

Introduction

Butterflies and moths, the insect group Lepidoptera, are disappearing from our countryside at an alarming rate, but nowhere more dramatically than in woodlands. Many species that were common only a few decades ago have become great rarities.

Gareth Krass



The Pearl-bordered Fritillary has declined across the UK and is now scarce in woodland habitats

The decline of so many butterflies and moths is a warning sign that all is not well in our woods and that other wildlife is threatened. Major losses in Lepidoptera populations will have serious impacts on woodlands because of the significant roles butterflies and moths play in food webs and as pollinators and herbivores. Similar declines have been noted in birds and plants and are also likely to have occurred in other wildlife groups that are not so well monitored.

Declines in woodland butterflies

Woodland habitats support 40 (67%) of Britain's 59 butterfly species and 16 of these rely on woodland in all or part of their range, and are considered "woodland specialists". While pronounced population cycles

may be natural in many butterflies, the long-term trend has clearly been one of severe decline. Data from the UK Butterfly Monitoring Scheme, collected across 619 woodland sites, show that there has been a significant decline for both the specialists (16 species) and generalists (24 species) occurring in woodlands. Specialist species, which are associated with mature broadleaved woodlands or open habitats within semi-natural woodlands, have declined by 56% since 1990 and by 27% from 2000-2009. These figures use a baseline figure of 1990, and do not include the historical declines that took place before monitoring began, which are likely to be even more severe.

A lack of woodland as such cannot be causing the decline of woodland butterflies. It is estimated that the amount of broadleaved woodland in Britain actually increased by 20% between 1800 and 1980 and by a further 5% since 1990 (although much new woodland is of limited value for Lepidoptera). It is when we examine trends within the woodland specialist butterflies, and focus on groups of species associated with particular habitat types, that underlying patterns begin to emerge.

The butterflies associated with mature woodland stages (Speckled Wood, White Admiral, Silver-washed Fritillary and Purple Hairstreak) have done relatively well over the last 25 years with an overall increase of 65% since 1985. These species are associated with shadier woods, including thinned woodland, the edges of conifer plantations, shady woodland rides, and in the case of Purple Hairstreak,

with the mature oak canopy.

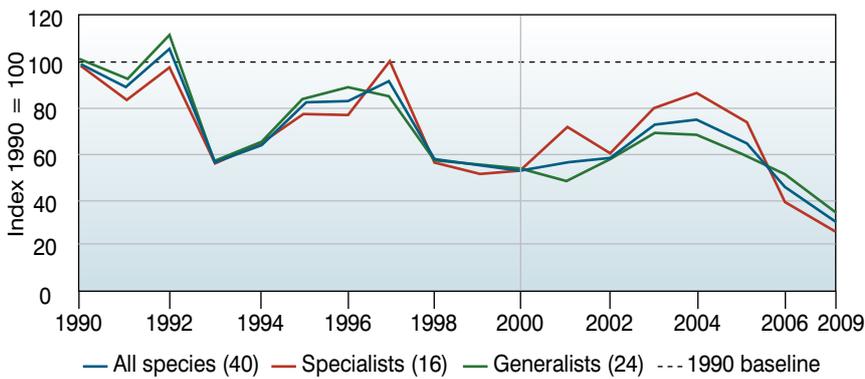
In contrast, species associated with short swards and herb-rich vegetation on woodland rides declined by 66% between 1985 and 2009. These butterflies (Wood White, Dingy Skipper and Grizzled Skipper) are now rare in woodland, although they can still be found in other non-woodland habitats.

The specialist butterflies associated with woodland clearings have done worst of all, declining by 80% since 1985. These species, the Pearl-bordered Fritillary, Small Pearl-bordered Fritillary and the Duke of Burgundy, are now among the UK's most threatened butterflies. Some can be found in rides but struggle to survive there in the long-term without additional open space. Suitable open space can include coppice (usually Hazel or Sweet Chestnut), clearfells, young plantations or permanent grass/Bracken clearings that may be cut or grazed.

