellow composites	☑	R	Odd plants among sward, along paths					
Yellow loosestrife	☐							
Grasses, Rushes and Sedges								
Agrostis curtisii	☐							
Anthox. odoratum	☐							
Desch. cespitosa	☑	ALD	Extensive areas					
Festuca ovina	☑	R	Small areas on drier slopes					
Luzula campestris	☐							
Luzula multiflora	☐							
Molinia caerulea	☑	ALD	Extensive areas in flush zones					
Lower Plants	☐							
Bracken	☑	O	Some on dry ground at edges					
Fungi	☐							

Figure 9 - Completed Feature Recording Sheet for Hazeley Heath - Sheet 1

Non-vegetative Resources				
	Feature	☑	**Abund-ance (DAFOR)**	**Comments**
4–Structural	**Mature/degenerate dry heath with deep moss and lichen layers**	☐		
	Dwarf gorse on dry heath	☐		
	Dry, tussocky acid grassland	☐		
	***Molinia* litter and tussocks on humid or wet heath**	☑	ALD	Extensive areas in flushes
	Accumulated decomposing vegetation	☑	R	Grass litter
	Heather – Grass interface	☑	F	Lengthy transition zones
	Dry areas with bare ground and early successional vegetation.	☑	R	On dry slopes/hill
	Dry areas with bare ground bordering mature heath	☐		
	Wet bare ground, margins of ponds including draw-down zones.	☑	VR	Around flushes and paths
	Dry Heath – Wet Heath interface	☑	R	Not much 'dry heath' present
	Bare soil/sand	☑	VR	Only on dry slopes/hill
	Short vegetation	☑	R(L)	Some on dry hill slopes
	Tall vegetation and scrub	☐		
	Grazing tolerant plants	☐		

Other comments/observations

Figure 10 - Completed Feature Recording Sheet for Hazeley Heath - Sheet 2

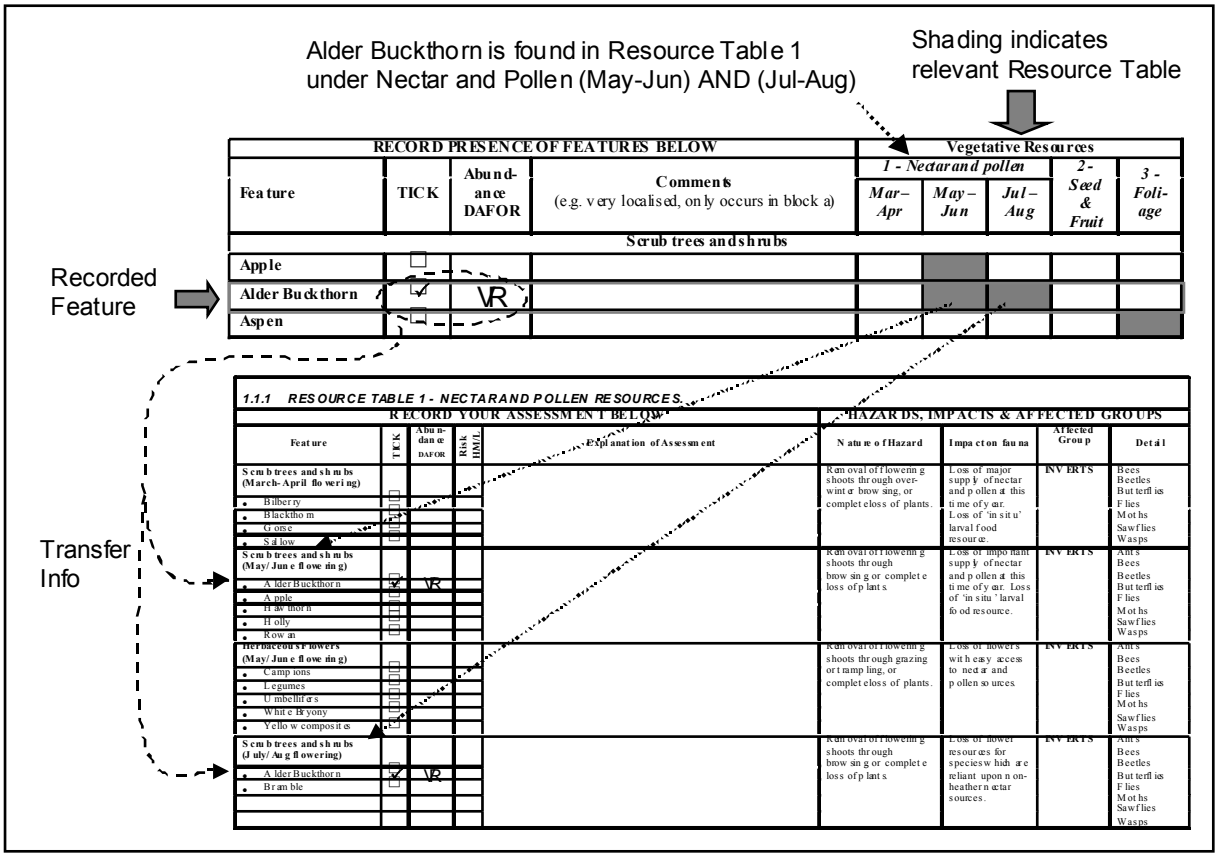

Figure 11 - Tranferring information from feature recording sheet to resource tables

4.4.2 Step 2 – Locate features in resource tables

Once the initial Feature Recording has been completed, the next step is to transfer the information from the Feature Recording Sheet into the Resource Tables, as illustrated above in Figure 11.

The Resource Tables can be found in 0 on the following pages:

For each of the features recorded on the Feature Recording Sheet, mark a tick in the in column 2 of the Resource Table and enter the abundance estimate in column 3. To help you locate the features in the Resource Tables, the **'Vegetative Resources'** columns on the Feature Recording Sheet correspond to the first three Resource Tables (note that Table 1 has three columns to cover different seasons). This indicates whether a feature is listed in more than one Resource Table, as shown above in Figure 11, which shows how alder buckthorn is listed under May/June and July/August flowering periods. Similarly, bilberry *Vaccinium myrtillus* is listed in the following Resource Tables:

- Table 1 – Nectar and Pollen Resources - Scrub (March – April Flowering);

- Table 2 – Seed & Fruit Resources - Scrub; and
- Table 3 – Foliage Resources - Scrub.

Worked Example: Step 2 - Record features within Resource Tables
The key features identified during Step 1 were located and marked in the Resource Tables along with estimates for abundance, as shown below in the excerpt from Resource Table 1.

RECORD YOUR ASSESSMENT BELOW				
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**
Scrub trees and shrubs (March-April flowering)				
• Bilberry	☐			
• Blackthorn	☐			
• Gorse	☑	**F**		
• Sallow	☑	**OLA**		
Scrub trees and shrubs (May/June flowering)				
• Alder buckthorn	☑	**VR**		
• Apple	☐			
• Hawthorn	☑	**R**		
• Holly	☐			
• Rowan	☐			
Herbaceous Flowers (May/June flowering)				
• Campions	☐			
• Legumes	☑	**R**		
• Umbellifers	☐			
• White bryony	☐			
• Yellow composites	☑	**R**		
Scrub trees and shrubs (July/Aug flowering)				
• Alder buckthorn	☑	**VR**		
• Bramble	☑	**R**		

4.4.3 Step 3 - Assess the likelihood of disruption

For each of the features identified on your site and marked on the Resource Tables you will need to assess the potential for them to be disrupted by grazing livestock. This will be determined by the initial grazing regime and by inter-linked factors such as the attractiveness of a feature to stock, the vulnerability of associated species to disruption and the relative abundance of the feature on the site.

For each feature you will need to record the perceived likelihood in column 4 of the Resource Table using the following categories:

H	**HIGH**	Likely to be seriously affected by grazing livestock
M	**MED**	Likely to be affected by grazing livestock but not seriously

L LOW Likely to be unaffected by grazing livestock

To make an assessment of the likely impact, you will need to consider:

- how each feature is likely to be affected, taking into account the considerations detailed below; and
- how stock are likely to utilise the site and thus affect different areas and the features they contain.

+

A. Attractiveness

i) Vegetative features

The likelihood that a given feature will be affected will vary according to its relative attractiveness to the chosen stock type, which is primarily driven by its palatability and nutrient content at a given time of year.

Some vegetative features will be more palatable than others and will therefore receive more grazing pressure at certain times:

- purple moor-grass will be grazed in summer in preference to scrub and heather;
- grass verges are likely to be grazed in preference to adjacent dwarf shrub areas;
- the new growth on sallow scrub in spring is attractive as browse to stock.
- heather is more likely to be grazed in winter.

Some vegetative features are unlikely to be greatly affected by grazing due to their poor palatability (e.g. pine *Pinus sylvestris*) whereas the palatability of others will vary during the year (e.g. birch *Betula pendula* leaves become less palatable as the summer progresses due to the progressive accumulation of tannins).

ii) Structural features

There will also be variation in the extent to which structural features are likely to be affected by grazing livestock. This will also result from the variable attractiveness of different areas to stock at different times.

However, disruption of structure occurs in two different ways:

i) gazing of vegetative features, which have a structural function (e.g. purple moor-grass tussocks); or
ii) dsturbance by the animals of physical features (e.g. bare sand) through trampling or lying up.

Therefore structural disruption of vegetative will be closely tied to the factors, introduced above, that determine the disruption of vegetative features.

Disruption of physical features will depend primarily upon their vulnerability to disruption (loose sand is more easily churned up than baked soil) linked with the amount of time that the stock spend in that particular area.

Thus, while mature and degenerate dry heath with deep moss and lichen layers can be damaged through trampling by livestock, there is generally little in the way of attractive forage in such areas for much of the year. Thus, stock are unlikely to spend long periods in such areas unless they are attractive for other reasons. They may, for example, be the only dry area on a predominantly wet heath site and therefore be utilised by stock for lying up when not grazing, which may result in an adverse impact.

B. Abundance

The extent to which disruption affects the vegetative and structural resources for the site will be determined by the relative abundance of the features:

- a feature that is Dominant or Abundant across a site will be best able to withstand grazing pressure;
- a feature that is Frequent on a site may be vulnerable to grazing pressure, if it is attractive to stock at certain times of year (see above) compared to adjacent areas.
- a feature that is only found Occasionally or Rarely on a site is likely at risk unless it is particularly robust or unattractive as forage.

C. Vulnerability

For the purposes of Grazing Impact Assessment, the nature and specificity of associated species' dependence upon a particular feature will contribute to its vulnerability to disruption. Thus, the vulnerability of a feature is determined by the extent to which grazing alters it to the extent such that it cannot be utilised by associated fauna.

For example, sand lizards require loose, bare sand in which to deposit their eggs. Disruption by stock will not eliminate loose, bare sand as a resource from a site, and may even enhance it in some respects. However, disruption by stock may make it unsuitable for egg-laying due to excessive disturbance and exposure or crushing of incubating eggs.

Most of the features listed in the Resource Tables will withstand some disruption. For example, flowering plants can remain present when grazed provided that the it is not sufficiently intense or regular to eliminate them in favour of grasses. However, it is not the presence of the flowering plants that need to be considered but the resources that they provide; i.e. Nectar and Pollen Sources and Fruit and Seeds. Thus, vulnerability should be considered in terms of the resources provided by a given feature such as pollen and nectar sources and fruit and seeds rather than the presence of the plant itself.

The information provided in the Resource Tables under **Impact on fauna** provides an indication of how the associated fauna is likely to be affected by disruption of each feature. Furthermore, the associations of species to specific features are indicated under **Association with Feature** in the Species Associations Tables (see 0)**,** which should also be referred to. The nature of the associations will indicate individual species' vulnerability to disruption of a

specific feature. For example, an insect dependent upon a certain species of plant for nectar or larval food will be highly sensitive to any disruption of that plant.

4.4.4 Step 4 – Determine intervention limits

Features for which there is a Medium or High risk of disruption should be recorded in the Assessment Summary Table (see 0 on page 87).

Table 2 - Example Intervention Limits

Feature	Intervention Limit
Alder buckthorn	Removal of more than 50% of flowering shoots
Sallow	Reduction in extent of sallow stands by 25%. Removal of more than 50% of flowering shoots by browsing.
Devil's-bit scabious	Reduction in flowering plants by 30%
Molinia litter and tussocks on humid or wet heath	Reduction in extent of mature tussocks by 50%
Dry areas with bare ground and early successional vegetation	Excessive disturbance (poaching, churning etc.) of more than 25% of the resource.

