Butterfly Conservation

Saving butterflies, moths and their habitats

A new Red List of British Butterflies

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JOINT NATURE CONSERVATION COMMITTEE

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Executive summary

1. This report has been produced as part of the Joint Nature Conservation Committee's Species Status Assessment and contains the first assessment of British butterflies against the new IUCN criteria, which now include far more explicit and quantified criteria. Butterflies are known to be one of the most rapidly declining groups of plants or animals (Thomas *et al.*, 2004) so the report is both important and timely.

2. All 62 resident and regularly breeding species (species that breed in Great Britain every year) were assessed, including three regular migratory species (Clouded Yellow *Colias croceus*, Red Admiral *Vanessa atalanta* and Painted Lady *V. cardui*).

3. The Red List assessment was carried out using data from two different, but complementary schemes that exist to monitor butterflies in Britain: a national distribution recording scheme (Butterflies for the New Millennium) and a population monitoring scheme (UK Butterfly Monitoring Scheme) (Fox *et al*. 2006). Limitations of the data are discussed.

4. The state of knowledge and nature of the data available on British butterflies from these two schemes enabled an assessment to be made based upon two quantitative IUCN criteria: A2 (rate of population decline) and B2 (area of occupancy).

5. The results show that four species are extinct (excluding the Large Blue *Glaucopsyche arion*, which became extinct in 1979 but has since been reintroduced), 19 species are threatened (Critically Endangered, Endangered or Vulnerable) and 11 species are Near Threatened. Thus 34 species or 55% of species are extinct or threatened to some degree. This increases to 58% if migrant species are excluded.

6. Two species are Critically Endangered (Large Blue *Glaucopsyche arion* and High Brown Fritillary *Argynnis adippe*), but eight are Endangered, and nine Vulnerable. The remaining 28 species are classified as Least Concern.

7. The results confirm that butterflies are a highly threatened group of insects, with 58% of permanently resident species either extinct or threatened to some degree. This compares to 28% of vascular plants (Cheffings *et al*. 2005).

8. A comparison with previous assessments shows that the number of species considered to be threatened has grown steadily as the criteria to assess extinction risk have been improved.

9. We consider that the current IUCN criteria provide a far more valid assessment of extinction risk than earlier versions and that this new Red List assessment provides an important foundation to define conservation priorities, including those within the UK Biodiversity Action Plan. Although such priorities are drawn up using different criteria, and select a slightly different suite of species, both lists include many of the same species and highlight the serious extinction risk facing butterflies in Britain.

1. Introduction

The first review of Red Data Book (RDB) and notable butterflies in Britain was produced by Shirt (1987) using the original IUCN criteria. An improved Red List of British butterflies was subsequently produced by Warren *et al.* (1997), using later IUCN criteria that included the rate of decline, as well as rarity, to assess threat. More recently, species have been prioritised for conservation action through the UK Biodiversity Action Plan process (Bourn *et al.* 2005, UK Biodiversity Group 1998).

Since the last two Red List assessments of butterflies in Britain, a great deal more detailed information on their distribution has become available through the publication of *The Millennium Atlas of Butterflies in Britain and Ireland* (Asher *et al*. 2001) and subsequent recording. Comprehensive new data on both distribution trend and population trend have recently been published in *The State of Butterflies in Britain and Ireland* (Fox *et al.* 2006), allowing an up-to-date and comprehensive assessment. It is clear from these data that the status of many butterfly species has changed since the first reviews and a revision of the original RDB and notable lists is now overdue.

This report has been produced as part of the Joint Nature Conservation Committee's (JNCC) Species Status Assessment, which aims to assess a range of taxa (e.g. Cheffings *et al*. 2005) using the new IUCN criteria for producing Red Lists at the regional level (Gärdenfors *et al*. 2001, IUCN 2001, 2003). This report contains the first assessment of British butterflies against the new IUCN criteria, which now include far more explicit and quantified criteria (IUCN 2001, 2003). Butterflies are known to be one of the most rapidly declining groups of plants or animals (Thomas *et al.* 2004) so the report is both important and timely.

2. Methods and data sources

2.1 Species coverage

All resident and regularly breeding species (species that breed in Great Britain every year) were assessed. This includes three migratory species (Clouded Yellow *Colias croceus*, Red Admiral *Vanessa atalanta* and Painted Lady *V. cardui*) that are common summer breeding species but do not maintain substantial year-round populations in Britain. Butterflies that formerly occurred as regular breeding species were also assessed. Other immigrant species were classified as vagrants according to IUCN guidelines (Gärdenfors *et al*. 2001), since they occur only occasionally within Britain. A total of 62 species were assessed. All taxa were assessed at the species level.

2.2 Data sources

The Red List assessment was carried out using data from two different, but complementary schemes that exist to monitor butterflies in Britain: a national distribution recording scheme (Butterflies for the New Millennium) and a population monitoring scheme (UK Butterfly Monitoring Scheme) (see Fox *et al*. 2006 for details).

