Managing woodland for butterflies and moths

Why manage woodland at all? Surely a natural woodland, without (or with minimum) intervention would best supply sustainable habitat for butterflies and moths?

The answer lies in the processes that have formed our present landscape. Almost no woodland in Britain today can be considered wholly natural. We have inherited a long history of forestry use that has substantially modified even our most ancient woodlands. We have, and still are, continuously changing the composition and structure of woods to meet our needs. The woodland wildlife we see today is a product of that history and many Lepidoptera survive in woodland habitats only because of repeated human use of woodland resources.

David Green

Sustainable removal of timber and firewood is an important part of woodland management

In Britain, applying a non-intervention approach using only natural processes within most of our woodlands will not create the habitats needed by many of our butterflies and moths. For example, many of our rarest butterflies are highly dependent on open, newly cleared woodland habitats. The natural processes that produce such habitats within woodland (such as fires, storms and the natural collapse of aging trees) typically occur too infrequently to provide the continuous cycle of clearings needed by these species. Woodlands would also have been subject to regular, extensive grazing and browsing by large herbivores which are now absent, and these effects are not replicated by the increasing number of deer now browsing our woods. The small size and fragmentation of most woods in the UK also prevent natural processes operating at a sufficient scale to conserve the full range of woodland wildlife. Low-intervention management strategies can make a contribution to the mosaic of habitats within a landscape, but need to be complementary to an active management process that maintains and enhances the valuable habitat features found in our woods.

Our current suite of woodland species coexisted in the past alongside often extensive active management of woodlands. So why is woodland management now considered a conservation issue? The reason lies in the extreme speed and the huge scale of recent changes. The usage of woodland has always changed over time, but change has happened very rapidly in the last hundred years. This has occurred not just within one type of woodland or one region of Britain, but across the whole landscape. At the same time urbanisation and intensive agriculture has removed or highly fragmented much of our woodland network.

For many species, the speed and extent of this change has made it very difficult to adapt and landscape changes have reduced opportunities to relocate to suitable habitat elsewhere.

Overall objectives

This guide outlines specific woodland management options designed to benefit butterflies and moths. These options are designed to achieve the following overall objectives:

- *Structural complexity*
- *Habitat diversity*
- *Foodplant diversity*
- *Management continuity*
- *Landscape connectivity*

The single most important factor that makes a woodland good for butterflies and moths is a diverse, uneven structure. This should include some mature or tall trees, some dense regrowth, numerous sunny rides and glades (both large and small) and patches of recently cleared and regenerating open areas with sparse ground vegetation and warm unshaded conditions. This diverse woodland structure creates a variety of habitats necessary for the various life stages of Lepidoptera, including larval foodplants growing in appropriate conditions, a limiting factor for many species.

Such a varied structure, with a diverse range of tree and plant species, not only provides good habitats for Lepidoptera, but also for a wealth of other insects and forest wildlife.

Specific requirements for specialist species requiring deadwood, lichens, mosses or wetland features can be integrated with this overall aim.

Continuity of management is the next vital factor to consider. Species usually occur on a site because its past use has created the habitat they need, and periodically repeating that management will be necessary for them to persist. This is particularly important at sites with a long history of a specific management regime. Where woodland landscapes have become fragmented management continuity is essential as it is harder for species to move to alternative habitats elsewhere.

Continuity of management is also important because habitats are dynamic: they will constantly change, often over very short time periods. Fundamentally, most woodland management for Lepidoptera is about working within a cycle of habitat succession rather than trying to maintain areas in a fixed state over time. In particular, trying to hold a permanent open area at an early stage of woodland succession (such as that used by Heath Fritillary) is almost impossible. Regular cutting or grazing may keep the site open, but will usually cause the woodland ground flora to be replaced by a grassland community which may not support the target species. Most sites will require a shifting and diverse habitat mosaic, created and maintained by regular management on different parts of the site to produce younger growth stages (clearings or short, herb-rich swards) which will in turn provide other habitats as they re-grow through woodland succession. Regular management provides continuity of short-lived habitat conditions.

Managing across the landscape

Looking beyond the survival of species on single sites, conservation must operate at the landscape scale to be effective in the long-term. There is now considerable evidence that the populations of many if not most butterflies and moths function as metapopulations. This is defined as a collection of local populations which occupy discrete habitat patches but which are connected by occasional dispersal of individuals. Each habitat patch is likely to undergo regular local extinctions and regular re-colonisations. Problems arise when the breeding patches become isolated, either by distance and/or because the intervening landscape is hostile.

Managing habitats at the landscape scale is essential given the evidence that some species are already shifting their geographical range, their habitat use and the timing of their life cycles in response to climate change. Enabling species to move

What butterflies and moths need

Peter Eeles

A Purple Emperor emerging from its chrysalis on the underside of a sallow leaf

Understanding the life cycles of butterflies and moths provides an insight into what they need from woodland habitats. All butterflies and moths go through a complex lifecycle from egg to larva (caterpillar) and then pupa (chrysalis) and adult. Some species spend much longer as an egg, larva or pupa than as an adult, and the habitat requirements of each stage may be very different.

Indeed, adult butterflies may be encountered in parts of the woodland away from the vital breeding habitat, especially when searching for nectar. In general, Lepidoptera require sheltered, warm sunny places as adults, often with a nectar source, as well as a suitable place to lay their eggs. The larvae will then require plentiful foodplants, often growing in specific conditions, and will move to a sheltered or inconspicuous spot to pupate before emerging as an adult. For highly threatened species in particular, understanding where they spend each of these stages, and at what time of year, can be the key to effective conservation. Land managers sometimes concentrate on providing the nectar-rich areas frequented by adult butterflies (where they are most often seen) at the expense of other habitat features. In fact it is rare that nectar is the factor limiting population growth, and suitable habitat for egg-laying and larval development is usually crucial. Details of individual species requirements are given in Section 4.

Sam Ellis

Open space as part of the wooded landscape at Whitbarrow, Cumbria

through the landscape and between habitats gives them a better chance of adapting to future changes. The aim should be to restore and construct landscape networks with interconnected, varied habitats. Working at the landscape scale also helps share responsibility for management, with each landowner only needing to do a small amount to contribute to the network. Coordinating management between multiple owners can be challenging, however, especially where woodlands have been split into many small plots.

The following sections detail management practices that can produce the diverse and dynamic woodland habitats that best support butterflies, moths and a variety of other wildlife. The options can be adapted to both small and large woodlands, and those with primarily conservation or commercial forestry objectives. While the suggested management has conservation aims, most will also produce commercial products such as coppice poles, timber, firewood and other wood fuels.

Management planning

Management for butterflies and moths often requires a long-term commitment to produce a diversity of habitats that will meet the requirements of a variety of species. It is essential to have clear priorities and defined aims to ensure that the main objectives are not lost in the day to day practicalities of management.

Careful planning allows you to work out what is possible and to set priorities. The stages are:

- *Assess what you have (consider what habitats and species are represented, in a local and/or regional context)*
- *Decide your objectives and priorities (incorporate the needs of butterflies and moths alongside other interests)*
- *Decide how these objectives are to be achieved over time, given your resources and any legal requirements (including felling licences, site designations and protected species)*
- *Monitor progress and examine how both vegetation and your target species respond to management (incorporating what you learn into future management)*

Once management is underway, be flexible and consider revising management prescriptions if they do not meet your objectives. It may be best to trial new management on only a proportion of the site, until monitoring results show that it does deliver the anticipated conservation outcomes.

Felling licences

As part of the management plan it must be noted that a felling licence from the Forestry Commission is generally required for the felling of trees, even if the work is part of a grant scheme. Full details are included in the Forestry Commission booklet, *Tree Felling – Getting Permission*.

Susan Clarke

Forestry operations provide a chance to improve habitat conditions whilst meeting other objectives

Dan Hoare

Using wood as fuel, in the form of logs, woodchip, pellets or charcoal, can provide an economic basis for sustainable management

Managing for different species

It may appear that many woodland butterflies and moths of conservation concern have incompatible requirements. Some species need regular woodland clearance, while others depend upon closed canopy mature trees. This does not normally cause problems except on very small sites. The following management techniques are all aimed at increasing the diversity of woodland structure and the diversity of foodplants for Lepidoptera. Diverse woodlands will contain a wide variety of habitats that will be capable of supporting a variety of species. The needs of closed canopy, high forest species and those needing early successional habitats should be seen as complementary rather than mutually exclusive. Where requirements do appear to be in conflict, particularly on small sites, it will be necessary to assess conservation priorities in a local context. Conflicting priorities will also be more easily addressed within a landscape scale approach to habitat management.

The implementation of sympathetic management regimes aimed at butterflies will, on the whole, deliver conservation for many moths. However, moths are a larger and more diverse group than butterflies. They exploit a far greater range of foodplants and habitats and additional features may need to be considered such as the availability of veteran trees, deadwood, fungi, lichens and wetland features.

Woodland management relevant to woodland butterflies and moths of concern

	Chequered Skipper	Dingy Skipper	Grizzled Skipper	Wood White	Brown Hairstreak	White-letter Hairstreak	Black Hairstreak	Duke of Burgundy	White Admiral	Purple Emperor	Small Pearl-bordered Fritillary	Pearl-bordered Fritillary	High Brown Fritillary	Silver-washed Fritillary	Heath Fritillary	UK BAP Priority moths	Other moths of concern
Promoting diversity of age structure	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Restoration and management of coppice	●	●	●	●				●			●	●	●	●	●	●	●
Ride and glade enhancement	●	●	●	●				●		●	●	●		●	●	●	●
Canopy thinning				●	●	●	●		●	●	●	●		●		●	●
Woodland edge buffering	●	●	●	●	●	●	●	●		●	●	●		●		●	●
Reinstating wetland features											●						●
Increasing deadwood resource																	●
Protection of veteran trees																●	●
Restoration of wood pasture	●										●	●					●
Managing deer to reduce browsing					●	●	●		●	●		●					●
Replacement of non-native trees																●	●
Improving connectivity	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Dan Hoare

Butterfly habitats can be ideal for a range of other wildlife - reptiles are common on this Grizzled Skipper site on the edge of a young plantation

Coppice

An active coppice cycle provides a continuous succession of open space and a varied woodland structure that can create suitable habitats for a range of wildlife

Coppice and its history

Coppice is a system of producing wood products that is based on the ability of trees to re-grow rapidly and vigorously from their cut stumps (stools). In coppice management, trees and shrubs are cut to the ground, allowed to re-grow, usually with multiple stems, and then re-cut on a set rotation. Coppicing appears to increase the life-span of trees, indeed some of the oldest coppiced stools have been estimated as more than 1,000 years old.