For each feature Intervention Limits need to be determined and recorded in the form, which establish the level of change in a feature at which intervention to alter the grazing will be required. The nature of these will vary according to the type of feature and the site context. They are simple, clear guidelines that indicate what aspects of a particular feature (e.g. area, height, number of flowering plants) that should be monitored during grazing.

Worked Example: Step 4 – Determine Intervention Limits

Several features were found to be at medium or high risk of adverse impacts due to grazing, as shown below. These were transferred into the Summary Table (see Table 3).

For each of the at risk features a limit was determined for the level of change due to grazing at which intervention would be required. The action that might be required should these limits be met or exceeded was also considered for each feature. Examples of the sorts of limits that might be chosen and examples of the types of action that might be considered are shown in Table 3.

Feature	Abund-ance	Risk	Comment
Table 1 –Nectar and Pollen Resources			
Meadow thistle	LF	M	May experience adverse grazing impacts
Devil's-bit	LF	M	---------- " ----------
Grasses (July/August flowering)	ALD	H	Attractive forage for stock
Table 2 – Seed and Fruit Resources			
Meadow thistle	LF	H	As above
Grass seeds	ALD	H	As above
Table 3 - Foliage Resources			
Sallow	R-LA	M	Likely to experience some browsing
Heath bedstraw	LA	L-M	May experience adverse impact through grazing of grass
Deschampsia cespitosa	ALD	H	Main forage for stock
Festuca ovina	R	H	Low quantity
Molinia caerulea	ALD	H	Main forage for stock
Sphagnum sp.	F	H	Sensitive to trampling pressure
Table 4 – Structural Resources			
Molinina litter and tussocks on humid or wet heath	ALD	H	Main forage for stock
Dry areas with bare ground and early successional vegetation	R	M	Dry areas likely to be used by stock for lying up
Wet areas with bare ground, margins of ponds, including draw-down zones	VR	H	Limited extent and likely to be disturbed by stock accessing water
Bare soil/sand	VR	M	See 'Dry areas…' above
Tall vegetation and scrub	A	H	Important for spiders – Nationally Notable species present

Features Assessed at MEDIUM or HIGH Risk	Abun-dance DAFOR	Risk H/M/L	Intervention Limits	Action
TABLE 1 –NECTAR & POLLEN	———	——	———	———
Devil's-bit	**LF**	**M**	Reduction in flowering plants of more then 50% in peak season	Remove stock if limit reached or exceeded
Grasses (July/August flowering)	**ALD**	**H**	Removal of over 75% of flowering grass by areas.	Remove stock if limit reached or exceeded
TABLE 2 – SEED AND FRUIT	———	——	———	———
Meadow thistle	**LF**	**M**	Reduction in numbers and extent of flowering plants by more then 50%	Remove stock if limit reached or exceeded
TABLE 3 – FOLIAGE	———	——	———	———
Sallow	**R-LA**	**M**	Removal of more than 50% of young flowering shoots	Exclude stock from areas of sallow or remove from compartment
Heath bedstraw	**LA**	**L-M**	Reduction on abundance of more than 75%	Remove stock if limit reached or exceeded
Deschampsia cespitosa	**ALD**	**H**	Removal of more than 90% of tussocks	Remove stock if limit reached or exceeded
TABLE 4 – STRUCTURAL	———	——	———	———
Molinia litter/tussocks on humid or wet heath	**ALD**	**H**	Elimination of more than 50% of tussocks by areas	Remove stock or exclude from wetter areas with tussocks
Wet areas with bare ground, margins of ponds, including draw-down zones	**VR**	**H**	Erosion, trampling or poaching of morethan 55% of the area.	Exclude stock from sensitive flush zones

Table 3 – Summary Impact Assessment Table for Hazeley Heath

4.4.5 Step 5 – Adjust grazing regime

Once the risk of features being disrupted has been assessed, it will be necessary to decide:

1. whether the grazing regime proposed at the outset needs fundamental adjustment to avoid causing disruption in the first place; and/or
2. whether actions will need to be taken if and when intervention limits for particular features look likely to be or are actually reached.

Adjustments to the grazing regime, whether fundamental or as a result of the need for intervention during the grazing period, can involve changes to the following areas:

1. Choice of stock

Some stock will be more likely to affect particular features than others. Selecting an alternative type may therefore reduce or prevent a feature from being disrupted. For further information, please refer to the Breed Profiles Handbook (Tolhurst & Oates, 2001).

2. Changing timing and duration of grazing

Impacts on some species can be avoided by excluding grazing at certain times of year (e.g. flower-rich verges providing spring nectar sources).

3. Intensity of grazing

Some features may be able to withstand, and even benefit from, grazing pressure, whereas others will be seriously disrupted by grazing. For example, sand lizards can be affected even by extensive, light grazing due to disruption of small, localised areas of bare ground which are vital as nesting areas.

Worked Example: Step 5 – Adjust grazing regime

The worked example for the wet/humid heath compartment at Hazeley Heath suggests that no fundamental problems are likely under the proposed grazing regime.

However, the assessment has shown that some features will be at risk of adverse impact and that they therefore need careful monitoring. For example, *Deschampsia* and *Molinia* are at high risk of disruption precisely because they are what the grazing animals will graze most. This is in line with the intention of reducing their dominance in favour of other heathland flora but it will be vital to ensure that in so doing other important features such as tussocks and taller stems are not eliminated.

The assessment has therefore has also helped to highlight how important the identified features are for a range of heathland fauna. This has been welcomed by the site manager who considers it to be a valuable contribution to deciding how best to manage the site. Without the assessment such features and their associated species might otherwise have been overlooked when considering management in terms of plant species and communities.

Whether grazing will return to Hazeley Heath remains to be seen. However, it is likely that, in the event it does, a more detailed Grazing Impact Assessment will be required before livestock are introduced.

4. Controlling stock activity

It may be possible to exclude stock from particular features at certain times by electric or permanent fencing. The location of water and shelter can affect how stock utilise a site, particularly during the summer period.

Intervention during the period of grazing will entail altering access for stock to a particular feature either for the long term or for a shorter period so as to prevent further disruption. To address the problem in the longer-term, it will be necessary to consider changes to the grazing regime as outlined above, so that the likelihood of intervention to address the same problem is reduced.

4.5 Summary

The Grazing Impact Assessment presented in this report is a prototype and there is potential for the technique to be further developed and improved through feedback from those involved in managing nature conservation sites.

The current process leads from an initial identification of key features to the production of a summary of features deemed to be at risk of adverse impacts. The process will have highlighted whether there is a need to fundamentally modify to the initial grazing regime or to make minor adjustments in the event of adverse impacts on key features.

It should be apparent however that this assessment is not a replacement for the site manager's understanding of the flora and fauna found on their site. It is rather a tool for use by site managers when seeking to make better informed management decisions. Much is left to the individual's judgment, ability to assess risks to key features and develop appropriate proposals for intervention. This is unavoidable because sites differ so much, even when they support the same habitat, and may react in different ways to similar management regimes or even from year to year.

As has been suggested earlier, it is highly unlikely, particularly in a heathland context, that grazing will deliver a complete solution to the management needs of a particular site. Therefore, once completed, the results from the assessment need to be considered in the context of the wider site management programme. The grazing can then be most effective through integration with an overall prescription for a site that incorporates the required additional operations, such as scrub removal.

Progress achieved through grazing will need to be monitored against objectives for the site. Monitoring of those features at medium or high risk will need to be incorporated into any monitoring programme for the site. The information gathered by such monitoring may guide further adjustments to the grazing regime or other site management activities (see Figure 12 below).

The assessment can be repeated during the grazing period, using the Resource and Associations Tables to interpret the effects of grazing on particular features and associated fauna. These tables can be used to decide whether remedial action is required and what form this might take (e.g. removal of stock, exclusion from a particular area).

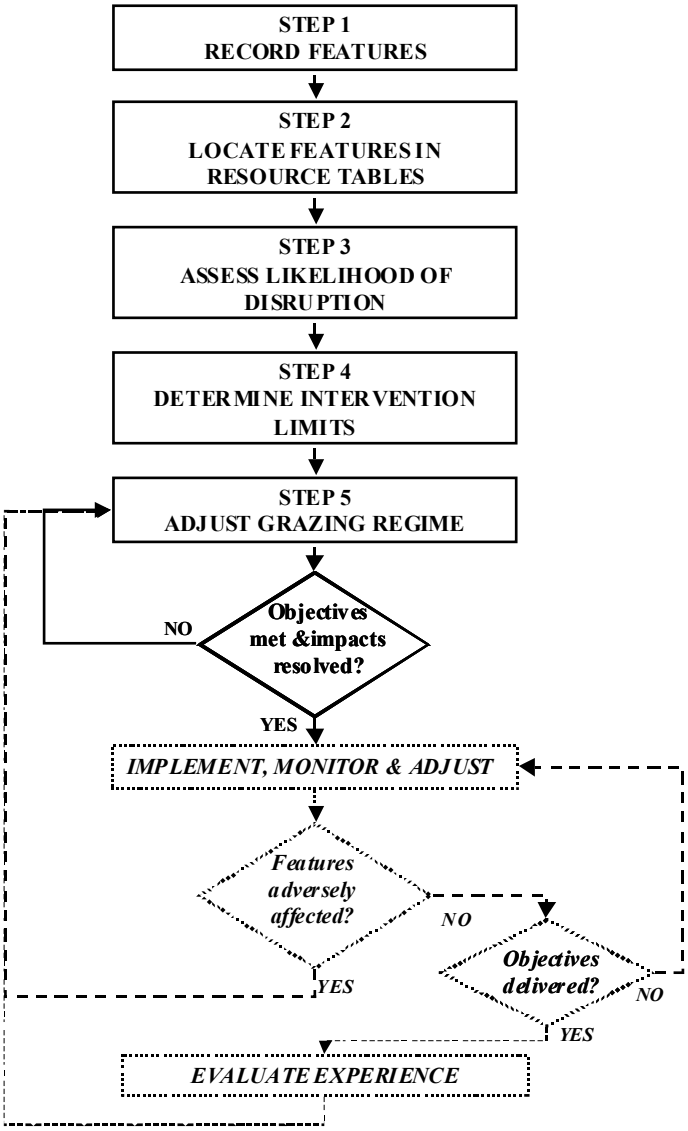

Figure 12 – Revised Grazing Impact Assessment Process

5. Evaluation

In its current form, the Grazing Impact Assessment provides a tool for improving heathland grazing, so that it better caters for insects and reptiles. It will help site managers to better understand the complex relationships between these two groups and key features of heathland sites. Furthermore, the Resource and Species Associations Tables bring information about the value of such features, associated fauna and the nature of these associations into a single source for the first time.

The current approach has been structured to make the application of the assessment as simple and clear as possible. However, it is possible that this may need to be refined as a result of further practical application by site managers.

During the development of the current assessment procedure several issues have become apparent:

1) training in the technique;
2) promotion of the technique;
3) integration with other site management tools;
4) development of an IT-based assessment package; and
5) further refinement and application to other situations.

5.1 Training in the technique

Development of the initial approach has indicated that there is a need for some training in the technique to be developed. A field-testing seminar was held as part of the development process, which was attended by a range of site managers. This indicated that participants gained a greater degree of confidence through guided application of the assessment than was possible through reading written material.

The GIA approach requires site managers to look at their sites in a slightly different way from that which they are used to and think more about the value of the features for related organisms than the management problems they present. Training would assist those wishing to utilize the process to gain maximum understanding of the concept and its application.

5.2 Promotion of the technique

Although this project has involved consultation with a wide range of conservation professionals, there is a need to promote the concept more widely in order to gain more feedback and develop it further. This would help to refine and develop the technique both as it stands and for additional habitats or groups. It has been suggested that an appropriate avenue for promotion would be through an article in British Wildlife. Additionally, the southern region of the Countryside Management Association (CMA) have expressed interest in a seminar sometime in 2003 to present and explain to process to their members.

5.3 Integration with other site management tools

Integration of the technique with other site management and assessment tools has been beyond the scope of the current project. However, discussions with site managers from various organisations suggest that there is potential for the Grazing Impacts Assessment to link to other land management tools. For example, the features identified by the Impact Assessment could be utilised as target features used to assess site management progress within the Countryside Management System (CMS) management-planning package.

Furthermore, the features identified by this assessment may add another dimension to the Site Condition Assessments currently being applied to Sites of Special Scientific Interest by English Nature. This would bring in consideration of habitat condition for insects and reptiles in addition to floristic characteristics.