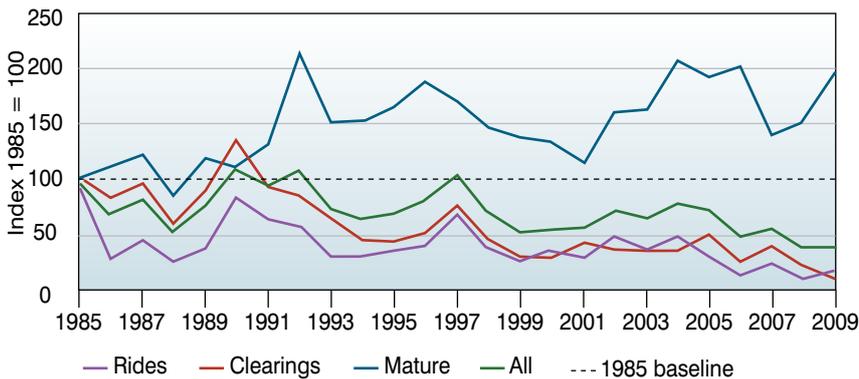


Dan Hoare

Changes in habitat structure, particularly the loss of open habitats, are responsible for the decline of many woodland species



Trends in woodland butterflies



Trends in woodland butterflies by habitat

Declines in woodland moths

More than 380 species of larger moths (out of around 900) are tree-dependent species. A further 200 additional larger moths occur in associated woodland habitats. Deciduous oaks alone support about 220 moth species in the British Isles.

Recent studies have found that many moths are declining, including a large number of woodland species.

The State of Britain's Larger Moths report in 2006 found that the total abundance of moths had declined by a third since 1968. In addition to concern about the future of moths themselves, there is serious concern about the impact of these declines on other wildlife, such as birds and bats, which depend on moths and their caterpillars as food sources. *The State of Britain's Larger Moths* report was based on research carried out by Rothamsted Research and Butterfly Conservation. The report's key conclusions are that since 1968:

- The number of larger moths in Britain has decreased by 32%
- Southern Britain has seen a decrease in larger moth numbers of 44%

- Twice as many species have declined as have increased
- In southern Britain 75% of species are in decline
- Sixty-two moth species became extinct during the 20th century

Woodland moths have declined following much the same pattern as woodland butterflies. Although the enormous diversity of moths makes comprehensive assessments difficult, there is clear evidence of very significant declines in many woodland specialists. Particularly affected are those associated with open spaces and principally those dependent upon regular woodland management.

Woodland Lepidoptera as indicators of environmental change

Woodland butterfly and moth populations can be considered to be good long-term biodiversity indicators because they respond rapidly to changes in the environment and to woodland management. They occur in a wide range of woodland habitats and are representative

of many other invertebrates. Lepidoptera are also particularly sensitive to the impacts of climate change.

The value of butterflies as indicators of woodland biodiversity has been recognised for some time, for example, by the Forestry Commission (FC) in England which in 2000 published *A Species Action Plan for Butterflies on Forestry Commission Land*. This strategy, produced in partnership with Butterfly Conservation and reviewed in 2007, outlines the action FC will take, in partnership with others, to conserve and increase butterfly populations on the public forest estate.



Richard Revels

Spotted Flycatcher with Brimstone moth: Lepidoptera form an important part of the food chain for other groups such as birds and bats

Lepidoptera of concern

Throughout this guide we use the term *Lepidoptera of concern* to describe a suite of scarce and threatened butterflies and moths for which woodlands are an important habitat in the UK. These species may also occur in non-woodland habitats, but are either declining in woodland or are at risk without ongoing appropriate woodland management. They include Priority species listed under the UK Biodiversity Action Plan (UK BAP), as well as scarce species with limited geographic distributions. We focus on these species because their conservation involves management targeted to their specific requirements, which are outlined in Section 4. The future of many other butterflies and moths is also of concern, but their needs can be met through generic habitat management approaches outlined in Section 3.

Why are woodland butterflies and moths declining?

Woodland butterfly and moth declines are primarily caused by loss of habitat through changes in woodland structure, a result of long-term changes in both the type and extent of woodland management.

Loss of structural diversity

Reductions in the structural diversity of woodlands mean that the habitat opportunities for woodland butterflies and moths are fewer and less varied. Changes in woodland structure are directly linked to the changing uses of woodlands, which have been largely driven by economics. The combined effects of declines in the production of coppice products, declines in woodland grazing and increasing agricultural use of land around wood edges have all contributed to greatly reducing the structural diversity of many woodlands. This lack of management results in the development of a closed canopy, with simplified shrub and herb layers. In addition, many woodlands are now managed primarily for timber production and have been planted with even-aged blocks of non-native conifers or monocultures of deciduous species. Such management creates a uniform woodland structure and reduces the variety of habitats available for butterflies, moths and other wildlife.