2.2.1 Butterflies for the New Millennium (BNM)

The BNM scheme was launched by Butterfly Conservation in 1995 and has provided the impetus for 10 years of the most intensive butterfly recording ever undertaken in Britain (and Ireland). Data from the first five-year recording period (1995–99) were used to prepare *The Millennium Atlas of Butterflies in Britain and Ireland* (Asher *et al*. 2001) and ongoing recording led to an update publication, *The State of Butterflies in Britain and Ireland* (Fox *et al*. 2006), which made use of additional data collected during 2000-04. Since 1995, some 10,000 volunteers have contributed a total of 3.2 million butterfly distribution records for Great Britain, representing 99.4% of 10km grid squares on the Ordnance Survey National grid. Almost all of these records are at a 1km or 100m grid square resolution. The recording since 1995 is only one facet of the BNM scheme. Historical (i.e. pre-1995) butterfly records have been brought together and incorporated into the BNM data set. These records provide a good level of national coverage for the period 1970–82 and more patchy (geographically and taxonomically) data covering the 1690–1969 and 1983–94 periods.

The BNM data provide area of occupancy (AOO) and enable the assessment of long-term trends by comparing species' distributions in different time periods. However, such trends have to be constructed and interpreted with care as the intensity and geographical coverage of recording has varied over time. We calculated distribution change (AOO change) at the 10km square resolution between the survey periods 1970-82 and 1995-2004 (duration between mid-points of surveys= 25 years) by using a sub-sampling analysis (Fox *et al*. 2006, Thomas *et al*. 2004). This technique provides a way to reduce the bias resulting from differences in recording intensity in the two periods by producing an approximate equalisation of recording effort. The results correlated closely with trends from butterfly population monitoring, suggesting that distribution change (even at the relatively coarse 10km square resolution) can be a valid surrogate for population change (Thomas 2005, Warren *et al*. 2001).

2.2.2 UK Butterfly Monitoring Scheme (UKBMS)

Detailed population monitoring of butterflies commenced at a national scale in the UK in 1976 with the launch of the Butterfly Monitoring Scheme, co-ordinated by the Centre for Ecology and Hydrology and JNCC. The scheme's transect methodology was taken up independently by many conservation organisations, landowners and amateur naturalists. The

number of transects operating outside the official scheme grew and eventually greatly outnumbered those within it. Butterfly Conservation started to collate and co-ordinate these transects in the late 1990s and, in 2006, the UKBMS was set up to integrate all transects under a single, unified project and database. The UKBMS has collated data from over 1,000 transects so far, representing nearly 150,000 weekly walks and records of over 10.5 million individual butterflies.

The methodology and development of transect monitoring for butterflies has been reviewed in detail elsewhere (Pollard and Yates 1993). In brief, a fixed-route walk (transect) is established at a site and butterflies are recorded along the route on a regular (weekly) basis under reasonable weather conditions for a number of years. In addition to standard butterfly transects, the UKBMS also collates data from single species transects and from timed counts. These are used to supplement standard transect data in the assessment of certain rare species (e.g. the High Brown Fritillary *Argynnis adippe* and Heath Fritillary *Melitaea athalia*). The UKBMS provides a standardised annual measure (index) of butterfly populations at transect sites, which can be used to generate long- and short-term population trends.

Both transect counts and timed counts are used primarily to produce an annual estimate (site index) of the abundance of a butterfly species at a site. These site indices have been shown to relate closely to other, more intensive, measures of population size such as mark/release/recapture methods (Pollard *et al*. 1986). The site index can be thought of as a relative measure of the overall population size, being a more or less constant proportion of the number of butterflies actually present. Although they are relative measures, site indices can be combined to derive regional and national collated indices and be used to estimate trends over time. However, this collation is not a straightforward calculation because not all of the1,000+ transect sites in the UKBMS data set have been recorded each year. A statistical model is needed and, in common with most butterfly and bird monitoring schemes in Europe, a log-linear Poisson regression model, as performed by the statistical software TRIM (Pannekoek and van Strien 1996), has been used to analyse the UKBMS data (Fox *et al*. 2006).

Collated indices of abundance were calculated for butterflies that have been recorded from a minimum of five sites per year, although many have been monitored at a much larger number of sites. A few species however do not meet this criterion or are insufficiently sampled and, therefore, have no population trend (the Swallowtail *Papilio machaon*, Brown Hairstreak *Thecla betulae*, Black Hairstreak *Satyrium pruni*, Glanville Fritillary *Melitaea cinxia* and Mountain Ringlet *Erebia epiphron*). Species now extinct in Britain do not have population data as all were lost before the advent of monitoring or shortly thereafter. Finally, there are no population trends for the Small Skipper *Thymelicus sylvestris* and Essex Skipper *T. lineola*, as these two species are not normally distinguished during transect monitoring in Britain.

Adoption of the minimum five sites per year criterion enabled the calculations of 10-year and long-term population trends for 49 butterfly species in total. In most cases, this provided population index values from 1976 to 2004, showing how the overall abundance of each species has changed over this time period. The regression slope of log collated index on years was used to measure the trends over time both for the full time period and for the last 10 years (1995–2004). The statistical significance of these long-term and 10-year trends was determined by the correlation coefficient between the log collated index and years (Pollard *et al*. 1995).

2.3 Data limitations

Although distribution and population data on butterflies are more comprehensive than for any other invertebrate group in Britain, the data sources used in this assessment do have limitations.