5.4 Development of an IT-based assessment package

There is potential for the technique to be delivered through a computer-based or web-based package. The current table-based system has drawbacks due to the amount of information

being presented. The Associations Tables are particularly daunting due to the quantity of species information contained within them.

On several occasions during development of the current approach, the concept of a web-based delivery tool was discussed. This would enable more effective integration of the Resource and Species Associations Tables and allow automated production of Assessment Summary Tables. Furthermore it would be possible to provide more detailed information about the specific ecology of the species in the Species Associations Tables through links to other data held electronically. In an electronic format the assessment could also be more easily updated and kept in line with current knowledge about particular species' requirements.

5.5 Further refinement and application to other situations

The process presented in this report is a prototype. During this project, the reaction from site managers has been generally favourable, once they have understood the concept behind the approach. However, the process would probably benefit from further refinement, which has been beyond the scope of current resources, to make it more accessible and effective.

The current assessment procedure focuses upon insects and reptiles on heathland as two groups causing particular concern. However, there is potential to apply the technique to other habitats, groups and even management activities. Many of the adverse impacts attributed to grazing as part of the current assessment can also result from alternative techniques such as cutting, scraping or scrub removal.

Grasslands are most likely to be considered appropriate for grazing management. There is therefore potential for adverse impacts upon insect fauna of such habitats due to inappropriate grazing. It is therefore suggested that a further project should develop a grazing impact assessment for insects in key lowland grassland habitats (chalk grassland, neutral grassland etc.).

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Appendix 1 Feature recording sheet

RECORD PRESENCE OF FEATURES BELOW				Vegetative Resources				
Feature	☑	Abund-ance DAFOR	Comments (e.g. very localised, only occurs in block a)	*1 - Nectar and pollen*			*2 - Seed & Fruit*	*3 - Foli-age*
				Mar–Apr	*May–Jun*	*Jul–Aug*		
Scrub trees and shrubs								
Apple	☐							
Alder buckthorn	☐							
Aspen	☐							
Bilberry	☐							
Birch	☐							
Blackthorn	☐							
Bramble	☐							
Broom	☐							
Gorse	☐							
Hawthorn	☐							
Heather	☐							
Holly	☐							
Pine	☐							
Rose	☐							
Rowan	☐							
Sallow	☐							
Herbaceous Flowers								
Campions	☐							
Harebell	☐							
Heath bedstraw	☐							
Knapweeds	☐							
Legumes	☐							
Sheep's-bit	☐							
Sheep's sorrel	☐							
Spurreys	☐							
St. John's wort	☐							
Umbellifers	☐							
White bryony	☐							
Wood sage	☐							
Yellow composites	☐							
Yellow loosestrife	☐							
Grasses, Rushes and Sedges								
Agrostis curtisii	☐							
Anthox.odoratum	☐							
Desch. cespitosa	☐							
Festuca ovina	☐							
Luzula campestris	☐							
Luzula multiflora	☐							
Molinia caerulea	☐							
Lower Plants	☐							
Bracken	☐							
Fungi	☐							

Continued overleaf

Non-vegetative Resources				
	Feature	☑	**Abund-ance (DAFOR)**	**Comments**
4–Structural	**Mature/degenerate dry heath with deep moss and lichen layers**	☐		
	Dwarf gorse on dry heath	☐		
	Dry, tussocky acid grassland	☐		
	***Molinia* litter and tussocks on humid or wet heath**	☐		
	Accumulated decomposing vegetation	☐		
	Heather – Grass interface	☐		
	Dry areas with bare ground and early successional vegetation.	☐		
	Dry areas with bare ground bordering mature heath	☐		
	Wet bare ground, margins of ponds including draw-down zones.	☐		
	Dry Heath – Wet Heath interface	☐		
	Bare soil/sand	☐		
	Short vegetation	☐		
	Tall vegetation and scrub	☐		
	Grazing tolerant plants	☐		

Other comments/observations

Appendix 2 Resource tables

Resource table 1 - Nectar and pollen resources

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
Scrub trees and shrubs (March-April flowering)					Removal of flowering shoots through over-winter browsing, or complete loss of plants.	Loss of major supply of nectar and pollen at this time of year. Loss of 'in situ' larval food resource.	**INVERTS**	Bees Beetles Butterflies Flies Moths Sawflies Wasps
• Bilberry	☐							
• Blackthorn	☐							
• Gorse	☐							
• Sallow	☐							
Scrub trees and shrubs (May/June flowering)					Removal of flowering shoots through browsing, or complete loss of plants.	Loss of important supply of nectar and pollen at this time of year. Loss of 'in situ' larval food resource.	**INVERTS**	Ants Bees Beetles Butterflies Flies Moths Sawflies Wasps
• Alder buckthorn	☐							
• Apple	☐							
• Hawthorn	☐							
• Holly	☐							
• Rowan	☐							
Herbaceous Flowers (May/June flowering)					Removal of flowering shoots through grazing or trampling, or complete loss of plants.	Loss of flowers with easy access to nectar and pollen sources.	**INVERTS**	Ants Bees Beetles Butterflies Flies Moths Sawflies Wasps
• Campions	☐							
• Legumes	☐							
• Umbellifers	☐							
• White bryony	☐							
• Yellow composites	☐							
Scrub trees and shrubs (July/Aug flowering)					Removal of flowering shoots through browsing, or complete loss of plants.	Loss of flower resources for species which are reliant upon non-heather nectar sources.	**INVERTS**	Ants Bees Beetles Butterflies Flies Moths Sawflies Wasps
• Alder buckthorn	☐							
• Bramble	☐							

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
Heather (s) (July/Aug flowering)	☐				Removal of flowering shoots through browsing, or complete loss of plants.	Loss of largest single pollen and nectar source.	**INVERTS**	Ants Bees Beetles Bugs Butterflies Flies Moths Wasps
Herbaceous Flowers (July/August flowering)					Removal of flowering shoots through grazing or trampling, or complete loss of plants.	Loss of important nectar and pollen resources for wide variety of insects.	**INVERTS**	Ants Bees Beetles Bugs Butterflies Flies Moths Sawflies Wasps
• Harebell	☐							
• Knapweeds	☐							
• Legumes	☐							
• Sheep's-bit	☐							
• Umbellifers, e.g. Wild parsnip and hogweed	☐							
• Wood sage	☐							
• Yellow composites (includes Ragwort!)	☐							
• Yellow loosestrife	☐							
Bracken , Hawthorn (Extra-floral nectarines, July-August)	☐				Reduction in extent through trampling.	Loss of nectar resource in flower-poor areas.	**INVERTS**	Ants Flies Wasps
Grasses (July/August flowering)	☐				Removal of flowering shoots through grazing or trampling, or complete loss of plants.	Loss of important pollen source for adult insects.	**INVERTS**	Flies

Resource table 2 – Seed & fruit resources.

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
SCRUB SEEDS & FRUIT					Removal of flowering/ fruiting shoots through browsing, or complete loss of plants.	Loss of protein (in seed) for larval development and sugars (in fruit) for adults.	**INVERTS**	Beetles Moths Flies Bugs
• Bilberry	☐							
• Blackberries	☐							
• Blackthorn	☐							
• Broom	☐							
• Gorse	☐							
• Hawthorn	☐							
• Holly	☐							
• Rose–hips	☐							
• Rowan	☐							
HERBACEOUS PLANT SEED AND FRUIT HEADS					Removal of flowering/ fruiting shoots through grazing, trampling, or complete loss of plants.	Loss of protein for larval development. Seed head may be required all year round. Pupation often occurs in seed head/pod. Adult food resource.	**INVERTS**	Beetles Bugs Flies Moths
• Campions	☐							
• Knapweed	☐							
• Legumes	☐							
• Umbellifers	☐							
• Yellow composites	☐							
GRASS SEEDS	☐				Removal of flowering/ fruiting shoots through grazing, trampling, or complete loss of plants.	Loss of protein for adults and larvae.	**INVERTS**	Ants Beetles Bugs

Resource table 3 – Foliage resources.

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
SCRUB					Removal of foliage through grazing, trampling, possibly leading to complete loss of plants. Foliage variably palatable to stock. Therefore potential severity of impact also very variable. E.g. Only goats and deer will make any impact on Pine, but sucker aspen is highly palatable to all grazing animals.	Loss of major food resource, both for larvae and many adults. Young, isolated bushes or sucker growth in warm microclimates very important resource. Old senescent trees also valuable. Over long time-scales recruitment to mature trees an issue.	**INVERTS**	Aphids Butterflies Beetles Bugs Gall Wasps Leaf-hoppers Moths Sawflies
• Aspen	☐							
• Bilberry	☐							
• Birch	☐							
• Broom	☐							
• Gorse (all species)	☐							
• Heather	☐							
• Pine	☐							
• Rowan	☐							
• Sallow	☐							
HERBACEOUS PLANTS					Removal of foliage through grazing, trampling, possibly leading to complete loss of plants. Foliage variably palatable to stock. Therefore potential severity of impact also very variable. E.g. Sheep's Sorrel of very low palatability, major threat through trampling, but Yellow Loosestrife highly palatable to all grazing animals.	Loss of major food resource for larvae and many adults.	**INVERTS**	Aphids Beetles Bugs Bush-crickets Butterflies Gall Wasps Grasshoppers Leaf-hoppers Moths Sawflies
• Heath bedstraw	☐							
• Sheep's-bit	☐							
• Sheep's sorrel	☐							
• Spurreys	☐							
• St. John's-wort	☐							
• Yellow loosestrife	☐							

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
GRASSES, RUSHES AND SEDGES					Removal of foliage through grazing, trampling, possibly leading to complete loss of plants. Foliage of most species highly palatable.	Loss of major food resource for larvae and many adults.	**INVERTS**	Aphids Bugs Bush-crickets Butterflies Grasshoppers Leaf-hoppers Moths Sawflies
• *Agrostis* curtisii	☐							
• *Anthoxanthum odoratum*	☐							
• *Deschampsia cespitosa*	☐							
• *Festuca ovina*	☐							
• *Luzula campestris*	☐							
• *Luzula multiflora*	☐							
• *Molinia caerulea*	☐							
LOWER PLANTS	☐				Removal through grazing, or more likely, trampling.	Loss of food resource for larvae	**INVERTS**	Moths
FUNGI	☐				Loss through trampling	Loss of food resource for larvae	**INVERTS**	Moths

Resource table 4 – Structural resources.

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
MATURE AND DEGENERATE DRY HEATH WITH DEEP MOSS AND LICHEN LAYERS	☐				Old heather especially sensitive to trampling damage leading to loss of cover. Lichen and moss layer sensitive to trampling leading to reduced depth and moisture retention.	Loss of prime areas for reptiles, ideal for basking, foraging, and hibernation. Excellent shelter due to locally high humidity in lichen layer - crucial on dry heath.	**REPTILES**	
							INVERTS	Spiders Springtails and other litter fauna
DWARF GORSE ON DRY HEATH	☐				Decline in abundance due to direct grazing	Loss of areas with good protection from predators	**REPTILES**	
							INVERTS	Spiders
DRY, TUSSOCKY ACID GRASSLAND	☐				Reduction in structural diversity. Reduction in litter layer due to grazing and trampling	Loss of areas for basking, foraging, shelter, hibernation	**REPTILES**	
							INVERTS	Spiders Beetles Bugs Flies Springtails and other litter fauna
***MOLINIA* LITTER AND TUSSOCKS ON HUMID OR WET HEATH**	☐				Breaking up of tussocks and reduction in litter layer due to grazing and trampling	Loss of areas for basking, foraging, shelter & hibernation sites	**REPTILES**	
							INVERTS	Spiders Ants Beetles Bugs Bush-crickets Flies Springtails and other litter fauna
ACCUMULATED DECOMPOSING VEGETATION	☐				Trampling and compaction	Loss of Egg-laying, foraging, shelter & hibernation sites	**REPTILES**	
							INVERTS	Beetles Flies Springtails and other litter fauna