Dan Hoare



Structural diversity is often greatest on the edges of rides and clearings, incorporating varied scrub and grassland features

Key issues affecting woodland structure:

- Lack of active management, such as coppicing and thinning, resulting in the development of a closed canopy, simplified shrub and field layers and reduced diversity of woodland age structure
- A reduction in the number and extent of clearings, glades and rides
- Changes in woodland management for timber production, including the replacement of broadleaved woodland with conifers, large-scale uniform management and continuous-cover forestry
- Changes in grazing and browsing pressure, particularly by deer, which simplify the shrub and herb layers and prevent woodland regeneration

Replacement of native by non-native tree species

The species composition of many woods has changed, especially where they have been replanted with non-native conifers. The result is a loss of foodplants for tree and shrub feeding species. Perhaps more importantly, there is an associated loss of structural diversity as mosaics of habitats are replaced with uniform monocultures. Whilst this can mean a relative abundance of the open, early succession clearings favoured by some species for a few years following planting, these conditions are short-lived and closed canopy conditions soon predominate. There is typically little or no understory and no ground vegetation. Further losses of Lepidoptera habitat are caused through associated drainage work and the replacement of vegetated rides with surfaced extraction tracks within these new plantations.



David Green

Extensive plantations of non-native species provide few opportunities for native insects

Lack of habitat continuity

Continued availability of suitable habitat from year to year is vital to the survival of populations of butterflies, moths and other insects. Lepidoptera typically have to complete their life cycle at least once a year and do not have dormant stages that can survive temporary periods of adversity. Thus even a short break in habitat availability can mean local extinction if there is no alternative site close by. Long-term continuity of management within a woodland is therefore crucial to ensure species survival. Many conservation schemes have been unsuccessful in this respect. They have sometimes failed through insufficient long-term planning or simply because much traditional woodland management is no longer economically self-sustaining.

Secondary factors in the decline of woodland butterflies and moths

Many of the factors affecting woodland butterflies and moths are interconnected, and often contribute to an overall reduction in structural diversity. The following factors may all have a negative impact on woodland butterflies and moths, although there is less evidence that they are directly responsible for widespread declines.

Woodland fragmentation

Land use changes have resulted in many large woodlands being broken into smaller pieces, reducing the area and increasing the isolation of the remaining woodland patches. This is especially true where they are surrounded by agricultural landscapes, which are often of little value to butterflies and moths. Fragmentation increases the risk of species going locally extinct in a woodland patch and hinders the movement of individuals between the remaining fragments.

It can be useful to consider fragments in terms of 'connectivity' (a measure of how easy it is for a species to move between suitable habitat patches), which varies between species depending upon their dispersal ability. Increasing connectivity between habitat patches, both within and between woods, to create interconnected habitat networks, is essential to secure populations of our woodland butterflies and moths.



Dan Hoare

Intensive agricultural management damages valuable woodland edge habitats and makes it harder for woodland species to move through the landscape to other suitable sites

Free-ranging herbivores such as deer can cause major changes in the structure of woodlands. They can also have major impacts on vegetation diversity and composition.



Dan Hoare

Wild boar digging creates patchy soil disturbance but can damage tree roots

Deer: The impact of deer on woodlands in the UK is complex and as yet imperfectly understood. However, there is no doubt that as deer numbers increased greatly during the 20th century, considerable changes have taken place in the ground flora and structure of many woods. Deer damage to both woodland structure and tree regrowth is an increasing problem, particularly in lowland woods, as both the range and population density of native and introduced species continue to increase. The effects vary with deer species, number and woodland type, as well as local landscape factors such as surrounding non-woodland habitats. Some of these changes may be beneficial in some circumstances but only for certain species and the overall effect is a loss of diversity of plant species and a simplification of structure. Very high deer numbers will tend to result in a field layer dominated by grasses.

Wild Boar: Wild Boar were once native to British woodlands and, since becoming extinct in the 18th century, have reappeared in parts of England as escapes from farms. Although now established in some areas it is unclear what their long-term future is here. There is little evidence that they are a major factor in structural change of woodlands at present, but there may be potential future issues. Wild Boar rooting in woodland may be beneficial as it can encourage regeneration of early successional woodland plants, but at high density there is potential to cause damage by repeated disturbance.

Rabbits: Rabbit populations fluctuate as a result of periodic disease outbreaks, but can have a significant impact on butterfly and moth habitats in woodlands. Rabbits strip bark and browse young shoots, causing particular damage to young trees and coppice regrowth. In permanent clearings high densities may also influence the composition and height of the sward.



Jamie Cordery / The Deer Initiative

A young Muntjac deer: this introduced species can cause serious damage to trees, shrubs and ground flora

Agricultural intensity

Agricultural practices can impact on both the woodland itself, through grazing or agricultural chemical drift, and on habitats around the woodland such as unimproved grassland, hedgerows and scrub.