Distribution recording is uneven in time and space, requiring the use of the sub-sampling analysis to normalize sampling effort. This approach greatly reduces the bias in distribution trends due to changing patterns of recording effort, but does not completely eliminate it. It may also reduce sampling effort bias unevenly across species. A second limitation is that the calculation of distribution change must be made at the 10km grid square resolution. This is because many records in the baseline 1970-82 survey only exist at 10km square resolution. Butterfly distribution change should ideally be measured at a finer spatial scale to obtain a reliable estimate of change at the population level: substantial rates of population extinction or colonization within 10km squares will not be identified by our analysis. Third, the measurement of distribution change is for a 25-year period, rather than the last 10 years as required by the IUCN criteria. Both the spatial scale and time period issues are addressed by modifying the category thresholds (see below).

Population monitoring data also have limitations. First, the butterfly transect method may not be equally appropriate for all species. For example, tree-canopy species such as the Purple Hairstreak *Neozephyrus quercus*, White-letter Hairstreak *Satyrium w-album* or Purple Emperor *Apatura iris* are difficult to record, and monitoring trends for these species should be treated with caution until further research has been undertaken to validate the method. Second, while the 10-year population trends required by IUCN criteria can be generated from the data, the dynamic nature of insect population levels can lead to short-term trends that do not accurately reflect the longer-term trend. The value of the monitoring carried out under the UKBMS is that short-term (e.g. 10-year) trends can be interpreted in the context of two- or three-fold longer time periods (see below).

2.4 IUCN Categories

The IUCN categories used in this national assessment are as defined in *IUCN Red List Categories and Criteria: Version 3.1* (IUCN, 2001), except that the category of Extinct is replaced by the category of Regionally Extinct (after Gärdenfors *et al*. 2001), since none of the butterfly species that have become extinct in Britain are endemic. Three additional IUCN categories were not used in this assessment: Extinct in the Wild, Data Deficient and Not Assessed.

REGIONALLY EXTINCT (RE). A taxon is Regionally Extinct when there is no reasonable doubt that the last individual has died in the region. A taxon is presumed Regionally Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range within the region have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR). A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN). A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU). A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT). A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC). A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

2.5 Application of IUCN criteria

The state of knowledge and nature of the data available on British butterflies enabled us to assess taxa quantitatively against two IUCN criteria: A2 and B2.

2.5.1 Application of criteria A2 (reduction in population size)

The criterion is defined as an observed, estimated, inferred or suspected population size reduction of threshold values, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on the following two sub-criteria available for British butterflies:
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

The 10-year population trends generated from the UKBMS data set can be applied directly under criterion A2(b). However, the initial classification produced must be considered in light of the data limitations discussed above. In particular, assessments over the short 10-year period may yield trends that are heavily biased by exceptional fluctuations in annual population indices. Thus it is relevant to compare the 10-year population trends with the long-term trends available for butterflies (see Table 1). For example, the Brown Argus *Plebeius agestis* has a 10-year population trend of –61% and would appear to qualify as Endangered. However, the long-term population monitoring of this species reveals that this dramatic 10-year trend derives from a decrease from uncharacteristically high population levels in 1995-1997 to more typical levels in recent years. There is no indication that the species declined continuously within the 10-year period; indeed over the longer-term (1976-2004), the Brown Argus population has increased by 16%. In this situation, and others like it, the initial categorisation has been downgraded. Long-term population trends are presented in the results table.

Assessment under criterion A2(c) requires some adjustment to take account of the difference between distribution (AOO) trends measured at the 10km square spatial resolution and the real population-level change and the difference in time period between the measured trends (25 years) and the IUCN thresholds (10 years). These adjustments have been made by altering the criteria thresholds as follows.

Spatial-scale adjustment of threshold values

Distribution trends measured at 10km square resolution normally seriously underestimate trends at a finer spatial scale (which more closely resemble population level change), but this relationship is not linear and is taxon specific. We applied the estimate derived by Thomas and Abery (1995) that losses of a species of intermediate rarity were 35% higher when plotted at the 2km square scale than at the 10km square scale. This 35% rule of thumb has also been used in other recent assessments of the status of British butterflies (e.g. Bourn *et al*. 2005, Warren *et al*. 1997).

Thus, for this assessment the A2(c) Critically Endangered threshold of 80% population decline was reduced by 35% to become 52% decline in AOO at 10km square resolution; the Endangered threshold of 50% reduced to 32.5%; and the Vulnerable threshold of 30% decline reduced to 19.5%.

Temporal-scale adjustment of threshold values
In order to further adjust the modified threshold values derived from the spatial-scale adjustment to take account of the different time periods of the trends and the IUCN criteria, the annual rate of change was calculated. This was done using the equation $(1-x)^n$ = proportion of population remaining, where x is the annual rate of change and n is the number of years over which the change has taken place.

Solving this equation for the modified thresholds gives:

Critically Endangered category threshold, the equation to be solved is $(1-x)^{10} = 0.48$. This resolves to x (the annual rate of change to give the 52% decline at 10km square level over 10 years) = 0.07077. Put back into the equation over 25 years gives a threshold decline rate of 84%. Thus, a species meets the Critically Endangered criteria if its AOO trend is equal to or greater than 84% over 25 years.