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
HEATHER – GRASS INTERFACE	☐				Reduction in structural continuity between habitats through grazing and/or direct trampling effects	Loss of local warmth, cover and plant species diversity	**REPTILES**	
							INVERTS	Spiders Ants Beetles Bugs Bush-crickets Butterflies Flies Grasshoppers Leaf-hoppers Moths Sawflies Wasps
DRY AREAS WITH BARE GROUND AND EARLY SUCCESSIONAL VEGETATION.	☐				Excessive disturbance through frequent trampling	Loss of specialist plant flora of dry areas (especially annual plants) and associated fauna. Reduction in plant structural diversity, basking and foraging areas.	**REPTILES**	
							INVERTS	Spiders, especially Wolf and Jumping spiders. Ants Aphids Bees Beetles Bugs Bush-crickets Butterflies Flies Grasshoppers Leaf-hoppers Moths Sawflies Wasps

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
DRY AREAS WITH BARE GROUND BORDERING MATURE HEATH	☐				Reduction in structural continuity between habitats through grazing and/or direct trampling effects.	Loss of local warmth, cover and plant species diversity. Egg-laying sites for reptiles and insects. Larval habitat for insects. Adult insect hunting areas	**REPTILES**	
							INVERTS	Spiders, especially Wolf and Jumping spiders. Ants Aphids Bees Beetles Bugs Flies Grasshoppers Wasps
WET AREAS WITH BARE GROUND, MARGINS OF PONDS INCLUDING DRAW-DOWN ZONES.	☐				Excessive disturbance through frequent trampling	Loss of specialist plant flora of wet areas (especially draw-down zone and sphagnums) and associated fauna. Reduction in plant structural diversity, basking and foraging areas	**REPTILES**	
							INVERTS	Spiders, especially Wolf and Jumping spiders. Ants Aphids Beetles Bugs Flies Leaf-hoppers Wasps
DRY HEATH – WET HEATH INTERFACE	☐				Reduction in structural continuity between habitats through grazing and/or direct trampling effects.	Loss of local warmth, cover and plant species diversity	**REPTILES**	
							INVERTS	Spiders Ants Aphids Beetles Bugs Bush-crickets Flies Grasshoppers Leaf-hoppers Moths Wasps

RECORD YOUR ASSESSMENT BELOW					HAZARDS, IMPACTS & AFFECTED GROUPS			
Feature	**TICK**	**Abun-dance DAFOR**	**Risk H/M/L**	**Explanation of Assessment**	**Nature of Hazard**	**Impact on fauna**	**Affected Group**	**Detail**
BARE SOIL/SAND	☐				Reduction of firm, bare ground by regular disturbance and trampling, e.g. in lying-up area, along very regularly used paths.	Loss of egg-laying sites for reptiles. Nesting sites for ants, bees and wasps. Larval development sites for beetles and flies. Hunting and basking sites.	**REPTILES**	
							INVERTS	Wolf and Jumping Spiders Ants Beetles Bugs Mining Bees Wasps
SHORT VEGETATION	☐				Compaction of soil/plant layer, without breaking through root mat.	Loss of underground ant nests Foraging sites and basking sites.	**REPTILES**	
							INVERTS	Ants
TALL VEGETATION AND SCRUB	☐				Removal of resource by grazing animals	Reduction or loss of 'pegs' from which to hang webs, including egg sacks. Shelter, especially in poor weather conditions	**REPTILES**	
							INVERTS	Spiders Ants Aphids Bees Beetles Bugs Bush-crickets Butterflies Flies Grasshoppers Leaf-hoppers Moths Sawflies Wasps
GRAZING TOLERANT PLANTS	☐				Loss of specialist plant flora through frequent trampling, e.g. Horsetails, Bracken	Loss or reduction in representation of specialist plant/insect associations	**REPTILES**	
							INVERTS	Moths Sawflies

Appendix 3 Species associations tables

A. Species associations table – reptiles

STRUCTURAL RESOURCES			
Specific Feature	**Affected group**	**Example species**	**Association with Feature**
Degenerate dry heath	Reptiles	All species, esp. **sand lizard** and **smooth snake**	Prime reptile habitat**, ideal for basking, foraging, shelter, hibernation**
Deep moss and lichen layers on degenerate dry heath		All species, esp. **smooth snake** and **slow worm**	Excellent shelter due to high humidity - **crucial on dry heath**
Mature dry heath		All species	Basking, foraging, shelter, hibernation
Dwarf gorse on dry heath		All species	Good protection from predators
Dry, tussocky acid grassland		All species, esp. **adder**	Basking, foraging, shelter, hibernation
***Molinia* straw and tussocks on humid or wet heath**		All species (except sand lizard)	Basking, foraging, shelter & reptiles often hibernate in ***Molinia*** tussocks
Bare sand		**sand lizard**	Egg-laying sites
Heaps of vegetation		**grass snake**	Egg-laying sites
Woodland glades and under-storey		Mainly **slow worm**, **grass snake**, **adder**	Foraging, basking and shelter
Pond margins		**grass snake**	Foraging, basking

B. Species associations table - insects

Table A - Vegetative Features: Scrub, Trees and Shrubs
Table B - Vegetative Features: Herbaceous Plants (Not Grasses)
Table C - Vegetative Features: Grasses, Sedges and Rushes
Table D - Vegetative Features: Lower Plants
Table E - Structural Features

Notes

i. The purpose of these tables is to aid the site manager in interpreting the general information given in the feature table, at the level of individual species. The information given is in no way exhaustive and we expect individual experience to extend and refine – even refute – some of it.

ii. The tables only lists species or groups for which there is greater specific detail than that given in the Resource Tables.

iii. Most species listed have major, or sole, populations associated with heathlands (where generic groups are listed there are strongly heathland associated species as well as more widespread ones involved).

iv. Species or groups in brackets have good populations in habitat types other than heathland. They may, however, form important prey resources for strongly heathland-associated fauna (e.g. large populations of plant-hoppers on aspen/birch/sallow are vital as prey for several species of solitary wasp (genus *Mimesa*) with strong heathland associations). Large populations of spiders form important prey for lizards.

v. Some species may be associated with widespread plants, but effectively restricted to heathlands due to other factors such as temperature, humidity and/or soil structure.

TABLE A - VEGETATIVE FEATURES: SCRUB, TREES AND SHRUBS			
Specific Feature	**Affected Group**	**Example Species**	**Association With Feature**
Alder buckthorn (flowers)	**BEES**	*Andrena* sp.	Nectar supply for adults.
		Lasioglossum sp.	Nectar supply for adults.
		Nomada sp.	Nectar supply for adults (Cuckoo bees).
		Sphecodes sp.	Nectar supply for adults (Cuckoo bees).
	FLIES	**Empid flies**	
		Empis sp.	Nectar Source. Capture visiting insects as prey.
		Rhamphomyia sp.	Nectar Source. Capture visiting insects as prey.
		Hoverflies	Nectar Source.
	WASPS	*Anoplius* sp.	Nectar supply for adults.
		Crabro sp.	Nectar supply for adults.
		Crossocerus sp.	Nectar supply for adults.
		Symmorphus sp.	Nectar supply for adults.
Alder buckthorn (foliage)	**MOTHS**	*Bucculatrix frangutella*	Larval food source.
		Sorhagenia rhamniella	Larval food source.
		Sorhagenia lophyrella	Larval food source.
		Sorhagenia janiszewskae	Larval food source.
		Eupoecilia ambiguella	Larval food source.
		Ancylis obtusana	Larval food source.
		Anclyis unculana	Larval food source.
		Ancylis apicella	Larval food source.
		The Tissue	Larval food source.
Aspen (flowers)	**MOTHS**	*(Dorytomus dejeani)*	Food resource for young.
		(Dorytomus tortrix)	Food resource for young.
		(Dorytomus tremulae)	Food resource for young.
Aspen (foliage)	**APHIDS**	(Large populations)	Food resource for adults and young.
	BEETLES	*(Byctiscus betulae)*	Food resource for adults and young.
		(Byctiscus populi)	Food resource for adults and young.
		(Cantharis sp. *)*	Food resource for adults.
		(Chalcoides aurea)	Food resource for adults and young.
		(Chalcoides nitidula)	Food resource for adults and young.
		(Chrysomela populi)	Food resource for adults and young.
		(Chrysomela tremulae)	Food resource for adults and young.
		(Gonioctena decemnotata)	Food resource for adults and young.
		(Rutidosoma globulus)	Food resource for adults and young.
		(Saperda populnea)	Food resource for young.
		(Zeugophora flavicollis)	Food resource for adults and young.
		(Zeugophora subspinosa)	Food resource for adults and young.
	BUGS	*(Brachyarthrum limitatum)*	Food resource for adults and young.
		(Neomecomma bilineatus)	Food resource for adults and young.
	LEAF HOPPERS (BUGS)	*(Idiocerus laminatus)*	Food resource for adults and young.
		(Idiocerus populi)	Food resource for adults and young.
		(Idiocerus tremulae)	Food resource for adults and young.
		(Idiocerus ustulatus)	Food resource for adults and young.

… **Aspen** (foliage)	**MOTHS**	*Ectoedemia argyropeza*	Sole larval food source.
		Stigmella assimilella	Larval food source.
		Paraleucoptera sinuella	Sole larval food source.
		Phyllonorycter sagitella	Sole larval food source.
		Gelechia nigra	Larval food source.
		Anacampsis populella	Larval food source.
		Pseudosciaphila branderiana	Sole larval food source.
		Ancylis laetana	Larval food source.
		Epinotia maculana	Larval food source.
		Gypsonoma sociana	Larval food source.
		Gypsonoma nitidulana	Sole larval food source.
		Gibberifera simplana	Sole larval food source (usually on sapling).
		Light-orange Underwing	Main larval food source.
		The Chevron	Larval food source.
		Small Chocolate-tip	Larval food source.
		Angle-striped Sallow	Larval food source.
	SAWFLIES	*Amauronematus puniceus*	Larval food resource
		Euura atra	Larval food resource
	WASPS	*Mimesa bruxellensis*	Prey on leaf-hoppers.
		Symmorphus crasicornis	Prey on *Chrysomela populi* larvae.
Bilberry (flowers)	**BEES**	*Andrena sp.*	Nectar source for adults. Pollen for nests, includes specialist (*A. lapponica*)
		Bombus sp.	Nectar source for adults. Pollen for nests.
		(Lasioglossum sp.)	Nectar source for adults. Pollen for nests.
		Nomada sp.	Nectar source for adults (Cuckoo bee).
	FLIES	**Conopids**	
		Conops vesicularis	Nectar source. Lays eggs in visiting queen wasps.
		Myopa sp.	Nectar source. Lay eggs in visiting solitary bees.
		Empid flies	
		Empis sp.	Nectar Source. Capture visiting insects as prey.
		Rhamphomyia sp.	Nectar Source. Capture visiting insects as prey.
	WASPS	*Vespula sp.*	Nectar source for queens.
Bilberry (fruit)	**FLIES**	(Many, no strong heathland associates with known strong dependence on resource)	Sugar source for adults.
Bilberry (foliage)	**MOTHS**	*Acleris hemana*	Larval food resource.
		Pyla fusca	Larval food resource.
		Rhopobata myrtillana	Sole larval food resource.
		Stigmella myrtillella	***Vaccinium*** sp. are sole larval food resource.
		Beautiful Snout	Sole larval food resource.
		Bilberry Pug	Sole larval food resource.
		Fox Moth	Sole larval food resource.
		Little Thorn	Sole larval food resource.
		Manchester Treble-bar	***Vaccinium*** sp. are sole larval food resource.
		Ringed Carpet	Larval food resource.
		Scarce Silver-Y	Larval food resource.
		Smokey Wave	Larval food resource.