Woodland edges can be strongly modified by agricultural chemical drift, direct mechanical trimming, or grazing by livestock. Cultivation now typically extends right up to the woodland boundary creating an abrupt edge, significantly reducing the habitat available to woodland butterflies and moths. At many sites, the only remaining woodland edge habitat exists within the wood along the ride verges.

Farming practices on land adjacent to woodland can greatly limit opportunities for woodland species. Land drainage can reduce the water table in woods and thereby affect species dependent on wetland features. The loss of scrub, hedgerows and hedgerow trees around the woods is also highly damaging. Hedges and hedgerow trees contribute to the breeding areas used by many species and also provide a resource for insects dispersing between woods.

Loss of wetland features

Wet areas within woodlands are often regarded as problem areas and with the increasing emphasis on large-scale timber production many have been drained and lost. Such features are of major importance to many invertebrates and several specialist moths rely on seepages, springs, streams, woodland ponds and the areas immediately adjacent to them. The loss of individual features or any disruption of the hydrology will be detrimental.

Reduced availability of deadwood

Deadwood of all ages, both standing and fallen, is a food source for some specialist moths as well as for a host of other specialist invertebrates. Either the decaying wood itself or its associated fungi can be used by moth larvae. A continuous supply of deadwood in a variety of situations is vital, because many deadwood feeding invertebrates have very specific requirements. Moisture content and exposure can be critical factors. Tidiness, over-enthusiastic removal of deadwood and the felling of trees because of perceived danger to public safety are the greatest threats to the survival of these species.

Air pollution

Lichens are used as food and sheltering areas by many moth species and are highly sensitive to subtle changes in environmental conditions, especially air pollution. In the past, sulphur dioxide from coal burning and industry was a major pollutant leading to a loss of lichens, particularly in industrial areas. Since the introduction of clean air laws in the 1950s, lichens are recovering, and there is evidence that lichen-feeding moths have increased in recent years. However, increasing nitrogen compounds from traffic and from intensive farming have become major pollutants and can affect woodland lichens in both urban and rural areas. Nitrogen pollution also has the potential to affect the growth of higher plants and may be a factor causing changes in woodland vegetation.

Climate change

The effects of climate change on Britain's woodlands are likely to be unpredictable and complex, and possible scenarios including radical changes in the vegetation communities of woodlands. Temperature and life cycles of Lepidoptera are closely linked and climate change may be expected to have direct effects on butterfly and moth ecology. Higher temperatures result in changing growth rates, flight periods and the ability to exploit differing habitat niches. Indirect changes can also be anticipated. For example, changes in tree phenology, such as an advancement of tree leaf-burst, may mean that caterpillars hatch out of synchrony with their food sources. The intricate relationship with parasites may be upset and, if more favourable climatic conditions permit insectivorous birds to raise additional broods, then predator numbers could be greatly increased.

There is clear evidence that some woodland Lepidoptera are already responding to climate change. For example, the Speckled Wood butterfly has spread northward in England during recent decades and many moth species are showing similar northward range expansions. This underlines the need to increase diversity in our woods and to restore landscape networks in order to give Lepidoptera the best chance possible to adapt to whatever changes occur.

Dan Hoare



Deadwood should be left where it is to undergo natural decay

Factors adversely affecting woodland butterflies and moths of concern

These are the broad factors that potentially threaten many of our scarce Lepidoptera. Direct loss of habitat due to woodland removal is no longer a common occurrence, while habitat loss or damage due to

inappropriate management occurs at the site level and can apply to all species. This table highlights the primary factors driving widespread declines in butterflies and moths, and the secondary factors which may

interact with them or have a negative impact on some species. More detailed information on the habitat preferences of individual butterfly and moth species using woodlands can be found in Section 4.

	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	Sliver-washed Fritillary	Heath Fritillary	UK BAP Priority moths*	Other moths of concern
Primary factors																	
Low diversity of woodland age structure	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●
Lack of clearings, glades and rides	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●
Abandonment of coppice management	●	●	●					●			●	●	●		●	●	●
Abandonment of stock grazing	●										●	●					●
High intensity deer browsing					●	●	●	●	●		●	●	●			●	●
Abrupt woodland edges	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●
Secondary factors																	
Woodland fragmentation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Loss of wetland features																	●
Insufficient deadwood																	●
Loss of native trees					●	●	●			●						●	●
Loss of veteran trees																●	●
Air pollution																●	●

*see links in Section 5 for full lists of UK BAP Priority species