Endangered category threshold, following the same procedure as above, but solving the equation to give a 32.5% decline at 10km square resolution over 10 years, gives x = 0.03854, giving a threshold decline rate in AOO of greater than 62.6% over 25 years. For the Vulnerable category, solving the equation to give a 19.5% decline at 10km square resolution over 10 years, gives x = 0.02146, giving a threshold decline rate in AOO of greater than 41.9% over 25 years. Species were defined as Near Threatened if their AOO trend exceeded 31.9% but did not exceed the Vulnerable category threshold of 41.9%.

These modified thresholds were used to produce the categorisation under A2(c).

Threat class	**IUCN criteria decline over 10 yrs**	**AOO distribution trend over 25 years**
CR	≥ 80%	≥ 84%
EN	50-79%	62.6 – 83.9%
VU	30-49%	41.9 - 62.5%
NT	-	31.9 – 41.8%

2.5.2 Application of criterion B2 (area of occupancy)

The criterion is defined as geographic range in the form of AOO estimated to be less than threshold values, and estimates indicating at least two of a-c:

a. Severely fragmented
b. Continuing decline
c. Extreme fluctuations

The BNM data enable the calculation of AOO for each species assessed for the last 10 years for which data are available (1995-2004). In accordance with recommended practice (Eaton *et al*. 2005, IUCN 2003), AOO was calculated at the 2km grid square level. While using this geographical resolution provides a better estimate of the true AOO of a taxon than the coarser 10km square resolution, many butterfly species will actually occupy only a small proportion of the 2km grid square. Thus our measure of AOO is likely to overestimate the

amount of land occupied by species, in some cases severely so, and thus potentially underestimate the IUCN threat category to which taxa should be assigned under criteria B2.

The criteria threshold values for categories were not modified and follow IUCN (2001). If a taxon met any of these AOO threshold values but did not meet two of the three sub-criteria (i.e. severely fragmented, declining, extreme fluctuations) then we classified it as Near Threatened under criteria B2.

Threat class	AOO (based on tetrads occupied)
CR	$<10km^2$ + 2 of three sub-criteria (a-c)
EN	$<500km^2$ + 2 of three sub-criteria (a-c)
VU	$<2000km^2$ + 2 of three sub-criteria (a-c)
NT	$<2000km^2$

2.6 Assessment process

IUCN recommend that regional Red List classifications (regional being any level below global) are carried out as a two stage process (Gärdenfors *et al*. 2001). Stage one is the application of IUCN criteria to taxon data at the regional level. Stage two involves an assessment of whether the regional extinction threat determined in stage one is affected by the existence of conspecific populations outside of the region in question. For example, if a species was very rare and declining in Britain then the stage one process might determine a high risk of national extinction and allocate an IUCN category such as Critically Endangered or Endangered. However, if the same species is widespread and not declining in continental Europe and is capable of dispersing to Britain, then there is potential for a 'rescue effect': the threatened British population being bolstered by individuals arriving from other countries. In such a situation, the extinction risk of the national population is lessened and a downgrading of the national Red List category should be considered.

In this 'regional' assessment of British butterflies, the two stage process has been adopted. In stage one, species were assessed against IUCN criteria using national data sources. For most taxa, three variables (population trend, distribution trend and AOO) were available for assessment against the quantitative thresholds in the above criteria. A precautionary approach was applied during the assessment, such that the highest threat category justified by the data (with expert interpretation) was applied.

For the second part of the assessment, the likely impact of conspecific populations outside of Britain was appraised. These taxon-specific judgements were made according to the checklist of questions in Gärdenfors *et al*. (2001) and IUCN (2003). While the British population of some butterfly species is clearly interconnected with populations in neighbouring countries (e.g. for highly mobile resident species such as Large White *Pieris brassicae*, Small White *Pieris rapae* and Small Tortoiseshell *Aglais urticae*, as well as for the migrant species that only breed in Britain during the summer), in all cases these taxa had been classified as Least Concern and therefore no downgrading of threat category was required. Conversely, all British taxa afforded an extinction threat category (including Near Threatened), were considered to be unaffected by the presence of conspecific populations elsewhere. The latter judgement was made primarily on the grounds of limited dispersal capability, although it is also true that many of the species qualifying for high extinction risk categories in Britain are also declining in neighbouring countries (Asher *et al*. 2001, van Swaay and Warren 1999).

3. Results: A new Red List of British Butterflies

The data available and assessment for all species is shown in Table 1 and a summary of overall results is shown in Figure 1.

The assessment shows that four species are considered extinct, 19 species are threatened (including the Large Blue *Glaucopsyche arion,* which became extinct but has been reintroduced), and 11 species are Near Threatened (Figure 1, Table 2). Thus 34 species or 55% of species are extinct or threatened to some degree. This increases to 58% if migrant species are excluded. Two species are critically Endangered (Large Blue *Glaucopsyche arion*, and High Brown Fritillary *Argynnis adippe*) and eight are Endangered.