Birch (catkins)	**MOTHS**	*Cochylis nana*	Sole larval food source.
		Epinotia bilunana	Sole larval food source.
		E. ramella	Sole larval food source.
		E/ demarniana	Larval food source.
		Pammene obscurana	Sole larval food source.
Birch (foliage)	**APHIDS**	(Large populations)	Food resource for adults and young.
	BEETLES	*(Ampedus balteatus)*	Larvae in dead stumps.
		Ampedus sanguinolentus	Larvae in dead stumps.
		(Anoplus plantaris)	Sole larval food resource.
		(Coeliodes rubicundus)	Sole larval food resource.
		(Cryptocephalus bipunctatus)	Sole larval food resource.
		(Cryptocephalus labiatus)	Food resource for adults and young.
		Cryptocephalus parvulus	Sole larval food resource.
		Cryptocephalus punctiger	Sole larval food resource..
		(Curculio betulae)	Food resource for adults and young.
		Curculio rubidus	Sole larval food resource.
		(Lochmaea capreae)	Food resource for adults and young.
		Luperus flavipes)	Food resource for adults and young.
		Luperus longicornis)	Sole larval food resource.
		(Magdalis carbonaria)	Sole larval food resource.
		(Orchestes rusci)	Sole larval food resource.
		Strophosoma capitatum	Adult food resource.
		(Phyllobius pyri)	Adult food resource.
		(Polydrusus cervinus)	Adult food resource.
		(Rhynchites nanus)	Sole larval food resource.
		(Rhynchaenus stigma)	Sole larval food resource.
		(Trichapion simile)	Sole larval food resource
	LEAF-HOPPERS (BUGS)	(*Cixius* sp., Oncopsis sp., Large populations)	Food resource for adults and young.
	MOTHS	*Eriocrania unimaculella*	Sole larval food source.
		Eriocrania sparrmannella	Sole larval food source.
		Eriocrania salopiella	Sole larval food source.
		Eriocrania haworthi	Sole larval food source.
		Eriocrania sangii	Sole larval food source.
		Eriocrania semipurpurella	Sole larval food source.
		Stigmella continuella	Sole larval food source.
	MOTHS	*Stigmella betulicola*	Sole larval food source.
		Stigmella sakhalinella	Sole larval food source.
		Incurvaria pectinea	Larval food source.
		Lampronia fuscatella	Sole larval food source.
		Heliozela hammoniella	Sole larval food source.
		Bucculatrix demaryella	Larval food source.
		Caloptilia populetorum	Sole larval food source.
		Caloptilia betulicola	Sole larval food source.
		Parornix betulae	Sole larval food source.
		Phyllonorycter cavella	Sole larval food source.
		Phyllonorycter anderidae	Sole larval food source.

… Birch (foliage)	**MOTHS**	*Phyllonorycter ulmifoliella*	Sole larval food source.
		Coleophora milvipennis	Sole larval food source.
		Coleophora fuscocuprella	Larval food source.
		Coleophora binderella	Larval food source.
		Coleophora ibipennella	Sole larval food source.
		Teleiodes proximella	Larval food source.
		Teleiodes alburnella	Sole larval food source.
		Anacampsis blattariella	Sole larval food source.
		Hypatima rhomboidella	Larval food source.
		Apotomis turbidana	Sole larval food source.
		Apotomis betuletana	Sole larval food source.
		Apotomis sororculana	Sole larval food source.
		Ancylis uncella	Larval food source.
		Ancylis upupana	Larval food source.
		Epinotia immundana	Larval food source.
		Epinotia trigonella	Sole larval food source.
		Epinotia brunnichana	Larval food source.
		Ortholepis betulae	Sole larval food source.
		Scalloped Hook-tip	Sole larval food source.
		Pebble Hook-tip	Larval food source.
		Yellow Horned	Sole larval food source.
		Orange Underwing	Main larval food source.
		Large Emerald	Sole larval food source.
		Small Grass Emerald	Larval food source.
		Birch Mocha	Sole larval food source.
		The Chevron	Larval food source.
		Autumnal Moth	Larval food source.
		Northern Winter Moth	Larval food source.
		Purple Thorn	Larval food source.
		Ringed Carpet	Larval food source.
		Grey Birch	Sole larval food source.
		Common White Wave	Main larval food source.
		Silvery Arches	Larval food source in later instars.
	MOTHS	Northern Drab	Preferred larval food source.
		The Miller	Larval food source.
		Angle-striped Sallow	Larval food source.
	SAWFLIES	*Cimbex femoratus*	Sole larval food resource.
	WASPS	Many species	Aphids and leafhoppers form important prey resource.
Blackthorn (flowers)	**BEES**	*Andrena* sp.	Nectar source for adults. Pollen resource for nests.
		Bombus sp.	Nectar source for adults. Pollen resource for nests.
		(Lasioglossum sp.*)*	Nectar source for adults. Pollen resource for nests.
		Nomada sp.	Nectar source for adults (Cuckoo bees).
	BUTTER-FLIES	(Comma, Small Tortoiseshell, Green-veined White, Brimstone.)	Provides early nectar for over-wintered/newly emerged adults. Heathland/wood edge provides a good, dry hibernation site for adults.
	FLIES	**Beeflies**	
		Bombylius major	Nectar source for adults.

…	**….**	**Conopids**	
Blackthorn (flowers)	**FLIES**	*Conops vesicularis*	Nectar source for adults.
		Myopa sp.	Nectar source for adults. Lay eggs in visiting solitary bees.
		Empid flies	
		Empis sp.	Nectar Source for adults. Capture visiting insects as prey.
		Rhamphomyia sp.	Nectar Source for adults. Capture visiting insects as prey.
		Hoverflies	
		(Cheilosia sp.)	Pollen and nectar source for adults.
		Plastycheirus ambig	Pollen and nectar source for adults. Strong association with blackthorn flowers.
Blackthorn (fruit)	**SAWFLIES**	*Hoplompa chrysorrhoae*	Larval food resource
Blackthorn (foliage)	**BUGS**	*(Cardiastethus fasciiventris)*	Food resource for adults and young.
	SAWFLIES	Various species	Food resource for adults and young.
Bramble (flowers)	**BEES**	*Andrena* sp.	Nectar source for adults. Pollen resource for nests.
		Anthophora bimaculata	Nectar source for adults. Pollen resource for nests.
		Bombus sp.	Nectar source for adults. Pollen resource for nests.
		Lasioglossum sp.	Nectar source for adults. Pollen resource for nests.
		Coelioxys rufescens	Nectar source for adults (Cuckoo bees).
		Nomada sp.	Nectar source for adults (Cuckoo bees).
		Sphecodes sp.	Nectar source for adults (Cuckoo bees).
	BEETLES	(*Strangalia* sp.)	Nectar source for adults. (Larvae often associated with woodlands at edges of heaths.)
	FLIES	*Thyridanthrax fenestratus*	Nectar source for adults.
		Bombylius minor	Nectar source for adults.
		Criorhina asilica.	Nectar source for adults. (Larvae often associated with woodlands at edges of heaths.)
	WASPS	*Ammophila pubescens*	Nectar source for adults.
		Ammophila sabulosa	Nectar source for adults.
		Crossocerus sp.	Nectar source for adults. Source of prey aphids.
Bramble (fruit)	**BUGS**	Many species	Sugar source for adults and young.
	FLIES	Many species	Sugar source for adults.
	MOTHS	Many species	Sugar source for adults.
Broom (seeds)	**BEETLES**	*(Exapion fuscirostre)*	Food resource for larvae.
		(Bruchidius villosus)	Food resource for larvae.
Broom (foliage)	**BEETLES**	*(Dryophilus anobiodes)*	Dead branches are larval food resource.
		(Cryptolestes spartii)	Dead branches are larval food resource.
		(Gonioctena olivacea)	Food resource for adults and larvae.
		(Hylastinus obscurus)	Dead branches are larval food resource.
		(Phlocophthorus rhododactylus)	Dead branches are larval food resource.
		Pirapion atratulum	Larvae in galls in young stems.
		Pirapion immune	Larvae in galls in young stems.
		Polydrusus confluens	Food resource for adults and larvae.
		(Sitona regensteinensis)	Larvae in root nodules.
		(Sitona striatellus)	Food resource for adults and young.

… **Broom** (foliage)	**BUGS**	*(Dictyonota fuliginosa)*	Food resource for adults and young.
		(Dictyonota strichnocera)	Food resource for adults and young.
		(Heterocordylus tibialis)	Food resource for adults and young.
		(Orthotylus adenocarpi)	Food resource for adults and young.
		(Orthotylus concolor)	Food resource for adults and young.
		(Orthotylus virescens)	Food resource for adults and young.
		(Piezodorus lituratus)	Food resource for adults and young.
	LEAF HOPPERS (BUGS)	*(Euscelis ohausi)*	Food resource for adults and young.
		(Gargara genistae)	Food resource for adults and young.
	MOTHS	*Phyllonorycter scopariella*	Sole larval food resource.
		Coleophora saturatella	Larval food resource.
		Agonopterix assimilella	Sole larval food resource.
		Agonopterix scopariella	Sole larval food resource.
		Agonopterix nervosa	Larval food resource.
		Anarsia spartiella	Larval food resource.
		Grass Emerald	Larval food resource.
		Lead Belle	Larval food resource.
		The Streak	Sole larval food resource.
		Broom-tip	Sole larval food resource.
		Grass Wave	Larval food resource.
		Dark Tussock	Larval food resource.
Cranberry (foliage)	**MOTHS**	*Olethreutes schulziana*	Sole larval food resource.
Gorse - all species (flowers)	**BEES**	*Bombus jonellus*	Pollen source for queen and for nest.
	FLIES	Empid flies	
		Empis sp.	Nectar Source. Capture visiting insects as prey.
Gorse - all species (flowers)	**FLIES**	*Rhamphomyia* sp.	Nectar Source. Capture visiting insects as prey.
	MOTHS	*Mirificarma mulinella*	Flowers are larval food resource (**Common Gorse**).
		Grass Wave	Flowers are larval food resource.
Gorse - all species (seed)	**BEETLES**	*(Exapion ulicis)*	Seed is larval food resource.
	WASPS	*Cerceris sp.*	Prey on weevils, which develop in gorse seeds.
Gorse - all species (foliage)	**BUTTER-FLIES**	Green Hair-streak	Larval food resource.
		Silver-studded Blue	Larval food resource.
	BEETLES	*Calomicrus circumfuscus*	Food resource for adults and young.
		(Hylastinus obscurus)	Dead branches are larval food resource
		Pirapion atratulum	Larvae in galls in young stems.
		Polydrusus confluens	Food resource for adults and larvae.
		(Sitona regensteinensis)	Larvae in root nodules.
		(Sitona striatellus)	Food resource for adults and young.
	BUGS	*(Asciodema obsoletum)*	Food resource for adults and young.
		(Cardiastethus fasciiventris)	Food resource for adults and young.
		(Pachylops bicolor)	Food resource for adults and young.
		(Piezodorus lituratus)	Food resource for adults and young.
		Phyllonorycter ulicicolella	Sole larval food resource.
		Agonopterix ulicetella	Sole larval food resource.

… Gorse - all species (foliage)	**MOTHS**	*Agonopterix nervosa*	Larval food resource.
		Anarsia spartiella	Larval food resource.
		Scythris grandipennis	Sole larval food resource (esp. ***Ulex minor***)
		Pempelia genistella	Sole larval food resource.
		Grass Emerald	Larval food resource.
		Lead Belle	Larval food resource.
		July Belle	Larval food resource.
Dwarf gorse (foliage)	**BEETLES**	*Calomicrus circumfuscus*	Food resource for adults and young.
		Hypera venusta	Food resource for adults and young.
		Stenopterapion scutellare	Larvae in stem galls.
Petty whin (seed)	**BEETLES**	*Exapion genistae*	Larval food resource.
Hawthorn (flowers)	**BEES**	*Andrena* sp.	Nectar source for adults. Pollen resource for nests.
		Bombus sp.	Nectar source for adults. Pollen resource for nests.
		Lasioglossum sp.	Nectar source for adults. Pollen resource for nests.
		Nomada sp.	Nectar source for adults (Cuckoo bees).
	BEETLES	*(Strangalia sp.)*	Pollen and nectar for adults.
		Megalithes sp.	Pollen and nectar for adults. Larval food resource.
		Cantharis sp.	Pollen and nectar for adults.
	FLIES	Conopids	
		(Myopa sp.)	Nectar source for adults. Lay eggs in visiting solitary bees.
		Empid flies	
		Empis sp.	Nectar Source for adults. Capture visiting insects as prey.
		Rhamphomyia sp.	Nectar Source for adults. Capture visiting insects as prey.
Hawthorn (foliage)	**SAWFLIES**	*Trichostoma lucorum*	Larval food resource
Heathers (flowers)	**CRAB SPIDERS**	*Evarcha arcuata*	Insects visiting flowers form important prey resource.
		Thomisius onustus	Insects visiting flowers form important prey resource.
		Oxopes heterophthalmus	Insects visiting flowers form important prey resource.
	ANTS	*Formica* sp.	Nectar source for adults.
		Lasius sp.	Nectar source for adults.
		Myrmica sp.	Nectar source for adults.
	BEES	*Andrena* sp.	Nectar source for adults. Pollen resource for nests.
		Bombus sp.	Nectar source for adults. Pollen resource for nests.
		Epeolus cruciger	Nectar source for adults. (Cuckoo bee).
		Lasioglossum sp.	Nectar source for adults. Pollen resource for nests.
		Nomada sp.	Nectar source for adults. (Cuckoo bee).
		Sphecodes sp.	Nectar source for adults. (Cuckoo bee).
	BUTTER-FLIES	Silver-studded Blue	Nectar source for adults.