Usually a coppice site will be divided into many small areas (typically called coupes) and each will be cut on rotation in such a way that at anytime the site will contain coupes of all stages of growth from newly cut to mature. Coupes typically range in size from 0.5 to 3ha. The length of time between a cut on each coupe will vary with the type of wood product required and the rate of growth, but can be anything between 3 and 50 years.

Morag McCracken

Coppiced Sweet Chestnut in the Blean Woods of Kent provides habitat for the Heath Fritillary

Traditionally in Britain, two systems were used: coppice with standards and simple coppice. In coppice with standards the wood contains coppiced trees or shrubs (underwood) and also scattered timber trees (standards). The underwood would be cut on every rotation but the standards would be left to grow for perhaps three rotations to produce larger timber. In simple coppice, only the underwood is present and it is all cut on every rotation. In many areas it was traditional for domestic animals to graze within the coupes once scrub growth was more than about 4 years old, but nowadays this is rare.

Coppicing was the main form of woodland management over most of lowland Britain until the end of the 19th century. Its purpose was to produce a regular crop of small timber and woodland products and, where standards were grown, to supply a smaller amount of larger timber. Only recently, in the last 30 to 40 years, has it been viewed as a specialist management aimed at providing nature conservation benefits. In particular, it has been successfully utilised to provide the specialist open early successional woodland conditions required by some of our most threatened butterflies such as Pearl-bordered Fritillary, Heath Fritillary and High Brown Fritillary. It has also been seen as an excellent management to maintain habitat for other threatened wildlife such as helleborine plant species, dormice and nightingales.

The practice of managing woodlands as coppice may go back into prehistory. Certainly, by the time of the Domesday Book in 1086, coppicing was widespread throughout lowland England. Coppice systems have been repeatedly modified throughout history in response to changing markets. As timber uses changed, this drove changes in species choice, rotation length, and in the proportion of standards required. However, it seems probable that whatever the system, coppicing took place on such a wide scale that it created a dynamic mosaic of woodland, from open to closed canopy, providing a range of habitats for woodland wildlife. It was not until the late 1800s that markets for coppice products began to disappear and commercial coppicing diminished. This decline continued through the 20th century: in 1947, 142,000ha of actively managed coppiced woodland were reported, compared to just 23,000ha by 2000.

By the end of the 20th century, much coppiced woodland had been grubbed out for farmland, development, or converted to conifer plantations. Other woods were abandoned and reverted to closed canopy woodland dominated by mature trees. The resulting woodland structure was generally less diverse and more shaded and provided little habitat for species of open woodland. However, since the 1970s, there has been some revival of coppice management, often but not exclusively as a tool to provide specialist wildlife habitats. There is still a small market for coppice products, together with a growing number of initiatives to promote and expand that market.

The value of coppice for butterflies and moths

The reduction of coppice management has been a major factor in the decline of several butterfly and moth species, especially the woodland fritillaries. These species are dependent on the habitats found only in the early stages of regrowth after a coppice cut, but a full coppice cycle is needed to create these habitat conditions. A closed canopy stage with several years of dense shade promotes shade tolerant woodland flora and suppresses competitive plants. When the coppice is cut once more it will then provide the open ground conditions and foodplants needed, such as violets in the case of the Pearl-bordered Fritillary. Comparatively few butterfly species utilise the older stages of coppice growth, but all stages of the coppice cycle are of value to moths.

For many butterfly species, the composition of tree species in the coppice is not particularly important because it is the ground flora that supplies their larval foodplants. However, the larvae of many moth species do feed on shrub and tree species. The presence of tall standard trees of different species will provide additional habitat.

When is coppicing a feasible option?

It is probably not worth initiating coppicing within established woodland that has no history of that management or on sites where coppice has now developed into high forest. The response to coppice management is likely to be poor and these sites may have developed fauna and flora associated with mature woodland that will be damaged by cutting.

Coppicing is almost certainly worthwhile on sites that have a recent history of this management and that still have a good density of stools. Sites that have been extensively cleared within the last 50 years are also likely to respond well to coppicing.

Coppicing may not be the best policy in very small woods. The area of potential coppice must be large enough to support the coupe sizes, the rotation/s and also the layout of age classes needed to meet the management aims. For example cutting a coupe size of at least 0.5ha per year under a rotation of 7 or 8 years will require an overall coppice area of at least 4ha. This can be a problem when managing for some of the fritillary butterflies. Although the butterflies require a continuous supply of newly cut areas, the coppice must still go through a long enough rotation to shade out vegetation as explained above. This problem can be overcome by cutting every other year, or by coordinating management across a group of adjacent woods as one unit.

Coppice structure and layout

Where coppicing is appropriate, the following factors must be considered to make it successful and sustainable:

Amber Rosenthal

Heath Fritillary nectaring on Bramble

Choosing simple coppice or coppice with standards? Unless planting a new coppice, this decision will probably depend upon the history of the site. Generally when managing for Lepidoptera the use of a long rotation coppice with standards is a good choice as it creates a diversity of habitats.

Number and rotation of standards: The value of standards in coppice can be enhanced by establishing a mixture of tree species and ages. If, however, the aim is to create sunny coupes with a varied ground flora for breeding butterflies and moths, then the number of standards must be strictly limited. One of the commonest reasons why coppicing fails to supply good butterfly habitat is that too many standards are present producing too much shade. Excessive shade will also reduce coppice growth and damage future coppice viability. It is most important that the total canopy cover of standards is no more than about 10 to 15% of the coupe area.

The appropriate number of standards will depend on their canopy cover, as each tree species produces a different canopy area when mature. It should also be noted that the shade cast by trees in leaf is often underestimated because most management is carried out in the winter, and that young specimens will quickly expand their canopy size once in an open situation. Generally 15 large standards per hectare should be the absolute maximum when managing for butterflies.

To reduce shading yet retain the valuable mature tree habitat, there are several options. Standards can be grouped rather than scattered, individual standards can be situated at the corners of coupes (they make good boundary markers) or small strips of un-cut woodland can be left between coupes. These strips should be carefully positioned to add shelter without excessive shading. A balance between standard quality and shading can be achieved by removing some older trees and allowing younger standards to grow on in their place.

In the long-term, some standards should be left uncut to produce the veteran tree and deadwood habitat required by many moths and other wildlife. Allowing some short-lived trees such as birch and willow to become standards can produce deadwood habitat quickly in comparison to species such as oak.

Rotation length: Historically, the length of the coppice cycle and the size of coupes varied between different areas, between woods and also over time. For conservation purposes, factors other than the size of the mature coppice stems usually take priority. Nevertheless, if there is a commercial product which can make the conservation management more sustainable, then the desired crop size must be taken into account when deciding both rotation lengths and coupe size.

The value of mature coppice stages for moths must not be forgotten in the effort to produce open sunny areas. If a site is large enough, then a solution can be to operate predominantly short rotations of less than 10 to 15 years but retain a series of coupes that are cut on rotation of 20 years or more. Sufficient young coppice can then be produced while also ensuring that a certain amount of old coppice is always present.

Ideally at least one coupe should be cut every year, but if labour is short or if the wood is too small to support a full rotation, then a compromise is to cut a larger area every two or three years.

Advantages and disadvantages of different rotations:

Short rotations

Advantages	Can maintain the supply of young growth areas, often better for butterflies
Disadvantages	Labour-intensive in large woods
	In some cases may be too short for the underwood to be of commercial value
	May not supply habitat for species that require older coppice
	Growth may not get dense enough to shade out the ground flora

Medium to long rotations

Advantages	Longer rotations create a wider range of habitats than short, often better for moths
	Can make coppicing economically viable in large woods
Disadvantages	In some cases may be too long for the underwood to be of commercial value
	Can be difficult to maintain the supply of young growth areas

Size of coupe: For the coppice-dependent Lepidoptera, the advice is not to cut less than 0.5ha per year per site. The main factor is to achieve the minimum area of breeding habitat required to support a population of the target species. This will be provided by the most recently cut coupe together with a number of the previously cut coupes depending on vegetation development. The appropriate flora needed for a species such as Pearl-bordered Fritillary is very likely to exist only in small patches within any single coppice coupe and this must be taken into account.

The total area cut each year can be divided into as many coupes as required, but single coupes of less than 0.5ha are usually too small to supply suitable unshaded, early growth habitat. They are generally shaded by adjacent woodland and are quickly encroached by the established vegetation at the coupe edges. Small coupes are often heavily browsed by deer and rabbit, as these animals prefer not to venture far from cover so avoid the open spaces of large cut areas.

Surprisingly, if the habitat is suitable then many butterfly species can have viable populations within only 1 to 2ha of coppice habitat within any one year, although a larger area is needed for the habitat to be rotated through the full coppice cycle.

Layout: When selecting the coupe areas, any special, legally protected or locally unique features and habitats that might be damaged or removed by coppicing should be retained. For example, stands of mature Aspen are uncommon and have high value for specialist invertebrate species, including moths. Retain any special or uncommon trees, veteran trees or old pollard specimens.