Figure 1 Summary of Red List assessment for British butterflies, 2006
(Key: RE = Regionally Extinct; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern)

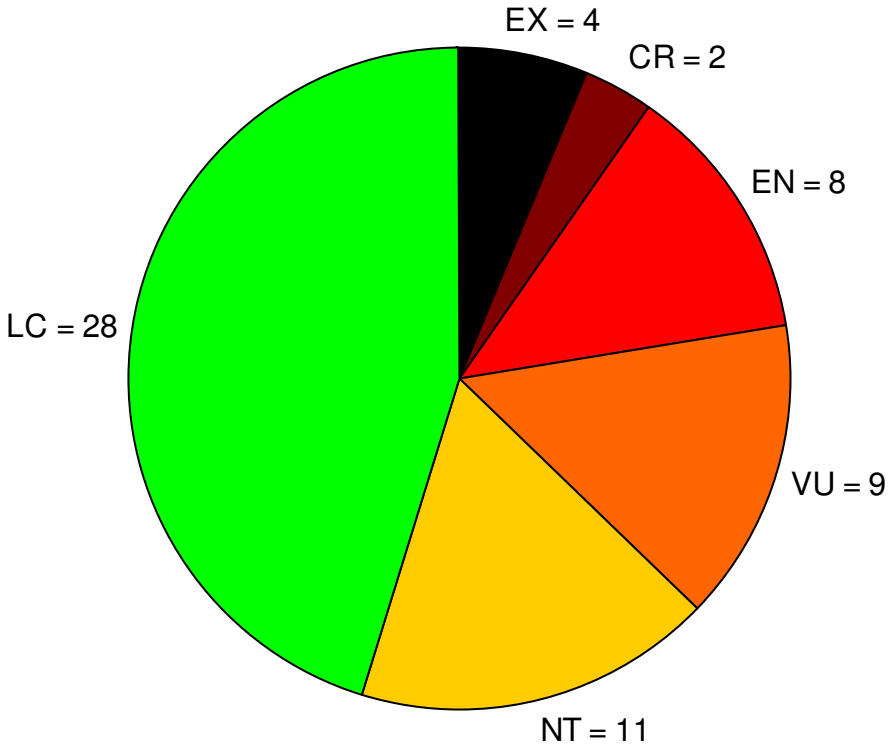

Table 1: New Red List of British Butterflies: all species with revised distribution and population trend data for 1995-2004

		Occupied tetrads 1995-2004	AOO from tetrads km^2	Red List on AOO CR=<$10km^2$, EN=<$500km^2$, VU=<$2000km^2$ + fragmented, declining, severe fluctuations)	AOO Trend: 25yr Distribution Trend (subsampling of 10km square data, 1970-82 to 1995-2004)	Red List on AOO trend: Thresholds over 25 yrs CR = 84% EN=62.6% VU=41.9%	Long-term Population trend (varies from 10-25 yrs) * p<0.05 ** p<0.01 *** p<0.001	10yr Population Trend (1995-2004) * p<0.05 ** p<0.01	Red List on 10yr pop trend CR=80% EN=50% VU=30%	**Overall assessment**	**Criteria for qualifying**	Notes
Chequered Skipper	*Carterocephalus palaemon*	106	424	EN	-38%		–	–		**EN**	B2 a,b	
Small Skipper	*Thymelicus sylvestris*	15,170	60,680		4%		–	–		LC		
Essex Skipper	*Thymelicus lineola*	6,660	26,640		46%		–	–		LC		
Lulworth Skipper	*Thymelicus acteon*	63	252		-15%		-13%	79%		**NT**	B2	AOO highly restricted (<500km2) but not fragmented, declining or fluctuating
Silver-spotted Skipper	*Hesperia comma*	168	672		4%		1524%***	2%		**NT**	B2 a	AOO restricted (<2000km2) but recent expansion
Large Skipper	*Ochlodes sylvanus*	13,534	54,136		-12%		12%	-38%*	VU	LC		10 yr pop decline not supported by long-term trend or AOO trend
Dingy Skipper	*Erynnis tages*	2,167	8,668		-48%	VU	-37%**	-26%		**VU**	A2 c	
Grizzled Skipper	*Pyrgus malvae*	1,409	5,636		-49%	VU	-34%	-42%	VU	**VU**	A2 b,c	
Swallowtail	*Papilio machaon*	32	128		-5%		–	–		**NT**	B2	AOO highly restricted (<500km2) but pops not fluctuating or fragmented
Wood White	*Leptidea sinapis*	236	944	VU	-65%	EN	-64%	10%		**EN**	A2 c	
Clouded Yellow	*Colias croceus*	6,592	26,368		144%		1117%	1877%		LC		Regular breeding migrant
Brimstone	*Gonepteryx rhamni*	13,109	52,436		-3%		22%	-11%		LC		
Black-veined White	*Aporia crataegi*									**RE**		Last record 1920s
Large White	*Pieris brassicae*	25,463	101,852		-7%		-28%	18%		LC		
Small White	*Pieris rapae*	25,753	103,012		-7%		15%	-34%	VU	LC		10 yr pop decline not supported by long-term trend or AOO trend
Green-veined White	*Pieris napi*	30,233	120,932		-1%		11%	7%		LC		
Orange-tip	*Anthocharis cardamines*	21,594	86,376		7%		22%	-8%		LC		
Green Hairstreak	*Callophrys rubi*	3,538	14,152		-29%		-25%	-25%		LC		