…	**FLIES**	Conopids	
Heathers (flowers)		*Myopa fasciata*	Nectar source for adults. Lays eggs in visiting solitary bees.
		Hoverflies	
		Dasysrphus tricinctus	Nectar source for adults.
		Empid flies	
		Empis vitripennis	Nectar source for adults.
		Rhamphomyia variabilis	Nectar source for adults.
	MOTHS	*Amblyptilia acanthadactyla*	Flowers & unripe seeds are larval food source.
		Ling Pug	***Calluna*** & ***Erica*** flowers are sole larval food source.
		Narrow-winged Pug	***Calluna*** flowers are sole larval food source.
		Shoulder-striped Clover	Main larval food resource; ***Calluna*** & ***Erica*** flowers.
	WASPS	*Elampus panzeri*	Nectar source for adults.
		Psen sp.	Nectar source for adults.
		Priocnemis sp.	Nectar source for adults.
Heathers (foliage)	**BEETLES**	*Altica ericeti*	Food resource for adults and young.
		Coniocleonius nebulosus	Food resource for adults and young.
		Cryptocephalus biguttatus	Food resource for adults and young.
		Lochmea suteralis	Food resource for adults and young.
		Micrelus ericae	Food resource for adults and young.
		Strophosoma sus	Food resource for adults and young.
	BUGS	*Globiceps juniperi*	Food resource for adults and young.
		Ischnocoris angustulus	Food resource for adults and young.
		Kleidocerys truncatulus	Food resource for adults and young.
		Macrodema micropterum	Food resource for adults and young.
		Nabis ericetorum	Food resource for adults and young.
		Nysius helveticus	Food resource for adults and young.
		Orthotylus ericetorum	Food resource for adults and young.
Heathers (foliage)	**BUGS**	*Pterometus staphyliniformis*	Food resource for adults and young.
		Rhacognathus punctatus	Food resource for adults and young.
		Scolopostethus decoratus	Food resource for adults and young.
		Trapezenotus desertus	Food resource for adults and young.
	BUTTER-FLIES	Silver-studded Blue,	Larval food resource.
	LEAF-HOPPERS (BUGS)	*Scleroracus corniculus*	Food resource for adults and young.
		Scleroracus decumanus	Food resource for adults and young.
		Scleroracus plutonius	Food resource for adults and young.
		Ulopa reticulata	Food resource for adults and young.
	MOTHS	*Pachythelia villosella*	Larval food resource; ***Calluna*** & ***Erica***.
		Coleophora juncicolella	Sole larval food resource; ***Calluna*** & ***Erica***.
		Coleophora pyrrhulipennella	Sole larval food resource; ***Calluna*** & ***Erica***.
		Amphisbatis incongruella	Larval food resource; ***Calluna***
		Aristotelia ericinella	Sole larval food resource; ***Calluna***
		Xenolechia aethiops	Sole larval food resource; ***Erica***
		Lita sexpunctella	Sole larval food resource; ***Calluna*** & ***Erica***

…	**MOTHS**	*Neofaculta ericetella*	Sole larval food resource; ***Calluna*** & ***Erica***
Heathers		*Argyrotaenia ljungiana*	Main larval food resource; ***Erica***
(foliage)		*Acleris hyemana*	Larval food resource; ***Calluna*** & ***Erica***
		Ancylis unguicella	Sole larval food resource; ***Erica cinerea***, occ. ***Calluna***.
		Ancylis uncella	Larval food resource; ***Erica***.
		Pyla fusca	Main larval food resource; ***Erica***.
		Pempelia palumbella	Larval food resource; ***Calluna*** & ***Erica***
		Fox Moth	Larval food resource; ***Calluna*** & ***Erica***
		Small Grass Emerald	Larval food resource; ***Calluna***.
		Smoky Wave	Larval food resource; ***Calluna***.
		Horse Chestnut	Sole larval food resource; ***Calluna***.
		Bordered Grey	Larval food resource; ***Calluna***.
		Ringed Carpet	Larval food resource; ***Erica***.
		Common Heath	Larval food resource; ***Calluna*** & ***Erica***
		The Annulet	Larval food resource; ***Calluna***.
		Grey Scalloped Bar	Sole larval food resource; ***Calluna*** & ***Erica***
		Grass Wave	Larval food resource; ***Calluna*** & ***Erica***
		Dark Tussock	Larval food resource; ***Calluna***.
		Clouded Buff	Larval food resource; ***Calluna*** & ***Erica***
		Neglected Rustic	Sole larval food resource; ***Calluna*** & ***Erica***
		Heath Rustic	Sole larval food resource; ***Calluna***.
		Beautiful Yellow Under-wing	Sole larval food resource; ***Calluna*** & ***Erica***
		Southern Chestnut	Sole larval food resource; ***Erica***.
		Light Knot-grass	Larval food resource; ***Calluna***.
		Scarce Silver Y	Larval food resource; ***Calluna***.
Bog Myrtle	**BUGS**	*Aphrophora alpina*	Larval food resource.
(foliage)		*Orchestes iota*	Larval food resource.
	MOTHS	*Hedya atropunctana*	Larval food resource.
		Silvery Arches	Larval food resource.
		Light Knot Grass	Larval food resource.
		Ringed Carpet	Larval food resource.
Pine	**BUGS**	*(Gastrodes grossipes)*	Food resource for young
(Cones)	**SAWFLIES**	Xyela julii	Larval food resource.
Pine	**APHIDS**	(Large populations)	Food resource for adults and young.
(foliage)	**BEETLES**	*(Ampedus balteatus)*	Larval food resource.
		(Ampedus nigrinus)	Larval food resource.
		(Anatis ocellata)	Food resource for adults and young.
		(Aphidecta obliterata)	Food resource for adults and young.
		(Arhopalus rusticus)	Larval food resource.
		(Arhopalus tristis)	Larval food resource.
		(Asemum striatum)	Larval food resource.
		(Cimberus atelaboides)	Larval food resource.
		(Corticeus fraxini)	Larval food resource.
		(Corticeus linearis)	Larval food resource.
		(Ernobius angusticollis)	Larval food resource.
		Ernobius nigrinus	Larval food resource.

… **Pine** (foliage)	**BEETLES**	*Ernobius pini*	Larval food resource.
		(Exochomus quadrimaculatus)	Food resource for adults and young.
		Ips sexdentatus	Larval food resource.
		(Magdalis memnonia)	Food Larval food resource.resource for adults and young.
		Melanophila acuminata	Larval food resource.
		(Myrrha octodecimguttata)	Food resource for adults and young.
		(Neomysia oblongoguttata)	Food resource for adults and young.
		Pogonocherus fasciculatus	Larval food resource.
		Scymnus nigrinus	Food resource for adults and young.
		(Scymnus suturalis)	Food resource for adults and young.
		(Thanasimus formicarius)	Larval food resource.
	BUGS	*(Acxompocoris alpinus)*	Food resource for adults and young.
		(Acompocoris pygmaeus)	Food resource for adults and young.
		(Alloeotomus gothicus)	Food resource for adults and young.
		(Atractotomus magnicornis)	Food resource for adults and young.
		(Camptozygum pinastri)	Food resource for adults and young.
		Dichrooscytus rufipennis	Food resource for adults and young.
		Megacoelum beckeri	Food resource for adults and young.
	LEAF-HOPPERS (BUGS)	*(Aguriahana germari)*	Food resource for adults and young.
		(Grypotes puncticollis)	Food resource for adults and young.
	MOTHS	*Ocnerostoma piniariella*	Sole larval food resource.
		Ocnerostoma friesei	Sole larval food resource.
		Epinotia rubiginosana	Larval food resource.
		Clavigesta purdeyi	Sole larval food resource.
	MOTHS	*Blastesthia posticana*	Sole larval food resource.
		Blastesthia turionella	Sole larval food resource.
		Rhyacionia pinivorana	Sole larval food resource.
		Bordered White	Sole larval food resource.
		Pine Beauty	Sole larval food resource.
		(Pine Hawk-moth)	Larval food resource.
	BEETLES	*Cimberus atelaboides*	Larval food resource.
	SAWFLIES	*(Neodiprion sertifer)*	Larval food resource.
		(Strongylogaster multifasciata)	Larval food resource (branches)
	WASPS	*Passaloecus eremita*	Aphids on pines form sole prey resource.
		Passaloecus turionum	Aphids form sole prey resource.
Rowan (flowers)	**FLIES**	**Empid flies**	
		Empis sp.	Nectar Source. Capture visiting insects as prey.
		Rhamphomyia sp.	Nectar Source. Capture visiting insects as prey.
Rowan (fruit)	**BEETLES**	*Rhynchites cupreus*	Larval food resource.
	MOTHS	*Stigmella nylandriella*	Sole larval food resource.
		Stigmella magdalenae	Sole larval food resource.
		Parornix scoticella	Larval food resource.
Rowan (foliage)	**SAWFLIES**	*Trichosoma sorbi*	Sole larval food resource.

Sallow (flowers)	**BEES**	*Andrena sp.*	Nectar source for adults. Pollen resource for nests. Includes specialists (*A. apicata, A. praecox, A. clarkella*)
Sallow (flowers)	**BEES**	*Bombus sp.*	Nectar source for adults. Pollen resource for nests.
		(Lasioglossum sp.)	Nectar source for adults. Pollen resource for nests.
		Nomada sp.	Nectar source for adults. (Cuckoo bee).
	BEETLES	*(Ellescus bipunctatus)*	Food resource for adults and young.
		(Dorytomus melanophthalmus)	Food resource for adults and young.
		(Dorytomus rufatus)	Food resource for adults and young.
		(Dorytomus taeniatus)	Food resource for adults and young.
	MOTHS	Most early spring species such as Pinions -	
		Lithophane sp.,	Nectar for adults.
		Quakers - *Orthosia sp.*	Nectar for adults.
		Adela cuprella	Sole larval food resource.
		Epinotia demarniana	Larval food resource; ***Salix caprea***.
		The Sallow	Sole larval food resource in early instars.
Sallow (seeds)			
Sallow (foliage)	**APHIDS**	(Large populations)	Food resource for adults and young.
	BEETLES	*Acalyptus carpini*	Food resource for adults and young.
		Agrillus viridis	Larvae mine small branches.
		(Chalcoides aurata)	Food resource for adults and young.
		(Chalcoides aurea)	Food resource for adults and young.
		(Chalcoides fulvicornis)	Food resource for adults and young.
	BEETLES	*(Chilocorus renipustulatus)*	Food resource for adults and young.
		(Gonioctena viminalis)	Food resource for adults and young.
		(Curculio salicivorus)	Food resource for adults and young.
		(Lochmaea capreae)	Food resource for adults and young.
		(Phyllodecta vitellinae)	Food resource for adults and young.
		(Rhynchaenus pseudostigma)	Food resource for adults and young.
	LEAF-HOPPERS (BUGS)	**(Large populations)**	Food resource for adults and young.
		(Aphrophora costalis)	Food resource for adults and young.
		(Aphrophora salicina)	Food resource for adults and young.
		(Idiocerus confusus)	Food resource for adults and young.
		(Idiocerus elegans)	Food resource for adults and young.
		(Idiocerus lituratus)	Food resource for adults and young.
		(Idiocerus rutilans)	Food resource for adults and young.
	MOTHS	**All Salix feeding species included here:**	
		Acanthapsyche atra	Larval food resource.
		Phyllonorycter quinqueguttella	Sole larval food resource
		Acleris ferrugana	Larval food resource.
		Hedya atropunctana	Larval food resource.
		Epinotia crenana	Sole larval food resource; especially ***Salix cinerea*** & ***Salix aurita***.
		E. brunnichana	Larval food resource.
		Small Grass Emerald	Larval food resource; ***Salix repens***.

…Sallow (foliage)	**…MOTHS**	Dingy Mocha	Sole larval food resource; small, isolated Sallow bushes up to 2m high.
		Ruddy Highflyer	Sole larval food resource; especially ***Salix aurita***.
		Dark Bordered Beauty	Sole larval food resource at English sites; ***Saix repens***.
		Dark Tussock	Larval food resource.
		Portland Moth	Main larval food resource; ***Salix repens***.
		Silvery Arches	Larval food resource in later instars.
		Northern Drab	Larval food resource.
		Dotted Chestnut	Larval food resource.
		Red-line Quaker	Sole larval food resource.
		Angle-striped Sallow	Larval food resource.
	SAWFLIES	*Euura* sp.	Food resource for young.
		Nematus sp.	Food resource for young.
		Pontania sp.	Food resource for young.
		Pristiphora sp.	Food resource for young.
	SOLITARY WASPS	Many species	Aphids and leaf-hoppers form important prey resource.