Coupes are best situated next to flower-rich sunny rides. These will supply nectar, act as a seed reservoir, provide insect flight paths between coppice areas and also allow access when cutting. For butterflies, it is best if coupes can be cut sequentially with areas cut in subsequent years being no more than 300m away. This is essential for many of the butterfly species dependent on early stage coppice as they are often poor at finding and colonising new areas.

Cutting slightly irregular coupe boundaries will increase the edge habitat and may be beneficial in adding another variation in structure to the woodland landscape. For the same reason areas or small strips of uncut woodland can be retained between coupes, but avoid shading the coppice.

Avoid creating narrow coupes, unless it is part of management along a ride edge. These are likely to have the same problems with shading, encroachment and browsing damage as small coupes. Aspect will affect the amount of sunlight falling on the coupe, and north or east-facing coupes may need to be larger to allow light to penetrate.

On a practical level, it is a good idea to mark out the corners of every coupe with permanent posts or by pollarding trees, and to produce a map of the proposed coupe rotation. The length of most coppice rotations means that the people doing the cutting will probably change from one cycle to the next, so markers and a map will be needed to guide future management.

Common failures and problems

- *Initiating management without defining the aims and objectives*
- *Underestimating the resources needed. Work is abandoned during the rotation because of labour shortages*
- *Short-term planning. Rotational coppice will not deliver conservation unless a long-term commitment is made to continue the management for many years*
- *Isolation. Habitat created is too distant for the target species to find and colonise before the habitat is lost to succession*
- *Sites or coupes are too small to provide a sufficient area of breeding habitat. Suitable ground flora fails to develop on otherwise suitable coupes*

Mark Parsons

The Common Fan-foot is often associated with rotational coppice management, although it probably breeds on oak standards rather than the underwood species

- *Leaving too much shade. Typically too many standards are retained, or coupes are too small*
- *Re-cutting before allowing the coppice to go through the full cycle. Re-coppicing part way through the cycle is sometimes attempted as part of emergency conservation measures for particularly threatened early succession species. This rarely has the desired result of restoring the early successional ground flora and tends to result in a uniform grassy sward of little value to the target species. The closed canopy stage is essential*
- *Excessive deer or rabbit browsing. High levels will damage or prevent regrowth. Damage may be reduced by cutting large coupes, as deer and rabbits prefer to be close to cover. It may be necessary to protect individual stools or fence entire coupes through the stage of young growth (see "Managing deer" for a more detailed discussion)*
- *Damaging the site during cutting and clearing. Use as few bonfire sites as possible. Locate them carefully where they will not damage stools or other habitats such as flower-rich grassland. Re-using previous burn sites is recommended*
- *Failure to monitor results and incorporate successes or failures into future management*

Restoring neglected (over-grown) coppice

The choice of management in neglected coppice (sometimes called stored coppice) is either to re-coppice, to manage as low intervention (leave to develop to high forest) or to clearfell and then re-establish a new coppice or a new broadleaved woodland.

Re-coppice: The choice to re-coppice will depend on the time since the last cut, the condition and density of the stools. Many sites with overgrown coppice have shown a surprisingly good response to re-cutting, although stool density may have to be increased by planting or by encouraging vegetative propagation. Techniques for creating new stools from the old stumps such as layering and stooling, as well as re-spacing the stools, can be found in most practical guides to coppicing.

Dan Hoare

A coppiced Sweet Chestnut stool showing vigorous regrowth two years after cutting

Low intervention: Neglected coppice could also be left to eventually take on the characteristics of a natural forest. In this case, it might be worth thinning some of the coppice by singling, that is by removing all but the best stem on each stool. This is generally used to try and produce good quality timber but in the context of habitat for Lepidoptera it is likely to speed up the creation of large mature trees that will provide additional structure and habitat.

Clearfell and replant: Another option is to clearfell the overgrown coppice and replant with native trees at fairly broad spacing, allowing the underwood to regrow as shrub layer. The site can then be managed as either coppice with standards or left to develop as mature woodland. In general, this option seems to carry few benefits for conservation over re-cutting. It is expensive in cost and labour and importantly unless small areas are clearfelled on a long rotation the risk of damage to the existing flora and fauna is high.

New coppice woodland

It is possible to create new coppice by planting or direct sowing, but unless the area has been wooded in the very recent past then creating the suitable flora required by many of the woodland Lepidoptera may be difficult. Many species of butterflies and moths will also have problems colonising a new coppice if it is any distance from their existing populations.

If new coppice woodlands are to be created specifically for conservation then they are best sited next to existing semi-natural woods, otherwise it will be difficult to establish the suitable woodland flora and fauna required by the rarer Lepidoptera.

The creation of new, short rotation simple coppice for biofuels is now being actively promoted (mainly willow or poplar species). It is not yet clear if this process will hold any benefits for the conservation of Lepidoptera.

Rides

A ride is any linear track or opening within the wood and includes the whole area between the mature trees on either side. That is the surface of the ride itself, any ditches and also the vegetation on the ride verges (grassland, scrub or coppice regrowth).

Most woods have at least some rides for access, shooting activities and increasingly for leisure activities such as walking, horse-riding and cycling. In commercial forestry, rides do serve a purpose as fire breaks but are primarily to give access for forestry operations, including timber extraction. As forestry machinery becomes larger, some of these rides have been surfaced to create woodland roads.

Why are rides important for Lepidoptera?

In many modern woodlands (particularly in conifer plantations), open areas are largely confined to rides and glades and these have become a refuge for the butterflies and moths that need open sunny conditions. Some of these species are woodland or wood edge specialists, but many will also be found in the wider countryside. Rides also usually provide the best way of connecting different habitats within woodlands, and prevent species having to move through unfavourable conditions to reach the next habitat patch. Providing these areas can be suitably managed, their value for Lepidoptera can be enormous.

Rides potentially provide a large diversity in structure and vegetation within a small zone. They combine sheltered grassland with typical wood edge habitat and this can provide diverse areas of nectaring and breeding. On many sites they also contain relics of habitat types that are now scarce in the wider countryside (for example; unimproved grassland, wetland habitat, heathland) and so can support the associated butterflies and moths.

When rides are managed with a scrub-zone cut as coppice, then some of the species associated with coppice rotation will use this habitat. However, this limited amount of coppicing is usually not adequate on its own to maintain the very specialist early-stage species such as the Heath Fritillary.

Ride verges may have associated ditches and these give not only additional structural diversity, but also can be a source of wetland or damp-loving plant species. The ditch banks are often particularly warm, sunny habitats.

Management of rides

For butterflies and moths, the four key factors are the:

- *amount of shade*
- *structure of the vegetation*
- *species composition of the ground-layer vegetation*
- *species composition of the ride edge trees and shrubs*

Although open sunny rides with less than about 20% direct shade are required by many butterfly species, other Lepidoptera (including some butterflies) prefer partially or even heavily shaded areas. Thus a variety of shade conditions and similarly a range of ride widths and orientations will need to be produced and maintained. Even a single species will require a range of rides to meet its requirements under different conditions. For example, the Wood White tends to use areas with less than 20% shade, but one study suggests that it not only moves between rides of different orientations during the day following the sun, but also on windy days it chooses sheltered but slightly shady rides, over the open sunny rides.

The amount of shade on a ride will be determined by its width, its orientation and the surrounding tree height. East to west orientated rides will receive more sun during summer months than those orientated north to south. As a rough guide, ride width must be 1.5 to two times the height of the surrounding trees to provide good unshaded butterfly habitat (width is measured from the base of the crop trees on either side). There can be scrub growth within this width as this tends to have only a slight shading effect.

Dan Hoare

Herb-rich vegetation in ride edges provides nectar, roosting sites and larval foodplants

Along some ride networks there may be a constant mix of different tree heights with many patches of low growth and in such cases the width and orientation will be less important.

Practical methods for achieving the required ride structure are given below. First the rides might need to be opened up or even created, then consideration must be given to ongoing management.

Widening existing rides

Often the first priority in a wood is to increase ride width to reduce shade levels. However, this should target areas with simple structure and dense crops close to the ride, to avoid damaging valuable semi-natural woodland and the species using the current ride edges.

Alan Reid / Forestry Commission

Ride widening for Wood Whites at Bury Ditches, Shropshire

In conifer plantations, often the only remaining deciduous trees and shrubs are located in a thin margin along the crop edge, and this will be removed by widening. Potential damage can be reduced if only short areas are done at a time and substantial lengths of the original ride edge habitat are left between widened sections.

Retain specimens or groups of locally uncommon trees (uncommon in terms of either species or age). A patch of Aspen for example, may be the only breeding area on the site for several species of moth. Sallows provide an important nectar source for many insects in spring and may provide breeding sites for Purple Emperor and many moths, and should be retained where possible.

An often-stated objection to ride widening is the wind tunnel effect - the channelling of wind between stands of tall trees. This can have an impact on a timber crop and may reduce the sheltered conditions favoured by many Lepidoptera. Ride layouts with curves rather than straight lines will not suffer from this effect, but many woods have straight line, grid system rides. Wind damage can also occur after ride widening, as wind-hardened trees on the edge are removed, exposing weaker trees that are then damaged or blown down. These issues can be minimised by widening using scalloped edges so that the ride is not uniformly wide and it remains sheltered. An alternative is to leave “squeeze-points” along a ride, retaining occasional mature trees which break up the exposed profile.

Creating new rides

In semi-natural woodland with no pre-existing rides it is suggested that a most careful examination of the site is required before creating ride habitat. If the site is an actively managed (or recently managed) pasture woodland or if it has a rich or uncommon ground flora, then ride creation may not be suitable. As always, consider the aim of the management and examine any conflicts that the new management might produce.

Try to create wide, gently curving rides with varying orientations along their length. Plan the routes of new rides carefully to avoid conflict with existing features. Any special, legally protected or locally unique features and habitats must be protected. Retain any special or uncommon trees, veteran trees or old pollard specimens.