Brown Hairstreak	*Thecla betulae*	926	3,704		-43%	VU	–	–		**VU**	A2 c	
Purple Hairstreak	*Neozephyrus quercus*	5,696	22,784		-15%		53%	-23%		LC		
White-letter Hairstreak	*Satyrium w-album*	2305	9,220		-53%	VU	-71%*	-63%	EN	**EN**	A2 c	
Black Hairstreak	*Satyrium pruni*	72	288	EN	-43%	VU	–	–		**EN**	B2 a,b	
Small Copper	*Lycaena phlaeas*	15,234	60,936		-16%		-8%	-41%	VU	LC		10 yr pop decline not supported by long-term trend
Large Copper	*Lycaena dispar*									**RE**		Last record 1864. Reintroduction attempts failed
Small Blue	*Cupido minimus*	803	3,212		-38%		-6%	121%		**NT**	A2 c	Decline in AOO close to VU
Silver-studded Blue	*Plebeius argus*	415	1,660	VU	-43%	VU	-1%	-72%*	EN	**VU**	A2 c	Decline in AOO. 10 yr pop decline not supported by long-term trend
Brown Argus	*Plebeius agestis*	4,382	17,528		16%		16%	-61%*	EN	LC		10yr pop trend not supported by AOO trend or long-term trend
Northern Brown Argus	*Plebeius artaxerxes*	384	1,536	VU	18%		-10%	-30%	VU	**VU**	A2 b + B2 a,b	
Common Blue	*Polyommatus icarus*	17,250	69,000		-15%		9%	-21%		LC		
Chalkhill Blue	*Polyommatus coridon*	867	3,468		-36%		31%	-34%	VU	**NT**	A2 b,c	Decline in AOO. 10yr pop decline not supported by long-term trend
Adonis Blue	*Polyommatus bellargus*	455	1,820		-19%		28%	63%		**NT**	B2 c	AOO restricted (<2000km2) following major decline but recent expansion
Mazarine Blue	*Polyommatus semi-argus*									**RE**		Last record 1904
Holly Blue	*Celastrina argiolus*	14,823	59,292		36%		281%	-30%	VU	LC		10yr trend part of natural cycle and not supported by long-term trend
Large Blue	*Glaucopsyche arion*		,<10				–	–		**CR**	B2 a,c	Extinct in Britain 1979 but re-introduced since 1980s to c. 10 sites
Duke of Burgundy	*Hamearis lucina*	322	1,288	VU	-52%	VU	-28%	-58%*	EN	**EN**	A2 b	
White Admiral	*Limenitis camilla*	1,501	6,004		-31%		-62%**	-36%	VU	**VU**	A2 b	
Purple Emperor	*Apatura iris*	260	1,040		-52%	VU	-18%	33%		**NT**	B2 a,b	AOO restricted (<2000km2) but trend not reliable for this canopy dwelling sp.
Red Admiral	*Vanessa atalanta*	23,960	95,840		25%		350%***	-38%	VU	LC		Regular breeding migrant. 10 yr decline not supported by long-term trend
Painted Lady	*Vanessa cardui*	19,395	77,580		32%		520%	118%		LC		Regular breeding migrant
Small Tortoiseshell	*Aglais urticae*	28,695	114,780		-3%		-15%	-34%	VU	LC		10yr trend not supported by AOO trend or long term trend
Large Tortoiseshell	*Nymphalis polychloros*									**RE**		Last record in 1980s. Only vagrants since
Peacock	*Inachis io*	25,238	100,952		17%		90%**	-40%	VU	LC		10yr trend not supported by AOO trend or long-term trend

Comma	*Polygonia c-album*	15,883	63,532		37%		305%***	64%		LC		
Small Pearl-bordered Fritillary	*Boloria selene*	2,308	9,232		-34%		-70%***	-10%		**NT**	A2 c	Decline in AOO close to VU
Pearl-bordered Fritillary	*Boloria euphrosyne*	667	2,668		-61%	VU	-66%**	-51%	EN	**EN**	A2 b	
High Brown Fritillary	*Argynnis adippe*	138	552	VU	-79%	EN	-13%	-85%*	CR	**CR**	A2 b	
Dark Green Fritillary	*Argynnis aglaja*	2,856	11,424		-30%		63%	-10%		LC		
Silver-washed Fritillary	*Argynnis paphia*	2,262	9,048		-29%		33%	-14%		LC		
Marsh Fritillary	*Euphydryas aurinia*	719	2,876		-46%	VU	-73%**	73%		**VU**	A2 c	
Glanville Fritillary	*Melitaea cinxia*	33	132	EN	-17%		–	–		**EN**	B2 b,c	
Heath Fritillary	*Melitaea athalia*	42	168	EN	-25%		-73%**	-46%	VU	**EN**	B2 a,b,c	
Speckled Wood	*Pararge aegeria*	18,583	74,332		31%		160%***	66%*		LC		
Wall	*Lasiommata megera*	9,400	37,600		-38%		-65%**	-2%		**NT**	A2 c	Decline in AOO close to VU
Mountain Ringlet	*Erebia epiphron*	131	524	VU	-12%		–	–		**NT**	B2 a,c	AOO restricted (<2000km2) but no major decline or extreme fluctuations
Scotch Argus	*Erebia aethiops*	1,415	5,660		-10%		165%**	-1%		LC		
Marbled White	*Melanargia galathea*	5,565	22,260		11%		129%**	-15%		LC		
Grayling	*Hipparchia semele*	2,085	8,340		-45%	VU	-51%**	-41%**	VU	**VU**	A2 b,c	
Gatekeeper	*Pyronia tithonus*	20,037	80,148		12%		-12%	-5%		LC		
Meadow Brown	*Maniola jurtina*	28,078	112,312		-4%		28%	-5%		LC		
Ringlet	*Aphantopus hyperantus*	15,738	62,952		16%		373%***	33%		LC		
Small Heath	*Coenonympha pamphilus*	12,165	48,660		-29%		-52%**	-29%		**NT**	A2 b,c	10 yr pop decline very near VU + supported by AOO and long- term trend
Large Heath	*Coenonympha tullia*	957	3,828		-43%	VU	-26%	58%		**VU**	A2 c	