TABLE B – VEGETATIVE FEATURES: HERBACEOUS PLANTS			
Specific Feature	**Affected Group**	**Example Species**	**Association With Feature**
Flowers	**CRAB SPIDERS**	Many species	Insects visiting flowers form important prey resource.
	ANTS	*Formica* sp.	Nectar resource for adults.
		Lasius sp.	Nectar resource for adults.
		Myrmica sp.	Nectar resource for adults.
	APHIDS	(Large populations)	Food resource for adults and young.
	BEES	*Andrena* sp.	Nectar resource for adults. Pollen resource for nests, includes specialists associated with: Yellow composites, *Andrena denticulata, Andrena humilis;* White bryony, *Andrena florea*
		Anthophora bimaculata	Nectar resource for adults. Pollen resource for nests.
		Colletes fodiens.	Nectar resource for adults. Pollen resource for nests, associated with Yellow composites.
		Dasypoda altercator	Nectar resource for adults. Pollen resource for nests, associated with Yellow composites.
		(Epeolus variegatus)	Nectar source for adults. (Cuckoo bee).
		Hylaeus sp.	Nectar resource for adults. Pollen resource for nests.
		Lasoioglossum sp.	Nectar resource for adults. Pollen resource for nests. Includes specialist associated with: **Yellow composites**, *Lasioglossum brevicorne.*
		(*Macropis europaea*)	Floral oil resource for adults. Pollen resource for nests, associated with **Yellow Loosetrife**.
		(*Melitta haemorrhoa)*	Nectar resource for adults. Pollen resource for nests, associated with **Harebell**.
		Nomada sp.	Nectar source for adults. (Cuckoo bees).
		*Sphecodes s*p	Nectar source for adults. (Cuckoo bees).
	BEETLES	*Leptura livida*	Nectar source for adults.
		Meligithes obscurus	Specialist on **Wood Sage**, larval food resource.
		Meligithes subrugosus	Specialist on **Sheeps-bit**, larval food resource.
		(*Cetonia aurata* Rose Chaffèr)	Nectar source for adults.
		Many other species	Nectar source for adults.
	BUGS	*Stictopleurus* sp.	Food resource for adults and young.
	BUTTER-FLIES	(Many species)	Nectar source for adults.
	FLIES	Many species	Nectar source for adults.
	MOTHS	Many species	Nectar source for adults**. Campions (*Silene* sp.)** especially important as night-time nectar source.
		Amblyptilia acanthadactyla	Larval food resource; **Hedge Woundwort**, **restharrow** sp., **mint** sp., **geraniums**, **goosefoot** sp.
		Bordered Grey	Larval food resource; **Common Bird's-foot Trefoil** and **docks**.
	WASPS	*Arachnospila* sp.	Nectar source for adults.

… Flowers	**… WASPS**	*Cerceris* sp.	Nectar source for adults. Bees associated with flower heads form important prey resource for *Cerceris rybyensis*.
		Crabro sp.	Nectar source for adults. Flies associated with flower heads form important prey resource.
		Crossocerus sp.	Nectar source for adults. Aphids and flies associated with flower heads form important prey resource.
		Gorytes sp.	Nectar source for adults.
		Melinus arvensis	Nectar source for adults. Flies at flower heads an important prey resource.
		Mimesa sp.	Nectar source for adults.
		Oxybelus sp.	Nectar source for adults. Flies associated with flower heads form important prey resource.
		Priocnemis sp	Nectar source for adults.
Fruit and seeds	**BEETLES**	*Apion* sp.	Adult and larval food resource.
		(Bruchidius sp.)	Adult and larval food resource.
		Olibrus corticalis	Larval food resource (flowers of **Heath Groundsel**)
		Sitona sp.	Adult and larval food resource.
	BUGS	Many *Lygaeid* species	Food resource for adults and young.
	FLIES	*(Urophora* sp.)	Larval food resource.
		(Chaetorellia sp.)	Larval food resource.
		(Chaetostomella cylindrica.)	Larval food resource.
		(Terellia sp.)	Larval food resource.
	MOTHS	*Coleophora saxicolella*	Larval food resource; **goosefoot** & **orache**.
		Coleophora squamosella	Sole larval food resource; **Blue Fleabane**.
		Coleophora vestianella	Sole larval food resource; **Common Orache**.
		Coleophora clypeiferella	Sole larval food resource; **Fat Hen**.
		Piercea minimana	Sole larval food resource; **Marsh Lousewort**.
		Falseuncaria ruficiliana	Larval food resource; **Cowslip**, **Lousewort**, **Goldenrod**.
		Falseuncaria degreyana	Larval food resource; **Common Toadflax**, **Ribwort Plantain**.
		Homoeosoma nebulella	Larval food resource; **Spear Thistle**, **Ragwort**, **Tansy**, **Ox-eye Daisy**.
		Grey Carpet	Sole larval food resource; **Treacle Mustard.**
		Shoulder-striped Clover	Larval food resource; **Bog Asphodel.**
	PARASITIC WASPS	(Many species)	Insect larvae associated with seed heads form important prey resource.
Foliage	**BEETLES**	*Apion haematodes*	Specialist on **Sheep's Sorrel**. Adult and larval food resource.
		Apion rubens	Specialist on **Sheep's Sorrel**. Adult and larval food resource.
		Apion rubiginosum	Specialist on **Sheep's Sorrel**. Adult and larval food resource.
		Chrysolina hyperici	Specialist on **St. John's-Wort**. Adult and larval food resource.
		Cneorhinus plumbeus	Adult and larval food resources (many plants).
		(Cryptocephalus fulvus)	Adult and larval food resources (many plants).

… Foliage	**BEETLES**	*Gronops lunatus*	Specialist on **Spurrey**. Adult and larval food resource.
		(Longitarsus sp.)	Six species on **Ragwort**. Adult and larval food resource.
		(Lythria salicariae)	Specialist on **Yellow loosetrife**. Adult and larval food resource.
		Nanophyes gracilis	Specialist on **Water purslane**. Adult and larval food resource.
		(Pelenomus comari)	Specialist on **Marsh cinquefoil**. Adult and larval food resource.
		Pelenomus olssoni	Specialist on **Water purslane**. Adult and larval food resource.
		(Pelenomus waltoni)	Specialist on **Water pepper**. Adult and larval food resource.
		Perapion marchicum	Specialist on **Sheep's sorrel**. Adult and larval food resource.
		Sibinia potentilae.	Specialist on **Spurrey**. Adult and larval food resource.
		(Tapinotus sellatus)	Specialist on **Yellow loosetrife**. Adult and larval food resource.
	BUGS	*Eysarcoris aeneus*	Specialist on **Slender St John's wort**. Food resource for adult and young.
		Rhopalus subrufus	Strong preference for **St. John's-Wort**. Food resource for adult and young.
		Spathocera dahlmanni	Specialist on **Sheep's sorrel**. Food resource for adult and young.
		Strongylocorus luridus	Specialist on **sheeps-bit**. Food resource for adult and young.
	BUTTER-FLIES	(Common Blue)	Larval food resource.
		(Small Copper)	Larval food resource (**sheep's sorrel** in heathland situations)
	MOTHS	*Stigmella poterii serella*	Sole larval food resource; **tormentil**.
		Enteucha acetosae	Sole larval food resource; **common sorrel** & **sheep's sorrel**.
		Opostega salaciella	Sole larval food resource; **Sheep's Sorrel**.
		Incurvaria praelatella	Larval food resource; herbaceous ***Rosaceae***.
		Coleophora chalcogrammella	Sole larval food resource; **Field Mouse-ear**.
		Coleophora tricolor	Sole larval food resource; **Basil Thyme** in early instars.
		Coleophora saturatella	Larval food resource; **Dyer's Greenweed**.
		Coleophora silenella	Sole larval food resource; **Bladder Campion** & **Nottingham Catchfly**.
		Amphisbatis incongruella	Larval food resource; ***Thymus*** sp.
		Agonopterix ulicetella	Sole larval food resource; **Hairy Greenweed**.
		Agonopterix nervosa	Larval food resource; ***Genista*** sp.
		Teleiopsis diffinis	Sole larval food resource; **Sheep's Sorrel**.
		Mirificarma lentiginosella	Sole larval food resource; **Dyer's Greenweed**.
		Aroga velocella	Sole larval food resource; **Sheep's Sorrel**.

… Foliage	**MOTHS**	*Neofriseria peliella*	Sole larval food resource; **Sheep's Sorrel**.
		Neofriseria singula	Sole larval food resource; **Sheep's Sorrel**.
		Scrobipalpa artemisiella	Sole larval food resource; **Wild Thyme**.
		Anarsia spartiella	Larval food resource; **Dyer's Greenweed**
		Scythris cicadella	Sole larval food resource; **Perennial Knawel**.
		Scythris potentillella	Sole larval food resource; **Common Sorrel** & **Sheep's Sorrel**.
		Acleris comariana	Larval food resource; herbaceous ***Rosaceae***.
		Pyrausta despicata	Sole larval food resource; **Ribwort Plantain** & **Greater Plantain**.
		Anania verbascalis	Sole larval food resource; **Wood Sage**.
		Pempelia palumbella	Larval food resource; **milkworts** & **Wild Thyme**.
		Oxyptilus parvidactylus	Sole larval food resource; **hawkweed**.
		Oxyptilus distans	Sole larval food resource; **hawkweed**, **Smooth Hawk's-beard**. 2nd generation on flowers.
		Buckleria paludum	Sole larval food resource; **Round-leaved Sundew**.
		Capperia britanniodactyla	Sole larval food resource; **Wood Sage**.
		Stenoptilia graphodactyla	Sole larval food resource; **Marsh Gentian**.
		Grass Emerald	Larval food resource; **Petty Whin**.
		Tawny Wave	Larval food resource; **dandelion**, **knot-grass**.
		Purple-bordered Gold	Sole larval food resource; **Marsh Cinquefoil**.
		Dotted-border Wave	Sole larval food resource; **dandelion, knot-grass.**
		Plain Wave	Sole larval food resource; **dandelion, knot-grass.**
		Oblique Striped	Sole larval food resource; **bedstraws**.
		Lead Belle	Larval food resource; ***Genista*** sp.
		July Belle	Larval food resource; **Petty Whin**.
		Purple Bar	Sole larval food resource; **bedstraws**.
		Mottled Grey	Sole larval food resource; **bedstraws**.
		Green Carpet	Sole larval food resource; **bedstraws**.
		White-line Dart	Larval food resource.
		Archer's Dart	Larval food resource.
		Lunar Yellow Underwing	Larval food resource; this UK BAP species has been shown to be very intolerant of grazing.
		Autumnal Rustic	Larval food resource.
		Silvery Arches	Larval food resource in early instars.
		White Colon	Larval food resource.
		Northern Drab	Larval food resource, esp. **Dyer's Greenweed**, **Ragwort**.
		Brown Rustic	Larval food resource.
		Marbled Clover	Larval food resource.
		Small Purple-barred	Sole larval food resource; **Common Milkwort** & **Heath Milkwort**.
		(Dentated Pug)	Specialist on **Yellow Loosetrife**. Larval food resource.

… Foliage	**LEAF HOPPERS**	(Many species)	Adult and larval food resource.
	SAWFLIES	(Many species)	Adult and larval food resource.
	GALL WASPS	(Many species)	Larval food resource.