After clearing, the stumps in the centre which will become the grass/herb zones can be removed, ground down or treated with herbicide. Stumps along the margin should not be treated but allowed to re-grow and then managed as coppice.

Creating and maintaining verge habitat

The best ride edges graduate from tall trees, to a variety of shrubs, to tall herb-layer vegetation then grassland flora. It will also include some bare ground and ideally there will be canopy gaps and height variation within the scrub zone.

If left to themselves, rides will quickly revert to high forest. In order to create and maintain diversity active management will be required. Several cutting regimes have been developed to specifically meet the needs of butterflies and moths: -

Two zone system: This is similar to the rideside management used in commercial forestry. It is low cost, low maintenance, but also comparatively low in structural diversity. It does not produce the good scrubby margin needed by many moth species, although under some rotations, patchy scrub is likely to develop. It can provide good open grassland habitat for butterflies.

The central ride zone is cut once or twice a year (unless it is surfaced) to maintain it as an access route.

A zone (2 to 5m wide on each side) either side of the central zone is cut on 4 to 7 year rotation, but this is carried out in sections so that only a portion is cut each year. Importantly, the whole ride, or even all of one side of a ride should not be cut in the same year.

Further habitat variety can be created by simply introducing two different cutting rotations, cut some margins on a short rotation (4 years) and some on a long rotation (7 years).

Three zone system with coppice: This is a more complex regime that can provide an excellent mosaic of habitat for both butterflies and moths, including habitat for some of the canopy-living species.

The central ride zone is cut once or twice a year (unless it is surfaced) to maintain it as an access route.

A zone of tall grassland vegetation is created either side of the central zone (2 to 5m on each side). This zone is cut, in sections, on a 3 to 4 year rotation with opposite sides being cut in different years. As with the two zone system, it is important that the whole, or even one side of a ride is not cut in the same year.

A mixed species scrub zone (5 to 10m on each side) is created between the tall grassland zone and the woodland. This is managed rather like coppice to provide mixed ages of woodland succession. A rotation of 8 to 20 years is suggested and as with the adjacent zone, it is

cut piecemeal.

As with coppice, the length of rotation must be balanced between providing sufficient open newly-cut woodland habitat and allowing the regrowth to shade out the ground vegetation so that sparse vegetation/bare ground conditions are produced after each cut. The ideal cutting rotation will depend on the growth and density of the scrub. If scrub density or species variety is poor then the zone can be planted, or temporary fencing can be used for protection while tree seedlings establish naturally.

Each section can be 50-100m in length dependent on the size of the woodland, and both section length and cutting rotations can be varied across a woodland.

A three zone ride edge

Dan Hoare

The three zones of a south-facing ride edge in a Hampshire woodland. The central ride zone (at right in this image), cut once a year, is grassy but holds plenty of herbs and bare ground, supporting Grizzled Skipper. The tall grassland zone, cut every 3 years, has a mixture of bracken, herbs and grasses, and at this site supports Pearl-bordered Fritillary. The mixed scrub zone at the back, cut as coppice, is predominantly birch and provides breeding sites for Argent & Sable.

Further enhancements to basic ride management

The following can be used along rides and forest roads in combination with the two and three zone cutting systems described above, or as stand-alone management:

Scalloped edges: A series of rideside bays, often called “scallops” are created along the ride verge/ tree boundary. These not only widen the ride to reduce shading but also provide shelter and increase the length of edge habitat.

A suitable size, as a very rough guide, is approximately 30 to 50m long by 10 to 20m deep. If the scallops are cut opposite each other then they provide a maximum open area, essentially widening the ride. They can also be staggered, alternatively or randomly along a ride.

They can be managed to produce one of two habitats, scrub or grassland, the difference is in the frequency of cutting. A scrub scallop is managed on a coppice-style rotation in the same way as a scrub zone in the three zone system. A grassland scallop is managed on the same system as the tall grassland zone in the three zone system.

Scallops can be used as a management in its own right or incorporated to add extra diversity within a three zone system (see case study “Chiddingfold Forest”).

Including rideside native trees: Native broadleaved trees can be a rare habitat in coniferous plantations. Even within mixed or deciduous woodland older trees may be uncommon. Many Lepidoptera seem to require mature trees that are slightly separate from woodland and that have ground-vegetation around their trunks rather than underwood.

A few, mixed species deciduous standard trees can be planted or left to grow in the ride margins (making sure the canopy cover along a rideside or within a scallop is less than 10 to 15%).These trees can be in small groups or as scattered individuals.

Bare ground areas: Many Lepidoptera require some bare ground patches to provide the suitable hot-spot microhabitat around their foodplant or for basking. It also provides structural diversity as well as floral diversity by encouraging seed germination. Several larval foodplants for scarce Lepidoptera are associated with regular ground disturbance, such as Wood Spurge which supports the Drab Looper moth. Activities or managements that regularly result in areas of bare ground can be most useful, as long as they only affect a part of the habitat in any given year.

It can sometimes be useful to create areas of bare ground under controlled conditions, to perhaps encourage seed germination or to produce patches of early successional vegetation. Varying sizes of patches could be selected on rotation and mechanically scraped free of all vegetation, making sure that a degree of soil disturbance also occurs. Allowing scuffing or scraping by ride-cutting machinery can also create bare ground habitat on a small scale. Small scrapes along the top of roadside banks are effective at establishing the low growing foodplants of the Grizzled Skipper, and more extensive scarification and rotovation techniques have been used to improve floral diversity in the Brecks of Norfolk and Suffolk.

The timing of verge cutting: The time of year and frequency of cutting plays a key role in determining the composition and structure of ride vegetation, but this is also affected by soil type so the effect will vary between sites. Cutting at any time of year, whatever method is used to cut and remove material, is very likely to affect or destroy some life stages. It is therefore important to only cut part of the verge in any one year and to monitor the impact on any target species. If the only breeding area for a species is in the portion due to be cut that year, consider whether cutting can be delayed to allow colonisation of nearby habitat.

General recommendations are as follows:

Cutting grassland vegetation: Cutting during the autumn is usually recommended, to avoid damage while insects are most active in summer, and to allow plants to set seed. In the past, however, most rides would have been maintained either by grazing or by cutting for hay in July or August. On particularly fertile sites with strong ground-flora growth then some cutting during July or August could be considered, as there is evidence that this encourages a broader range of flora. Alternatively, some cutting during the spring or very early summer would remove early grass growth yet still allow many species to flower later.

Spring or summer cutting may be beneficial in the long-term but will temporarily remove some breeding habitats and nectar sources. This issue can be limited by only cutting a small proportion of the site each year. Whatever cutting period is decided, it is worth building a degree of variation into the management because different plant species will respond to different regimes. Deciding the timing, frequency and rotation of cutting, together with an aim of what structure you are trying to create, is more important than defining precise cutting heights.

It is best to remove the cut material if at all possible (some forage harvesters can cut and gather the vegetation in one pass). Cuttings or mulch can smother the remaining vegetation and increase nutrient build-up which will reduce floral richness. Cuttings can be raked into heaps, but these must be carefully sited to minimise the effect on the rideside vegetation. Blowing or raking the material into the adjacent crop can be considered in coniferous woodland, but within deciduous woodland (or where there is a managed rideside scrub zone) this would cause damage to the ground flora under the canopy.

Cutting scrub vegetation: Ride edge scrub zones should be treated like coppice and are best cut during the winter. The section on coppice includes advice on the disposal and burning of cut material.

Combining conservation management with forestry operations

Forest roads are maintained to allow good access for forestry machinery so they are usually wide and kept clear of overhanging canopy. This also means that they can have high potential as Lepidoptera habitat. However, a forest road with its verge is a working environment and conservation management needs to take this into account. If forest roads and associated features are not maintained efficiently, then their maintenance incurs extra cost.

Many are managed on a similar cutting regime to the two zone system. The alternative three zone system can result in vegetation encroaching on the road surface as might occur on a 3 or 4 year rotational cut. In this case a slightly modified three zones can be used whereby the central zone is moved to a narrow strip (1 to 2m on each side) along either side of the road surface. This strip can then be maintained by annual or more frequent cutting. For ease of mowing, this strip can additionally be cut whenever the adjacent zone of tall grassland flora is cut.

Essential forestry operations may have significant adverse impacts on Lepidoptera breeding areas along rides. The road/verge edge tends to receive regular disturbance as all operational forest roads have a periodic maintenance (grading) during which this zone is scraped back to bare ground. This regular ground disturbance often provides good breeding habitat for species such as Grizzled and Dingy Skipper but road grading cannot usually be carried out piecemeal and will regularly remove all breeding habitat along the road edge. Timing forestry operations to the needs of Lepidoptera is also not usually possible, although often some compromise can be reached. It is therefore vital that similar habitat is available within a more secure location. If there are no refuge habitats nearby to provide continuity, then local extinction of species is highly probable.

Features such as turning circles and loading bays can, like the road edge habitat described above, provide good breeding habitat for species requiring sparse vegetation and bare ground, but this habitat will be damaged or destroyed at intervals. This is also the case for most roadside ditches, created to take the run-off from the surfaced roads. These ditches, their banks and associated vegetation can provide habitat for species such as Wood White, but they will be regularly re-dug, with spoil removed to the ditch banks or verge edge.

Forestry activities can have an impact on verge habitats, for example where vehicles use the verge during timber extraction or where wood is stacked on the ride edge. Minimise impacts by:

- *Ensuring that the entire ride network is not managed uniformly in any one year*
- *Providing refuge breeding areas for the species that may be affected*
- *Monitoring breeding areas used by susceptible species so that potential problems can be avoided or mitigated*
- *Protecting sensitive areas with temporary fencing during forestry work*

Dan Hoare

A wide sunny ride provides ideal breeding conditions for Pearl-bordered Fritillaries at a Forestry Commission site in Sussex

Glades

Woodland glades are permanent or semi-permanent areas that contain few or no trees but are surrounded by woodland. They are usually non-linear, in contrast to rides and wayleaves, and are distinct from young plantations or clearings containing young woodland.