Table 2. Red List of threatened butterflies in Britain

		Overall assessment	Criteria for qualifying
Black-veined White	*Aporia crataegi*	**RE**	Last record 1920s
Large Copper	*Lycaena dispar*	**RE**	Last record 1864. Reintroduction attempts failed
Mazarine Blue	*Polyommatus semi-argus*	**RE**	Last record 1904
Large Tortoiseshell	*Nymphalis polychloros*	**RE**	Last record in 1980s. Only vagrants since
Large Blue	*Glaucopsyche arion*	**CR**	Extinct in Britain 1979, re-introduced 1980s. Globally Endangered sp.
High Brown Fritillary	*Argynnis adippe*	**CR**	A2 b
Chequered Skipper	*Carterocephalus palaemon*	**EN**	B2 a,b
Wood White	*Leptidea sinapis*	**EN**	A2 c
White-letter Hairstreak	*Satyrium w-album*	**EN**	A2 c
Black Hairstreak	*Satyrium pruni*	**EN**	B2 a,b
Duke of Burgundy	*Hamearis lucina*	**EN**	A2 b
Pearl-bordered Fritillary	*Boloria euphrosyne*	**EN**	A2 b
Glanville Fritillary	*Melitaea cinxia*	**EN**	B2 b,c
Heath Fritillary	*Melitaea athalia*	**EN**	B2 a,b,c
Dingy Skipper	*Erynnis tages*	**VU**	A2 c
Grizzled Skipper	*Pyrgus malvae*	**VU**	A2 b,c
Brown Hairstreak	*Thecla betulae*	**VU**	A2 c
Silver-studded Blue	*Plebeius argus*	**VU**	A2 c
Northern Brown Argus	*Plebeius artaxerxes*	**VU**	A2 b + B2 a,b
White Admiral	*Limenitis camilla*	**VU**	A2 b
Marsh Fritillary	*Euphydryas aurinia*	**VU**	A2 c
Grayling	*Hipparchia semele*	**VU**	A2 b,c
Large Heath	*Coenonympha tullia*	**VU**	A2 c
Lulworth Skipper	*Thymelicus acteon*	**NT**	B2
Silver-spotted Skipper	*Hesperia comma*	**NT**	B2 a
Swallowtail	*Papilio machaon*	**NT**	B2
Small Blue	*Cupido minimus*	**NT**	A2 c
Chalkhill Blue	*Polyommatus coridon*	**NT**	A2 b,c
Adonis Blue	*Polyommatus bellargus*	**NT**	B2 c
Purple Emperor	*Apatura iris*	**NT**	B2 a,b
Small Pearl-bordered Fritillary	*Boloria selene*	**NT**	A2 c
Wall	*Lasiommata megera*	**NT**	A2 c
Mountain Ringlet	*Erebia epiphron*	**NT**	B2 a,c
Small Heath	*Coenonympha pamphilus*	**NT**	A2 b,c

4. Discussion and conclusions

The current assessment is based on the most comprehensive information on the distribution and status of butterflies ever available. The results confirm that butterflies are a highly threatened group of insects, with 58% of permanently resident species either extinct or threatened to some degree. This compares to 28% of vascular plants (Cheffings *et al*. 2005) and 29% of birds (Eaton *et al*. 2005), although the latter does not include extinct species.

A comparison with previous assessments (Table 3) shows that the number of species considered to be threatened has grown steadily as the criteria to assess extinction risk and the data available have improved. The first Red List assessment excluded many species now considered threatened because the IUCN criteria did not then include criteria for rate of decline (Shirt 1987). In the current assessment, 14 species qualify on this criterion alone.

We consider that the current IUCN criteria provide a far more valid assessment of extinction risk than earlier versions and are highly applicable to species with good quantitative data such as butterflies. The new IUCN criteria have far more serious limitations when applied to other insect groups, where objective information is lacking (Warren *et al*. in press).

