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The Butterfly Red List for Great Britain

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Executive summary

1. This report has been produced as part of the Joint Nature Conservation Committee's Species Status Assessment project and contains the first assessment of British butterflies against the new IUCN criteria (IUCN, 2001). 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 Great 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 Regionally Extinct (excluding the Large Blue *Glaucopsyche arion*, which became extinct in Great Britain in 1979 but has since been reintroduced), 19 species are threatened (Critically Endangered, Endangered or Vulnerable) and 11 species are Near Threatened. Only 28 species or 45% of British butterflies are classified as Least Concern.

6. Of the threatened species, two are Critically Endangered (Large Blue *Glaucopsyche arion* and High Brown Fritillary *Argynnis adippe*), eight are Endangered, and nine Vulnerable.

7. 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 refined.

8. 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 Great Britain.

Contents

1 Introduction to the series

1.1 The Species Status Assessment series

This publication is one of a series produced under the auspices of the Species Status Assessment project initiated by JNCC in 1999. The project established the means by which the statutory conservation agencies, in partnership with voluntary conservation organisations and leading specialists, assign conservation statuses to British species. It aims to work towards assessing the status of all native species against standard criteria based on the internationally accepted guidelines developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (see IUCN, 2001, 2003).

Comparisons are facilitated by assessing all taxa to the same standards. This is not without difficulty because species have a variety of life and reproductive strategies. Status assessments are prepared on the basis of the best available information for the group concerned, recognising that this will vary according to the intensity of recording and study, the majority of which is carried out by volunteer naturalists.

Assessments are produced as Red Lists or as broader National Reviews of taxonomic groups of species. Both types of publication provide an audit trail of the assessment. To enable assessments to reach as many practitioners as possible, the texts are made freely available via the JNCC web site (www.jncc.gov.uk) as well as hard copy publications.

1.2 The Red List system

The Red List system was initiated by IUCN in 1966 with the publication of the first Mammal Red Data Book. Since then Red Lists, and more detailed Red Data Books, have been published that deal with many plants, fungi and animals at global, regional, country, and even local scales. The aim has been to identify those species at greatest risk from extinction and to identify the critical factors responsible, so that action may be taken to improve the chances of these species surviving in the long term.

In Britain the first published Red Data Book endorsed by a statutory conservation agency was by Perring and Farrell (1977, 2nd edition published 1983), dealing with vascular plants. The Red Data Book for insects, edited by Shirt, was published in 1987, with volumes dealing with other animal and plant groups appearing thereafter. The geographic range is normally Great Britain, and hence excludes Northern Ireland as well as the Isle of Man and the Channel Isles. Only one volume has a combined treatment for Britain and Ireland, that by Stewart and Church (1992) for stoneworts, although separate statuses were provided.

The British Red List of vascular plants has had a full update twice (Wigginton, ed. 1999, Cheffings and Farrell, 2005) following the production by the IUCN of a new, quantitative approach to threat assessment (IUCN, 1994, 2001, 2003). The recent Red List of British Odonata (Daguet *et al,* eds., 2008) and reviews of Diptera (Falk and Crossley, 2005, Falk and Chandler, 2005) have continued to follow the revised IUCN guidelines.

1.3 Status assessments other than Red Lists for species in Britain

Conservation assessments that are broader in scope than the traditional Red Data Books and Red Lists have been produced. These assessments add GB-specific categories based on restricted distribution rather than risk. The term Nationally Scarce, originally coined for plants, is applied to species that are known to occur in 16 to 100 ten-km squares (or hectads). Early assessments of invertebrate taxa used the term Nationally Notable and, for some taxa this category was further split into Notable A (Na) for species occurring in 16 to 30 hectads and Notable B (Nb) for those occurring in 31 to 100 hectads.

A further category that has a very specific application is that of 'Nationally Rare'. This category is only used for plant and lichen species that occur in 15 or fewer hectads in Britain and is used in SSSI designation and Common Standards Monitoring.

The restricted distribution categories have now been standardised to Nationally Rare (used only for plants and lichens) and Nationally Scarce (used for all taxa including plants and lichens), without further subdivision. The GB system of assessing **rarity** based solely on distribution is used alongside the IUCN criteria which, although they also use measures of geographical extent, are concerned with assessing **threat**.

Publications that compile information about Red List species are known as Red Data Books and usually cover broad taxonomic groups (e.g. insects). Publications that include information about both Red Listed and Nationally Scarce species are known as National Reviews. The latter are usually produced for a more restricted taxon group (e.g. dragonflies or water beetles). Both types of publication contain individual species accounts that include information about their biology, distribution and status as well as threats to the species and their conservation needs.