Why are glades important for Lepidoptera?

Glades provide a larger area of open habitat than is found in rides, which may be important for the colony structure of some butterflies. Several species can reach high population densities in glades but will only ever occur in rides in low numbers. The Marsh Fritillary, for example, rarely breeds on rides even when its foodplant is abundant, but will use damp grassy woodland glades of at least 1ha, and does best when there are a series of such glades.

Creation of glades

Glades can be created either linked to the ride complex, or separate and located within the mature or semi-mature woodland. Overall the same principles of width, shading and crop height apply as discussed for rides, also the same concerns for cutting new glades within natural or semi-natural woodland. Glades linked to ride systems are better connected to the wider habitat network, whereas glades within mature woodland may be more isolated and difficult for some species to locate.

As part of the ride complex: With minimal tree removal a good sized glade can be created by simply enlarging the intersection of two rides to produce a “box junction” or “corner glade”. Usually all four corners of the junction are removed, but sometimes only two and the different segments to the glade do not have to be the same size.

Separate from the ride complex: It can involve a considerable felling of timber to create a suitably sized glade. Generally glades should be at least 0.25ha and preferably 0.5 to 2ha in size. Grouping glades within the same area and providing some connectivity with an existing open feature will aid the establishment of suitable ground flora and also the movement of Lepidoptera into these new habitats.

Management of glades

Glades can be treated in the same way as rides to provide a range of vegetation types, from open grassland through to scrub. A scatter of tall trees can also add diversity, but restrict canopy cover to less than 10% of the glade area.

The specific management will depend on the permanency of the glade. A glade can be a temporary open space, that is cut and then allowed to re-grow, or a more permanent opening where regrowth is controlled or suppressed.

If the glade is to be managed as a temporary open space then the habitat produced is similar to that created under coppice. Open bare ground conditions will dominate at first, regrowth then produces scrub and finally mature woodland. Such a light to shade cycle will maintain the typical woodland flora and will prevent the vegetation becoming grass dominated.

Management of true permanent open space in woodland has much in common with unimproved grassland. Repeated cutting, mowing or grazing will be needed to prevent scrub growth and without a period under dense canopy shade the vegetation usually becomes grass dominated.

If large enough, then a mixture of permanent and temporary open space can be created across the glade. Such a mosaic habitat structure is highly attractive to many Lepidoptera and mimics that found along a natural wood edge. The grassland areas could be cut on short rotations (1 to 4 years) and some scrub could be allowed to develop not only along the wood edge, but

Dan Hoare

Scrub cut on rotation within a permanent glade provides a varied age structure and sheltered conditions

also as small patches scattered across the glade. This can be enhanced using irregular, piecemeal cutting of the patches of scrub on anything between an 8 to 20 year rotation, depending on the rate of growth at the site.

On a box junction, each corner section could receive a different cutting regime. Some cut every 1 to 4 years to create grass and herb dominated vegetation. Others cut on a rotation longer than 4 years to allow the development of scrub. If the rotation is long enough to allow the scrub to shade out the ground vegetation, then after re-cutting, valuable early successional woodland habitat can be created for species like Pearl-bordered Fritillary.

On some sites there may also be an option of using domestic grazing animals within enclosures. Grazing creates a very different type of vegetation from cutting, so adding diversity. Grazing is more practical in woodland glades than rides and was often the traditional management. The aim would be to create diverse

Susan Clarke

A large permanent glade among planted conifers

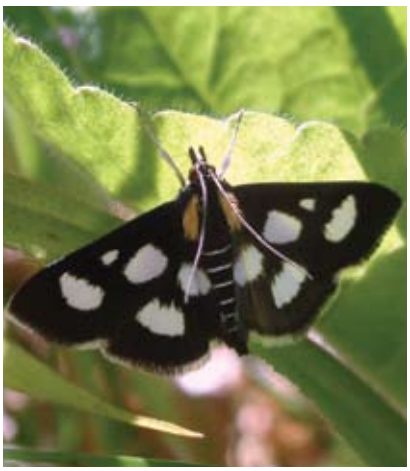
vegetation, while preventing or reducing the growth of scrub and trees. Rotational grazing can give a high level of control because stock can be moved periodically around a single large glade or from glade to glade. Grazing is discussed in more detail in the following pages.

Wayleaves

Wayleaves are the areas beneath power lines, and within woodlands these areas are regularly cut to keep scrub/tree growth away from the cables. This effectively means that wayleaves within woodlands are linear glades managed on a short coppice rotation, which can provide important wildlife habitat and improve connectivity between other open areas. Widths vary, but most are 10 to 20m wide. They are typically managed by the power company or a contractor, whose objective is to keep any vegetation a minimum distance away from cables and other equipment. This means that rotation lengths are not set, but depend on the height of the cables and the growth rate of the scrub.

To save expense, often only the tallest scrub (that which will breach clearance thresholds) is cut at any one time. This can create a mosaic of small scrub of various ages together with open, cleared areas. It is often the only habitat of its type within the woodland and can be excellent habitat for Lepidoptera. In Scotland, for example, wayleaves are extremely important as habitat for the Chequered Skipper and Pearl-bordered Fritillary in otherwise dense plantations or regenerating native woodland.

The management of wayleaves is often outside the control of woodland managers, but if scarce butterflies or moths are known to be using the site it is worth passing on specific recommendations to the power company. Where pipelines are buried beneath the surface the area above may also be kept clear to allow access and prevent root damage, providing very similar habitat opportunities. Best practice wayleave management is similar to ride management and includes the creation of scalloped edges along south-facing edges and rotational cutting of sections rather than uniform management. An alternative is to cut and treat stumps to create more permanent open areas, although this will require similar management to a ride or glade to maintain floral diversity.



Rob Petley-Jones

The moth Anania funebris *breeds on Goldenrod in glades, rides and wayleaves*

Open Bracken habitats in woodland

Bracken dominated areas are a key habitat for four species of violet-feeding fritillaries including two of the UK's most threatened butterflies, the High Brown and the Pearl-bordered Fritillary.

Susan Clarke

Violets growing amid light bracken litter are essential for several of the rarer fritillaries

Violet-rich Bracken habitats are typically found in grassland areas outside woodland, they can also occur in rides, glades, young plantations or woodland edges. This is an often overlooked habitat, but these areas can be highly important for both these butterflies and for other wildlife.

In early summer, the developing green fronds of Bracken act like a low growing tree canopy and suppress the ground layer vegetation, particularly coarse grasses, providing ideal conditions for many shade-tolerant woodland plants such as violets. In the autumn, the Bracken dies, but because the fronds and stems take some years to decay, a layer of litter and standing trash is formed (litter is the semi-degraded, dead fragments and standing trash refers to intact dead Bracken, either standing or fallen). This dead Bracken can provide an ideal warm microclimate and shelter for insects and indeed seems to be critical in the survival of some fritillary species on many woodland sites.

Each of the violet-feeding fritillary species has a very distinct microhabitat within the Bracken, some requiring a strong layer of dead litter and avoiding any grassy patches, others needing moist conditions with violets growing in a mosaic of Bracken and grass. It is certainly possible to meet the requirements of all four fritillary species at a single site by providing a varied structure.

The main objective in managing Bracken is to prevent it becoming too dominant, by reducing its vigour and density, without eradicating it. This maintains a mosaic of herb-rich grassland interspersed with growing Bracken and dead litter. Aim to create and maintain a varied Bracken structure that at one end of the spectrum has up to approximately 15cm depth of Bracken litter and less than a third grass cover and at the other end, a grassy Bracken mosaic with a light cover of litter and approximately two thirds grass.

Grazing and trampling by cattle and ponies, especially in winter and early spring, is an excellent way of producing the required variation in Bracken structure, but this is not often an option within woodlands. For most woodland rides, a standard 3 to 4 year rotation of verge cutting in autumn/winter combined with longer cutting rotations on the scrub-layer will provide adequate habitat where Bracken is present. If glades are to be managed to provide good Bracken habitat then a slightly longer cutting rotation of 3 to 4 years will be required on the grassy areas, rather than the suggested 1 to 4 year rotation used to produce grassland habitat.

Where High Brown Fritillary or Pearl-bordered Fritillary are present, more specialist management may be needed to maintain the necessary violet density and depth of Bracken litter. Cutting Bracken areas during late May or early June on a 3 to 10 year rotation has been found to be useful for these species, but this should only be carried out on patches where there is currently no potential breeding habitat.

If the Bracken structure becomes too uniform under the usual cutting then there are several options aimed at creating variation:

Cutting pathways of 0.5m to 1m width through Bracken in June. This encourages violet growth along path edges and is particularly suitable for High Brown Fritillary.

Removing Bracken litter by raking in autumn or winter, even on a small scale, can encourage violet growth and maintain litter in suitable conditions. This is a useful option between the rows of young plantations to keep them suitable for longer.

Bracken bruising can be useful to reduce the density of growing Bracken and is often used on rough terrain where cutting is difficult. Rollers with bruising bars are used to damage, but not to sever the stems, often pulled behind a quad bike or tractor. This is best carried out when fronds are fully open between June and August, in patches or strips so as to vary the Bracken mosaic across a site. Bracken whipping is similar to bruising but is done by hand using a stick or light aluminium rod.

Spraying patches or strips of Bracken with a selective herbicide (such as Asulox) can be beneficial within dense Bracken where violets have become scarce. Only spray part of the Bracken area, avoiding currently good breeding habitat. Target the denser areas and avoid spraying near water courses. Within young plantations, occasional spot-spraying around the trees can not only benefit the tree growth, but can create variable structure and bare ground patches for violet germination.