The current Red List assessment provides an important foundation to define conservation priorities, for example within the UK Biodiversity Action Plan (UK BAP), but it is important to remember that such priorities are drawn up using different criteria (UK Biodiversity Group 1998). A few Red List species identified in this report were not prioritised in the recent list of butterfly conservation priorities (Bourn *et al.* 2005) because they did not meet UK BAP decline thresholds (e.g. the Black Hairstreak *Satyrium pruni*). However, both lists include many of the same species and highlight the serious extinction risk facing butterflies in Britain.

Table 3. Comparison with previous assessments

IUCN Category	**Shirt (1987)**	**Warren *et al.* (1997)**	**This report**
Extinct	3	5	4
Critically Endangered	-	0	2
Endangered	2	0	8
Vulnerable	3	7	9
Near Threatened	-	7	11
Least Concern	-	-	28
Rare	3	-	-
Out of Danger	2	-	-
Total threatened or NT (excluding LC and Out of Danger)	**11**	**19**	**34**

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6. References

Asher, J., Warren, M., Fox, R., Harding, P., Jeffcoate, G., Jeffcoate S., 2001. *The millennium atlas of butterflies in Britain and Ireland*. Oxford University Press, Oxford.

Bourn, N.A.D., McCracken, M.E., Wigglesworth, T., Brereton, T., Fox, R., Roy, D., Warren, M.S., 2005. *Proposed changes to the BAP Priority Species list: butterflies*. Butterfly Conservation Report SO5-23, Wareham.

Cheffings, C.M., Farrell, L. (Eds), Dines, T.D., Jones, R.A., Leach, S.J., McKean, D.R., Pearman, D.A., Preston, C.D., Rumsey, F.J., Taylor, I., 2005. The vascular plant Red Data List for Great Britain. *Species Status* **7**: 1-116. Joint Nature Conservation Committee, Peterborough.

Fox, R., Asher, J., Brereton, T., Roy, D. and Warren, M., 2006. *The state of butterflies in Britain and Ireland*. Pisces Publications, Newbury.

IUCN, 2001. *IUCN Red List categories and criteria: Version 3.1*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

IUCN, 2003. *Guidelines for using the IUCN Red List categories and criteria*. IUCN Species Survival Commission, Gland, Switzerland and Cambridge, UK.

Pannekoek, J., van Strien, A., 1996. *TRIM (TRends & Indices for Monitoring data)*. Statistics Netherlands, Voorburg.

Pollard, E., Yates, T.J., 1993. *Monitoring butterflies for ecology and conservation*. Chapman & Hall, London.

Pollard, E., Hall, M.L., Bibby, T.J., 1986. *Monitoring the abundance of butterflies 1976–1985*. Nature Conservancy Council, Peterborough.

Pollard, E., Moss, D., Yates, T.J., 1995. Population trends of common British butterflies at monitored sites. *Journal of Applied Ecology* **32**, 9–16.

Shirt, D.B., 1987. *British red data books, number 2 insects*. Nature Conservancy Council, Peterborough.

Thomas, C.D., Abery, J.C.G., 1995. Estimating rates of butterfly decline from distribution maps: the effect of scale. *Biological Conservation* **73**, 59–65.

Thomas, J.A., Telfer, M.G., Roy, D.B., Preston, C.D., Greenwood, J.J.D., Asher, J. , Fox, R. , Clarke, R.T. & Lawton, J. H. (2004). Comparative Losses of British Butterflies, Birds, and Plants and the Global Extinction Crisis. Science **303**, 1879-1881.

Thomas, J.A., 2005. Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society B* **360**, 339–357.

Thomas, J.A., Telfer, M.G., Roy, D.B., Preston, C.D., Greenwood, J.J.D., Asher, J., Fox, R., Clarke, R.T., Lawton, J.H., 2004. Comparative losses of British butterflies, birds, and plants and the global extinction crisis. *Science* **303**,1879–1881.

UK Biodiversity Group, 1998. *Tranche 2 action plans. Volume 1 – vertebrates and vascular plants*. English Nature, Peterborough.

van Swaay, C., Warren, M.S., 1999. *Red data book of European butterflies* (*Rhopalocera)*, Nature and Environment, No. 99. Council of Europe, Strasbourg.

Warren, M.S., Barnett, L.K., Gibbons, D.W., Avery, M.I., 1997. Assessing national conservation priorities: an improved red list of British butterflies. *Biological Conservation* **82**, 317–328.

Warren, M.S., Hill, J.K., Thomas, J.A., Asher, J., Fox, R., Huntley, B., Roy, D.B., Telfer, M.G., Jeffcoate, S., Harding, P., Jeffcoate, G., Willis, S.G., Greatorex-Davies, J.N., Moss, D., Thomas, C.D., 2001. Rapid responses of British butterflies to opposing forces of climate and habitat change. *Nature* **414**, 65–69.

Warren, M.S. Bourn, N., Brereton, T., Fox, R., Middlebrook, I. and Parsons, M. (2007) What have Red Lists done for us?: the value and limitation of protected species listing for invertebrates. *Proceedings of the Royal Entomological Society Conference on Insect Conservation*, Sussex, Sept 2005. CABI publishing.