TABLE C - VEGETATIVE FEATURES: GRASSES, SEDGES, RUSHES			
Specific Feature	**Affected Group**	**Example Species**	**Association With Feature**
Flowers	**FLIES**	**Hoverflies**	
		Pelecocera tricincta	Pollen source for adults.
		(Platycheirus sp.)	Pollen source for adults.
Fruit and Seeds	**ANTS**	*Lasius* sp.	Adult food resource.
		Myrmica sp.	Adult food resource.
	BEETLES	*(Amara* sp.)	Adult and larval food resource.
		(Harpalus sp.)	Adult and larval food resource.
Foliage	**APHIDS**	**(Many species)**	Food resource for adult and young.
	BEETLES	*Aphanisticus emarginatus*	Specialist on ***Juncus articulatus***. Adult and larval food resource.
		(Athous haemorrhoidalis)	Larval food resource.
		Bagous lutulosus	Specialist on ***Juncus subnodulosus***. Adult and larval food resource.
		(Chaetocnema subcoerulea)	Adult and larval food resource.
		(Prosternon tessellatum)	Larval food resource.
	BUGS	*(Acetropis gimmerthali)*	Food resource for adult and young.
		(Amblytylus nasutus)	Food resource for adult and young.
		(Capsus ater)	Food resource for adult and young.
		(Leptoterna dolobrata)	Food resource for adult and young.
		(Leptoterna ferrugata)	Food resource for adult and young.
		Lopus decolor	Food resource for adult and young.
		(Megaloceraea recticornis)	Food resource for adult and young.
		(Miridius quadrivirgatus)	Food resource for adult and young.
		Myrmus miriformis	Food resource for adult and young.
		Nabis pseudoferus	Food resource for adult and young.
		(Notostira elongata)	Food resource for adult and young.
		Phytocoris insignis	Food resource for adult and young.
		(Phytocoris varipes)	Food resource for adult and young.
		(Pithanus maerkeli)	Food resource for adult and young.
		(Stenodema calcaratus)	Food resource for adult and young.
		(Stenodema holsatum)	Food resource for adult and young.
		(Stenodema laevigatum)	Food resource for adult and young.
		(Stenotus binotatus)	Food resource for adult and young.
		(Trigonotylus ruficornis)	Food resource for adult and young.
	BUSH-CRICKETS	Bog Bush-cricket	Food resource for adult and young.
		Long-winged Cone-head	Food resource for adult and young.
	BUTTER-FLIES	Grayling	Larval food resource.
		Small Heath	Larval food resource.
	FLIES	Many species	Larval food resource.
	GRASS-HOPPERS	Mottled Grasshopper	Food resource for adult and young.
		Woodland Grashopper	Food resource for adult and young.

… Foliage	**LEAF HOPPERS (BUGS)**	*(Conomelus anceps)*	Associated with ***Juncus***. Food resource for adult and young.
		Cosmotettix panzeri	Associated with **Cotton Grass**. Food resource for adult and young.
		Deltocephalus maculiceps	Food resource for adult and young.
		Euconomelus lepidus	Associated with ***Juncus***. Food resource for adult and young.
		Psammotettix albomarginatus	Associated with **Grey Hair-Grass**. Food resource for adult and young.
		Sardius argus	Associated with fine grasses. Food resource for adult and young.
		Streptanus marginatus	Associated with grasses. Food resource for adult and young.
		Xanthodelphax flaveolus	Associated with "very fine hair-grass". Food resource for adult and young.
	MOTHS	*Acanthopsyche atra*	Larval food resource; grasses.
		Pachythelia villosella	Larval food resource; grasses.
		Glyphipterix fuscoviridella	Sole larval food resource; ***Luzula*** sp. esp **Field Wood-rush**.
		Coleophora tricolor	Larval food resource; grasses in later instars.
		Sophronia semicostella	Sole larval food resource; **Sweet Vernal Grass**.
		Crambus silvella	Larval food resource; sedges.
		Crambus uliginosellus	Larval food resource; grasses.
		Crambus hamella	Larval food resource; grasses, (**Wavy Hair-grass**?).
		Agriphila inquinatella	Larval food resource; grasses, esp. **Sheep's Fescue**.
		Agriphila latistria	Larval food resource; grasses, esp. ***Bromus*** sp.
		Catoptria pinella	Larval food resource; grasses and sedges.
		Pediasia contaminella	Larval food resource; grasses.
		Platytes cerussella	Larval food resource; grasses.
		Anerastia lotella	Larval food resource; grasses.
		Speckled Footman	Sole larval food resource; **Bristle Bent** growing as isolated tussocks.
		Feathered Gothic	Larval food resource; grasses.
		Striped Wainscot	Larval food resource; grasses, esp. **Purple Moor-grass** & rushes.
		Anomalous	Larval food resource; grasses, esp. **Wavy Hair-grass**.
		Marbled White-spot	Larval food resource; grasses, esp. **Purple Moor-grass**
		Silver Hook	Larval food resource; sedges & grasses, esp. **Wood-sedge** & **Wavy Hair-grass**.
		Silver Barred	Larval food resource; grasses, esp. **Purple Moor-grass** & **Smooth Meadow-grass**.
	SAWFLIES	*Dolerus* sp.	Larval food resource.

TABLE D - VEGETATIVE FEATURES: LOWER PLANTS			
Specific Feature	**Affected Group**	**Example Species**	**Association With Feature**
Bracken (Flowers - extra-floral nectaries	**ANTS**	*Formica* sp.	Nectar source for adults.
		Lasius sp.	Nectar source for adults.
		Myrmica sp.	Nectar source for adults.
	FLIES	**Many species**	Nectar source for adults.
	WASPS	**Many species**	Nectar source for adults.
Bracken (foliage)	**BUGS**	*(Monalocoris filicis)*	Food resource for adult and young.
	LEAF HOPPERS (BUGS)	*(Ditropis pteridis)*	Food resource for adult and young.
	SAWFLIES	*Aneugmenus* sp.	Larval food resource.
		Strombocerus delicatulus	Larval food resource.
		Strongylogaster sp.	Larval food resource.
Fungi	**MOTHS**	*Apomyelois bistriatella*	Sole larval food resource; ***Daldinia*** fungus on burnt birch and gorse.
		Waved Black	Sole larval food resource; fungi, esp. those growing under fallen timber.
Mosses and Lichens	**MOTHS**	*Chionodes fumatella*	Sole larval food resource; mosses.
		Olethreutes palustrana	Sole larval food resource; mosses.
		Four-dotted Footman	Sole larval food resource; lichens and algae.
		Scarce Footman	Sole larval food resource; lichens.

TABLE E - STRUCTURAL FEATURES			
Specific Feature	**Affected Group**	**Example Species**	**Association With Feature**
Interface between plant communities	**BUGS**	*Coranus subapterus*	
***Molinia* litter and tussocks**	**ANTS**	*Formica candida*	Nesting habitat.
		Lasius platythorax	Nesting habitat.
	BUSH-CRICKETS	Bog Bush-cricket	Structural habitat for adult and young, egg-laying habitat.
	FLIES	**Hover-flies**	
		Microdon analis	Associated with *Lasius* ants in damp heathland situations.
Dry areas with bare ground and early successional vegetation.	**SPIDERS**	*Aelurillus v-insignatus*	Structural habitat. Visiting insects form prey resource.
		Xerolycosa nemoralis	Structural habitat. Visiting insects form prey resource.
		Xylotes sp.	Structural habitat. Visiting insects form prey resource.
	ANTS	*Lasius alienus*	Structural resource, nesting habitat for thermophilous species.
		Tapinoma erraticum	Structural resource, nesting habitat for thermophilous species.
		Tetramorium caespitosum	Structural resource, nesting habitat for thermophilous species.
	APHIDS	**(Many species)**	Food resource for adult and young.
	BEES	**Many species**	Structural resource, nesting habitat for a very large proportion of species. Pollen specialists having an association with typical plants of this habitat such as *Hylaeus signatus,* which collects pollen from Weld.
	BEETLES	*Bledius femoralis*	Burrowing habitat for adults and young.
		Byrrhus pustulatus	Adult and larval habitat.
		Carabus arvensis	Hunting habitat for adults and young.
		(Cicindela campestris)	Adult hunting habitat, larval burrow habitat.
		Cicindela sylvatica	Adult hunting habitat, larval burrow habitat.
		Porcinolus murinus	Adult and larval habitat.
		(Pterostichus versicolor)	Hunting habitat for adults and young.
	BUGS	*Alydes calcaratus*	Hunting habitat for adults and young.
		Coranus subapterus	Hunting habitat for adults and young.
		Hallodapus rufescens	Thought to be associated with ants
		Megalonotus dilatatus	Adult and larval habitat.
		Myrmecoris gracilis	Associated with ants, especially *Formica fusca*
		Rhyparochromus pini	Adult and larval habitat.
		Systellonotus triguttatus	Associated with ants, especially *Lasius niger* and *Formica fusca*

Dry areas with bare ground and early successional vegetation.	**BUTTER-FLIES**	Grayling	Adult and larval habitat.
		Silver-studded Blue	Adult and larval habitat.
		Small Heath	Adult and larval habitat.
		Small Copper	Adult and larval habitat.
	FLIES	**Beeflies**	
		Thyridanthrax fenestratus	Adult and larval habitat. Larva is a parasite of nests of *Ammophila* wasps in this habitat.
		Hoverflies	
		Chrysotoxum sp.	Adult and ?larval habitat (probably associated with ant nests in this habitat).
		Stiletto flies	
		Thereva bimacualata	Adult and larval habitat. Larvae predatory on other insect larvae in warm sandy areas.
		Robberflies	
		Eutolmus rufibarbis	Adult and larval habitat. Larvae predatory on other insect larvae in warm sandy areas.
	GRASS-HOPPERS	Mottled Grasshopper	Food resource for adult and young.
		Woodland Grasshopper	Food resource for adult and young.
	LEAF-HOPPERS (BUGS)	**Many species**	Very favourable warm microhabitat.
		Idionotus cruentatus	Adult and larval habitat.
	MOTHS	Speckled Footman	Very favourable warm microhabitat.
	SAWFLIES	**Many species**	Very favourable warm microhabitat with variety of plant species present.
	WASPS	**Many species**	Structural resource, nesting habitat for a very large proportion of species. Some species also prey on habitat specialists, e.g. *Methocha articulata* preys on larvae of tiger beetles.
Wet areas with bare ground, margins of ponds, including draw-down zones.	**SPIDERS**	*Sitticus caricis*	Structural habitat. Visiting insects form prey resource.
		Dolomedes fimbriatus.	Structural habitat for part of lifecycle. Visiting insects form prey resource.
		Pyrata sp.	Structural habitat. Visiting insects form prey resource.
	BEETLES	*Agonum sexpunctatum*	Adult hunting habitat.
		Aphodius niger	Adult and larval habitat.
		Bagous brevis	Specialist on **Lesser Spearwort**. Adult and larval food resource.
		Bagous collignensis	Specialist on **Water Horsetail**. Adult and larval food resource.
		Bagous czwalinae	Adult and larval habitat.
		(Bagous limosus)	Adult and larval habitat.
		Carabus nitens	Adult hunting habitat.
		(Elaphrus cupreus)	Adult hunting habitat.
	BUGS	*Hebrus ruficeps*	Sphagnum at margins of water bodies forms hunting habitat for adults and young.
		Nabis brevis	Habitat for adult and young.
		Pachybrachius fracticollis	Habitat for adult and young.
	BUGS	*Pachybrachius luridud*	Sphagnum at margins of water bodies.
		Saldula sp.	Adults and young hunt at the margins of water bodies.

… **Wet areas with bare ground, margins of ponds, including draw-down zones.**	**FLIES** **…** **FLIES**	**Dolichopid flies**	
		Dolochopus sp.	Adults hunt at the margins of water bodies.
		Hercostomus nigripennis	Habitat for adults and young.
		Notiphila sp.	Adults hunt at the margins of water bodies.
		Ochthera mantis	Adults hunt at the margins of water bodies.
		Hydroporus sp.	Adults hunt at the margins of water bodies.
		Craneflies	
		Tipula holoptera	Larvae live in wet mud/peat in bogs.
		Tipula marginella	Larvae live in wet mud/peat in bogs.
		Tipula melanoceros	Larvae live in wet mud/peat in bogs.
		Tricyphona schmellii	Larvae live in wet mud/peat in bogs.
	LEAF-HOPPERS (BUGS)	*Cicadula quinquenotata*	Adults and young in ***Sphagnum*** bogs.
		Delphacodes capnodes	Adults and young in ***Sphagnum*** bogs.
		Delphacodes venosus	Adults and young in ***Sphagnum*** bogs.
		Jassargus sursumflexus	Habitat for adult and young.
		Paradelphacodes paludosus	Adults and young in ***Sphagnum*** bogs.
		Tyrphodelphax distinctus	Adults and young in ***Sphagnum*** bogs.
	WASPS	*Anoplius concinnus*	Adult hunt spider prey at margins of ponds.

Appendix 4 Impact assessment summary sheet

Features Assessed at MEDIUM or HIGH Risk	Abun-dance DAFOR	Risk H/M/L	Action	Limits of Acceptable Change

ENGLISH NATURE

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Front cover photographs:
Top left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888