Although burning is a useful management technique for Bracken in open habitats it is not a management option within woodlands.

Caution

Any management of Bracken between March and August must be carried out with great care and only within small areas at any one time, because Bracken is well used at this time of year by ground-nesting birds and reptiles (particularly adders). It is important to only cut, roll or bruise Bracken when conditions are warm enough for reptiles to move out of the way. For this reason, avoid managing Bracken early or late in the day.

Woodland edges

Developing boundary habitat as a buffer strip along the woodland edge can greatly increase the potential habitat for Lepidoptera and will also protect the woodland from the effects of intensive agriculture.

Importantly, this can also integrate woodland habitat within the surrounding landscape, rather than leaving it as an isolated feature. Buffer strips can even be used to connect nearby woods separated by intensive farming. The wider the buffer strip the greater its impact, but they are usually between 2 and 15m. Strips wider than 15m would provide far greater benefits.

Three basic structures of buffer strips are suitable for Lepidoptera. Agri-environment schemes can provide funding for similar buffer strips through a variety of options:

- *Grassland and tall-herb buffer strip*
- *Scrub and grassland mosaic buffer strip*
- *Scrub buffer strip*

The choice of basic structure and of subsequent management may be influenced by the presence of woodland Lepidoptera of concern either within the wood itself or within the landscape area. For example, if the wood is in an area supporting Black Hairstreak, then the scrub option may be the preferred choice. For Duke of Burgundy, the choice would be for the scrub and grassland mosaic.

Grassland and tall-herb buffer strip: Establish a grassy strip either by sowing (native grass or wild flower mixes) or natural regeneration along the wood edge. Do not fertilise or use manure and avoid using herbicide (except to spot-treat specific injurious or alien weeds). Cut buffer strips on a 2 or 3 year rotation to control woody growth (see under Ride Cutting for timing).

Scrub and grassland mosaic buffer strip: This type of buffer strip will need to be more than 5m in width if it is to provide a suitable habitat structure. It is established as for the grassland and tall-herb buffer strip above, but then left uncut for a period to allow scrub to develop. The scrub can then be cut to produce a 50:50 mix of scrub and grassland, within irregular patches along the strip.

Cut the scrub piecemeal, on anything between a 4 and 20 year rotation depending on the rate of scrub growth and the habitat structure required. Cut the grassland patches on a 2 or 3 year rotation (see under Ride Cutting for timing). If possible, during the rotation allow some scrub patches to develop on the grassland and balance this by reverting some cut scrub areas back to grassland.

Dan Hoare

Complex structure at the woodland edge provides habitat opportunities for a range of wildlife

Scrub buffer strip: This type of buffer strip will need to be more than 5m in width if it is to provide a suitable habitat structure. It is left to develop scrub and then managed like coppice, cutting during autumn or winter on a rotation of 8 to 20 years depending on the rate of scrub growth and the habitat structure required.

In some locations, a narrow strip of regularly cut grassland may be needed alongside the scrub zone for ease of access.

Grazed woodland:
pasture woodland and parkland management

Grazing is beneficial in maintaining specific woodland types such as wood pasture, particularly in the upland/Atlantic oakwoods in the north and west of Britain.

Mark Monk-Terry ©Sussex Wildlife Trust

Cattle grazing a Sussex Wildlife Trust site in the Western Weald

It can also be used within woodland to produce an open structure, or at low intensity to maintain a healthy shrub layer. However, without control, it is easy for grazing and browsing pressure to cause damage to the woodland structure and its regenerative capacity.

For woodlands with a historical tradition of grazing the aims should be:

- *To restore grazing where this no longer occurs*
- *To link appropriate grazing animals and grazing levels with conservation objectives*
- *Give support to commoners and other graziers*

Grazing of the ground layer of woodlands is traditional in many parts of Britain, particularly western oak woods, where sheep, and to a lesser extent cattle, are still given access from hill land to seek shelter and protected forage. This contributes to the development of closed canopy woodland with a sparse shrub layer, which is important for several moths associated with the lichens and rich ground flora. The livestock suppress sapling growth, often prevent regeneration and also the development of a dense shrub layer and mid-strata. Elsewhere woodland grazing has largely died out, other than on some wooded commons and wood pastures.

Relatively light grazing pressure will maintain the ground layer, and will enhance variations in its structure. Livestock preferentially take the most palatable species and the degree to which the ground layer is altered or enhanced will depend on the relative proportions of the palatable to non-palatable plants. Higher livestock densities cause more intensive grazing, which will compromise structural diversity as the livestock become less selective in their feeding. Heavy grazing will keep the vegetation short, suppress many larval foodplants, and so limit the potential to support Lepidoptera.

Grazing animals will consume seedling trees, and as with the ground flora, the more palatable species will be removed at low stocking densities. Where grazing levels are intense only the most inedible tree and shrub species will survive. Over time, this has implications for the species composition of the wood, and for its diversity. Elms and limes are usually absent from woodlands with a long history of grazing. Thorny species are avoided and will develop thickets beneath gaps in the canopy or on the woodland edge. However, the hardier breeds of livestock adopt more browse in their diet and some, particularly old pony breeds are even adept at taking Holly and gorse.

It is important to note that wild deer grazing is very different to domestic livestock grazing, as deer are more selective, and their impacts are more unpredictable and difficult to control.

David Green

Distinct browse lines where low vegetation has been removed can indicate grazing is too intense

Impacts of different livestock at low stocking levels

Cattle are unselective grazers, particularly more traditional breeds which will also browse. They tend to leave a tussocky structure across a wide area. They dung randomly, which is then avoided when grazing, increasing the variation in ground vegetation.

Sheep are selective grazers, and will tend to produce a tight sward in patches by favouring the most palatable species. Dunging is largely random, although concentrations develop where night gatherings occur. Some older breeds readily browse on woody growth.

Ponies are selective and graze palatable vegetation tightly. Local alteration of fertility and vegetation can occur around dung sites. Certain breeds such as New Forest and Exmoor, have a high propensity for browsing.

Goats will eat virtually anything and they browse more than other livestock, which means they can cause damage to saplings and shrubs even in low numbers.

Pigs mainly root in the soil surface, eating roots and rhizomes including Bracken, but will also take grasses and stems. Rooting behaviour creates seed beds for plants that otherwise are vulnerable to competition, but can suppress sapling development.

High forest

High forest is a loosely-used term. In Britain, it usually refers to mature woodland which has the appearance of a natural structure. The trees may be of mixed age when a product of natural regeneration, or even-aged as in a plantation.

David Green

Well-developed high forest habitats can be particularly important for woodland moths

Until recently most high forest was managed by clear-felling, in which a whole stand is felled at once. The open area is then usually replanted or allowed to regenerate naturally.

Continuous cover systems

In recent years various systems of continuous cover forestry have been proposed and tested in the UK. These systems use small-scale felling within a stand and allow much of the woodland cover to be retained at all times, with the intended result being a mosaic of age-structures. The most common continuous cover systems are:

Single tree selection: Single trees are felled as they reach the height required. They are replaced by natural regeneration or by planting.

Group selection: A small area is felled (maximum about 0.5ha) and replaced usually by planting.

Shelterwood: The stand is partially felled, but a scatter of mature trees is retained, often spaced by leaving approximately 6 to 10m gap between the remaining canopies. Usually the seed from the mature trees is left to regenerate in the canopy gaps, but sometimes the gaps are planted. Once either regeneration or the growth of the planted trees is strong, then the remaining mature trees are felled.

Neither clearfell nor continuous cover systems are specifically aimed at delivering conservation for Lepidoptera. However, both systems have the potential to provide some benefits for woodland butterflies and moths if they produce open areas within formerly closed canopy monocultures, even temporarily. Continuous cover systems could also improve landscape connectivity by providing a more varied mosaic of open and closed canopy habitats across the woodland rather than the extremes associated with clearfelling. However, it remains unclear whether these systems will provide habitat suitable for many of our most threatened woodland species, particularly those with a strong requirement for open space.

Conservation management for high forest

Conservation management for Lepidoptera in high forest should attempt to introduce the features covered under glades and rides whilst paying particular attention to the requirements of species associated with the canopy layer of mature trees. Management should focus upon:

- *Introducing greater structural diversity and uneven age of trees*
- *Introducing glades and enhancing ride features*
- *Improving tree species diversity*
- *Protecting veteran trees, which may involve removing competing trees*
- *Restoring hydrology*
- *Retaining and promoting deadwood features*
- *Reinstating grazing where appropriate*

Wet woods and wetland features

Many specialised and uncommon moths rely on these features, which have been lost from many woodlands through a combination of management neglect and changes in hydrology.

Although these habitats do not support any UK BAP Priority butterflies or moths they are vital for many other invertebrates. The overall aim should be to restore degraded or destroyed wetland features and to maintain hydrology within woods.

Managing wet woods

Maintain structural diversity: Wet woodland is often a transient successional stage between open wetland areas and drier woodland. Maintain as diverse a habitat as possible and maintain any transitions with other semi-natural habitats. There should also be a good age structure of trees.

Maintain hydrology: It is crucial that appropriate water levels of wet woodland areas are maintained. A draw down of groundwater levels tends to result in an invasion of Common Nettle and Bramble and with it the potential loss of the Lepidoptera. If the woodland is prone to flooding, then ensure the maintenance of the natural flood regime and, if necessary, dam existing drains to restore water levels if a site is beginning to dry out.

Maintain open areas and edge habitat: Edge habitat is of great value to insects and so clearings and rides should be kept open. Rotational coppicing of Alder or sallow can create temporary glades, but this should not be done at the expense of stands of mature trees.

Grazing management: Extensive, low-level grazing to maintain open areas can be beneficial, but boggy habitats can be fragile and easily damaged by trampling. Excessive grazing by deer or stock will inhibit tree regeneration and may have a detrimental effect on the ground flora.

David Green

Wet woodlands such as this Alder carr provide a range of damp habitats for invertebrates

Managing specific wet habitat features

The following features are likely to be an integral part of a wet woodland site, but also can often be found as more isolated features within other woodland types:

Reed and sedge beds. An important habitat for many scarce moths. Water levels need to be high enough to ensure their continuity and dead plant matter should be allowed to form a layer of deep litter. Avoid excessive cutting or tidying and use rotational management.

Streams and seepages. Avoid channelling or piping. Seepages may appear to be a minor feature, but should always be incorporated into any woodland evaluation and management plan.

Water-filled ditches. Ditches are of particular value where light penetrates to allow herbs or aquatic plants to grow, and support a range of moths and other invertebrates.

Woodland ponds. Ponds can support many specialised moth species. Retain and manage by rotation to ensure all successional stages (open water to dense marginal plant cover) are present every year. Also, do not cut all marginal or bankside vegetation in any one year. Always provide both shaded and unshaded pond habitat if possible.

Deadwood management

Deadwood habitats support a number of moths and many other invertebrates.

Susan Clarke

Deadwood can support lichens and fungi that in turn support moths and other invertebrates

Dead fallen wood should ideally be left where it falls or stacked in piles, preferably in shaded locations, although a range of both shaded and unshaded deadwood should be encouraged.

Pollarding can be a good management for extending the lifespan of old trees and their associated deadwood features, but some forms of tree surgery such as the unnecessary felling of limbs are very damaging. Trees with top-heavy limbs should be pruned rather than removed and any fungus-infected trees or those with sap runs should be retained. Rot-holes should not be drained or filled. In areas where there is little deadwood it may be beneficial to increase this by ring barking limbs.

Veteran trees

Living veteran trees typically contain a valuable deadwood resource and are also of conservation value in their own right. Some Lepidoptera have a strong association with mature or over-mature trees.

The priority is to conserve all existing mature and ancient trees and their associated deadwood niches. Tidiness and over-zealous removal of deadwood and felling of trees on the grounds of a perceived threat to public safety are the greatest threats to the survival of species associated with these trees.

Management regimes that will ensure the persistence of old trees should be adopted including:

- *Use traditional tree management techniques such as pollarding, to prevent trees becoming top-heavy and collapsing*
- *Protect veteran trees and in particular the tree roots from damage including soil compaction and erosion caused by factors including; livestock trampling, car parking, the application of fertilizers/ pesticide, ploughing and changes in ground-water levels.*

Of equal importance is to plan ahead and ensure that as the older trees die, there will be an adequate number reaching post maturity to ensure continuity. A problem at many sites, including such key areas as the New Forest, is gaps in the age structure of trees. Recruitment of new pollards and large trees is vital if the specialist invertebrate fauna is to survive. As discussed for standards within coppice, it could be useful to also select a few short-lived trees to become future veterans (birch and willow) as these will mature and produce deadwood habitat quickly in comparison to species such as oak.

Tree Preservation Orders can be a valuable tool for protecting old trees and the Ancient Tree Forum and local tree officers can provide advice and support.

David Greene

Veteran birches are important for a number of moths including Welsh Clearwing

Managing deer

Deer influence Lepidoptera and other woodland wildlife by altering both the structure and the species composition of woodland. Within coppice, high levels of browsing can damage or even prevent regrowth and can reduce the quality of the resulting poles.

At low densities and in areas managed for conservation, the presence of deer can have some beneficial effects. Browsing can reduce dense scrub, maintain grassy open glades and add a diversity of habitat structure. Studies examining the use of coppice as butterfly habitat suggest that a low level of deer browsing can sometimes be useful. If the resulting crop does not need to be of high quality, and if browsing merely reduces the initial growth rate but does not kill the stools, then the delayed growth can allow a longer period of open conditions suitable for coppice butterflies. However, these effects need to be monitored closely, as floral diversity may also decline as grasses and sedges increase. Deer can also delay natural regeneration on clear-felled areas, an effect that is particularly striking in Scotland, where areas that are fenced to exclude deer rapidly become rank or heavily scrubbed and lose their value for butterflies.

At high densities, deer impacts can include severely reduced woodland regeneration, altered tree species composition, removal of the shrub layer and reduced floral diversity. There is increasing evidence of the ecological impact of deer on breeding birds, small mammals and plants, and there may also be direct negative effects on butterflies. For example, deer grazing of Honeysuckle can greatly reduce potential egg sites for the White Admiral. Changes to the shrub layer can include reducing the amount of Bramble, a key resource for butterflies, moths and other invertebrates both as a foodplant and a nectar source.

Dan Hoare

Deer browsing on a one-year-old Sweet Chestnut coppice stool: regrowth is limited and will be of low quality even if it survives.

Assessing the absolute number of deer on a site is less important than understanding whether they are having a negative impact on the woodland and your management objectives. Where deer impacts are apparent a range of methods can reduce the damage, although none seem universally successful:

- *The simplest is to cut coppice in large coupes as deer prefer to be close to cover, which will tend to limit damage to the edges of the coupe. This may work best where deer densities are low.*
- *Protecting individual stools with brush is sometimes effective against larger deer species, but can encourage Muntjac and rabbits by providing protective cover beneath which they can browse the regrowth. Dense layers of brush may also have an adverse effect on both the development of ground flora and the quality of coppice regrowth.*
- *Fencing of coupes or woodland areas. There are various options of temporary or permanent fencing, but these are generally expensive, often need maintaining and may only be effective at excluding some species of deer. Expert advice on fencing should be sought as this will save costly mistakes. In addition, excluding deer from one area will simply shift the pressure to another part of the woodland.*
- *Where deer impacts are severe, a coordinated approach by neighbouring landowners may be necessary, perhaps combining both fencing and deer culling. The wide woodland rides and open glades that suit butterflies also provide useful features when culling deer.*

David Green

Fallow deer feeding on young vegetation in a woodland clearing

Dan Hoare

Rides are often good sites for pheasant feeders, but they need careful placement to avoid damaging valuable habitats

Game management and woodland Lepidoptera

The use and management of woodland for game such as pheasants is largely compatible with the needs of woodland Lepidoptera. Pheasants are birds of the woodland edge, requiring scrubby growth and open glades, the same habitats favoured by some woodland butterflies and moths.

Woodland management for game often aims to produce habitat features that are similar to those recommended to encourage Lepidoptera. For example, wide rides and glades are needed to provide access, positions for the guns, flushing points and suitable feeding sites for the birds. A study by the Game & Wildlife Conservation Trust found that coppicing was used by many site managers, although due to the labour required, they did not usually reinstate a full rotation cycle and often managed only small areas of a wood.

Predation of butterfly or moth caterpillars by game birds has not been shown to be significant, even close to release pens. High bird densities may still be cause for concern, however, if they are released or fed in an area with limited breeding habitat for a threatened species. In general, managing semi-natural woodlands for game interests supplies more benefits than conflicts for Lepidoptera.

Although game management can be complementary to conservation, care is needed to integrate the two and a number of potential issues should be considered:

- *Non-native species planted as game cover, such as Rhododendron, cotoneaster or Snowberry, can out-compete and overwhelm native shrubs and young trees. Plant only native shrubs in woods of conservation importance, and avoid planting invasive species on all sites*
- *Avoid locating release pens on or near habitat features of conservation importance, as soil enrichment and changes in ground vegetation can occur, especially where game bird densities are high*
- *Feed from hoppers, rather than on straw, as it can suppress natural vegetation in rides and glades and cause long-term degradation of flora. Where straw is used, minimise the area covered and avoid features of conservation importance*

Connectivity and landscape scale conservation

Effective conservation of threatened Lepidoptera can only be achieved if measures on individual sites are combined with actions at the landscape scale.

Colonies of butterflies and moths surviving in small, isolated woodlands remain highly vulnerable to extinction however successfully the individual woods are managed. This can even be a problem if a species becomes restricted to a small patch of suitable habitat within a single large woodland complex.

Increasing the ability of species to move between habitat patches can have major and long-lasting benefits on butterfly and moth populations, enabling metapopulations to function more effectively and persist for longer. This can be achieved by increasing the area or quality of habitat at occupied sites (which increases core populations and thus the probability that they will disperse outside the habitat patch).

If the intervening landscape between patches of breeding habitat can be made more favourable for butterflies and moths it will greatly enhance dispersal opportunities, although this will vary considerably between species.

Connectivity within woodlands

A number of features can encourage dispersal between patches of possible breeding habitat within the same woodland or woodland complex:

- *Wide interconnecting rides with good nectar sources. These increase movement through the wood and increase the chances of insects finding new open areas*
- *A varied habitat mosaic including successional stages from open space to closed canopy woodland makes it easier for species to move between suitable habitats*
- *Boundary margins around woodlands can encourage movement around the site*

Connectivity between woodlands

The following can improve the ability of species to move between separate woodland blocks which contain possible breeding areas:

- *Hedgerows/walls/ditches with boundary strips/verges connecting woodland blocks*
- *Unsprayed and uncultivated margins on fields in the surrounding landscape*
- *A graded woodland edge containing scrub and a wide flower-rich margin*
- *Small habitat patches, such as a field corner with abundant nectar plants*

Individual site managers can make a significant contribution to landscape condition by improving the habitats on their own site and coordinating management work with neighbours. Effective landscape scale conservation is best delivered through schemes where agencies, organisations and land owners work together towards shared objectives. Additional support through targeted woodland grants or agri-environment schemes can greatly increase management activity and encourage the coordinated habitat improvements that are necessary to improve the fortunes of our most threatened butterflies and moths.

Rich Howorth / ©Sussex Wildlife Trust

Connections between woodland blocks, and the habitat quality of the intervening landscape, are important features in the wooded landscape, as shown here in the West Weald

Case studies – conservation management in practice

Ride management for a range of species at Chiddingfold Forest

David Green

A scallop cut into the ride edge during forestry operations provides temporary open space

Chiddingfold Forest is a large complex of woodlands managed by the Forestry Commission. This landscape has long been important for Lepidoptera, and holds a nationally important population of Wood Whites, but the key breeding areas often tend to be isolated and concentrated along ride verges. The periodic clearance and maintenance of road verges during necessary forestry operations can have significant adverse impacts on this important habitat, although this is also the very process that creates floral diversity and increases the conservation value in the long-term. The main risk in such operations is that if there are no refuge habitats nearby from which species can repopulate the ride verges, local extinction of some of these threatened species is highly likely.

In response, in 2006 the Forestry Commission planned 63 rideside scallops, each at least 30m x 10m, cut on rotation over five years, to provide a continuous supply of early successional, open woodland habitats across the landscape. The scallops will supply secure refuges compensating for any losses on the ride edges and with this network in place the value of the ride verges is also increased. The opportunistic, temporary habitat that develops on the verges as a result of regular clearance now becomes a valuable bonus rather than the most important habitat in the wood.

Management

Existing verges are cut on a short rotation (c. 2 years), scallop areas on a longer rotation (c. 5 to 10 years). One or two deciduous trees are left in each scallop to provide leaf-litter and some shelter. Ditches at the edge of the graded road provide a well-drained sunny bank which can supply further valuable habitat.

The results have been monitored each year and in 2010 the scallops were assessed as providing potential breeding habitat for 12 of the target Lepidoptera species including 8 UK BAP Priority species. In total, 84% of the surveyed scallops produced potential habitat for at least one of the target Lepidoptera, including Wood White, Grizzled Skipper, Purple Emperor and Drab Looper. Due to slow regrowth in the scallops the cutting rotation has been increased to 7-10 years.

Jessica Pelling

The Drab Looper is dependent upon Wood Spurge which typically flourishes following woodland management

Blean Woods, Kent: coppice management for the Heath Fritillary

David Green

Sweet Chestnut coppice in East Blean

The Heath Fritillary has been found to be highly dependent on coppice management and is an extreme example of a species that needs a targeted and continuous supply of newly cut coppice.

The Blean Woods are a large complex of woodlands north of Canterbury with a number of different owners, and hold one of the few remaining populations of the Heath Fritillary in the UK. A rapid decline in the butterfly across the complex was shown to be due to a reduction in overall coppicing activity, an increase in the length of the coppice cycle and the planting of conifers over significant areas. A huge conservation effort was carried out over many years to examine how the butterfly used the woods and to improve management.

Research confirmed that Heath Fritillary colonies in the different management units of the Blean were not independent, and that instead each cluster formed part of a large metapopulation, exchanging individuals as the butterflies moved to find freshly cut coppice coupes.

The majority of coupes in the Blean were found to be suitable for the butterfly for only two to four years after clearance. The main larval foodplant, Common Cow-wheat, is erratic in distribution and abundance and management of potentially suitable habitat only produced sufficient foodplant in about a third of clearings. Adult Heath Fritillaries were shown to be very sedentary and only colonised new clearings if they were within 200 to 300 metres of an existing colony. Many isolated clearings were never colonised in the four years that they remained suitable.

It was concluded that continuous, carefully targeted coppice management was the only way to support the Heath Fritillary in the Blean. A 25-year programme of coppicing, with each cut in close proximity to previous colonies, combined with ride widening to improve connectivity, has saved the Heath Fritillary population here and allowed it to expand throughout the complex. This programme has of course provided benefits to other wildlife including the Goldenrod feeding micro-moth *Anania funebris* and Nightingales.

Rewell Wood, West Sussex: coppice stages and their value for moths

David Green

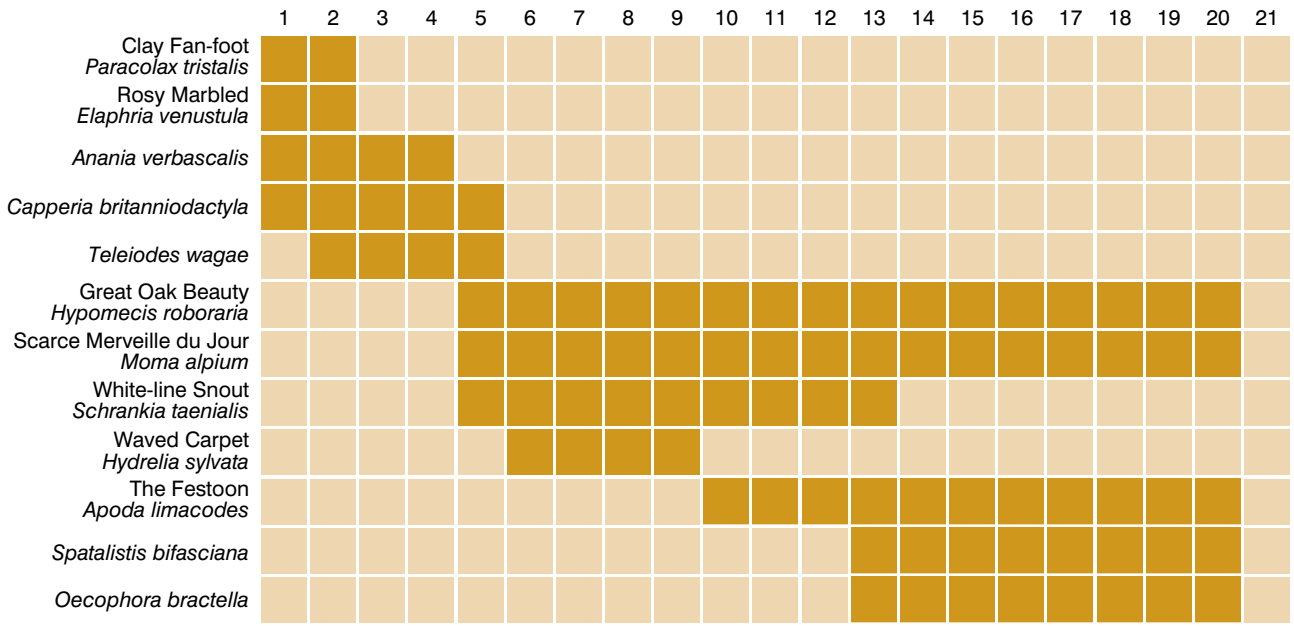
Scarce Merveille du Jour was associated with areas of coppice regrowth of 5 years and older

Rewell Wood is an actively coppiced Sweet Chestnut woodland well known for its coppice butterflies including a large population of Pearl-bordered Fritillary. The use of the coppice blocks by moths was less well understood. To assess whether the coppice was providing benefits for the scarce Waved Carpet and other moths, coppice coupes at this site (of between one and 20 years of coppice regrowth) were systematically sampled for night-flying moths with the cooperation of the woodland managers, the Forestry Commission.

The moths found in newly cut coppice areas were typically associated with open habitats. The moths recorded within the middle coppice stages were species typically associated with open woodland and scrub habitats and most utilised tree species as larval foodplants. Within the mature coppice coupes the moths were species typically associated with closed canopy woodland and some were specialists whose larval food comprised of material such as lichen and decaying leaves. All coppice stages including the mature closed-canopy coupes supported species of listed conservation status.

The study showed that active coppicing supports a variety of moth assemblages, with the species composition changing as coppice regenerates, and that closed-canopy stages are as valuable to moths as the open, newly-cut areas. Thus moth diversity can be promoted by providing a range of coppice growth stages.

Scarce and threatened moths associated with Sweet Chestnut coppice of different ages at Rewell Wood (Source: Butterfly Conservation/Forest Research)



Cattle grazing of woodland: conserving the Netted Carpet moth

Graham Jones

Cattle grazing at Coniston Water, Lake District

Touch-me-not Balsam is a nationally scarce plant occurring as a native primarily in the Lake District, but also in north Lancashire, Shropshire and North Wales. Larvae of the Red Data Book Netted Carpet moth can be found feeding on the seed-pods of Touch-me-not Balsam in the Lake District and north Lancashire.

Touch-me-not Balsam is an annual species of moist, nutrient-rich soils, usually occurring in damp woodlands. It can quickly colonise newly disturbed areas but is intolerant of competition with perennial plants; key to its persistence is an element of bare soil creation. It has a shortlived seed bank which means it is vulnerable to local extinctions. The successful conservation of the Netted Carpet relies on a year-on-year supply of abundant Touch-me-not Balsam.

Cattle were first introduced to National Trust woodlands near Coniston Water during 2002/2003. This has continued annually, with a small herd of traditional Blue-Grey cattle spending each winter and early spring moving round the various sites with the objective of lightly poaching the ground. The cattle move balsam seeds around on their hooves, thus spreading the plant widely. They also locally enrich the soil through dunging which encourages vigorous balsam germination and growth. The cattle are removed before the balsam germinates in the spring.

The effect of the introduction of cattle on both the plants and the Netted Carpet has been closely monitored. The results show a rapid increase in abundance of Touch-me-not Balsam to a level never previously seen. By 2007 the balsam population had multiplied by 3,400%, and the Netted Carpet larval count had increased by a similar proportion. Since the 2007 balsam peak, the plants numbers have stablised at around half the peak level, however, larval numbers have continued to increase.

In the seven years since the initiative began, the number of Netted Carpet larvae has risen from twelve, found on 400 balsam plants, to over 1,500 found on 25,000 plants.

Since the successful introduction of cattle in 2002/2003, this woodland management approach has been extended to additional sites around Coniston Water. Controlled winter cattle grazing is now a key management tool in Lake District woodlands, providing suitable conditions for the Netted Carpet to thrive.

Graham Jones

Netted Carpet, a UK BAP Priority species