1.4 Species Status Assessment and conservation action

Making good decisions to conserve species should primarily be based upon an objective process of determining the degree of threat to the survival of a species, in the present exercise by assigning the species to one of the IUCN threat categories. This assessment of threats to survival should be separate and distinct from the subsequent process of deciding which species require action and what activities and resources should be allocated.

When making decisions as to which species should be treated as priorities for conservation action, factors to be considered other than IUCN threat category include: the likely chances of recovery being achieved; the cost of achieving recovery (and whether sources of funding are available or likely to be available); the benefits to other threatened species of a recovery programme; the fit of a recovery programme with other conservation activities (including conservation actions to be taken for habitats); the likely gains for the profile of conservation; and the relationship and fit between national and international obligations. Under the UK Biodiversity Action Pan (see www.ukbap.org.uk) a list of priority species has been identified as a focus for conservation effort. In addition, certain species are legally protected in Great Britain under legislation such as the Wildlife and Countryside Act 1981, and British wildlife legislation is overlaid by international directives such as the Habitats Directive (Directive 92/42/EEC). For some species groups, threat assessments and rarity assessments also underlie the criteria used for protected site selection, and these species can then constitute protected interest features on the site.

1.5 References

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2 Introduction to this Red List

This report has been produced as part of the JNCC Species Status Assessment project, assigning conservation status to British flora and fauna using internationally approved IUCN Red List criteria and categories. Within this project, the remit of the present report is to assess the status of butterflies throughout Great Britain, using the updated IUCN Red List criteria and categories (IUCN, 2001).

The first Red List assessment of butterflies in Britain was produced by Shirt (1987) using the original IUCN criteria. Warren *et al* (1997) produced a Red List assessment of British butterflies 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), using criteria such as international importance, rate of decline and other important issues (see Warren *et al*, 2007 for overview).

Since the last two Red List assessments of butterflies in Great 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 were 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 reassessment of their Red List categories is now due. 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.

3 Methods and data sources

3.1 Species coverage

A total of 62 species were assessed including all resident and regularly breeding species (species that breed in Great Britain every year). 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 were included. Butterflies that formerly occurred as regular breeding species were also assessed. All taxa were assessed at the species level. Other immigrant species were classified as vagrants according to IUCN guidelines (Gärdenfors *et al*, 2001), since they occur only occasionally within Britain, and were not assessed.

3.2 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).

3.2.1 Butterflies for the New Millennium (BNM)

The BNM scheme was launched by Butterfly Conservation in 1995 and has provided the impetus for 15 years of the most intensive butterfly recording ever undertaken in Britain (and Ireland). Data from the first five-year recording period (1995–1999) 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 2000-2004. Between 1995 and 2004, some 10,000 volunteers contributed a total of 3.2 million butterfly distribution records for Great Britain, representing 99.4% of 10 km grid squares on the Ordnance Survey National Grid. Almost all of these records are at a 1 km or 100 m 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 1970–1982 and more patchy (geographically and taxonomically) data covering the 1690–1969 and 1983–1994 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 10 km square resolution between the survey periods 1970-1982 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 can be a valid surrogate for population change (Thomas, 2005, Warren *et al*, 2001).

3.2.2 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. 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, in collaboration with the Centre for Ecology and Hydrology and JNCC, to integrate all transects under a single, unified project and database. As of 2009, data have been collected from over 1,500 transects, representing over 170,000 weekly walks and records of over 12.5 million individual butterflies.

The methodology and development of transect monitoring for butterflies have 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 and are particularly important in the assessment of certain rare species (*e.g.* the High Brown Fritillary *Argynnis adippe* and Heath Fritillary *Melitaea athalia*). Both transect counts and timed counts are used primarily to produce a relative 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). Regional and national collated indices are derived by use of a log-linear Poisson regression model, performed by the statistical software TRIM (Pannekoek and van Strien, 1996), as is carried out for most butterfly and bird monitoring schemes in Europe (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. However, a few species 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).

3.3 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.

The BNM distribution recording is uneven in time and space, requiring the use of the sub-sampling analysis to normalise 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 10 km grid square resolution. This is because many records in the baseline 1970-1982 survey only exist at 10 km 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 as substantial rates of population extinction or colonisation within 10 km squares are not identified at this coarse scale. A third limitation is that the measurement of distribution change is for a 25-year period, rather than a 10-year period as would better fit with the IUCN criteria. Both the spatial scale and time period issues have been taken into account when deciding on thresholds of decline in area of occupancy that reflect the 10-year population decline category thresholds (see Section 3.6.1).

The UKBMS population monitoring data also have limitations. Firstly, 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. Secondly, 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.

3.4 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.

The definition of the categories is given in Box 1 and the hierarchical relationship of the categories in Figure 1 (after IUCN, 2001).

Box 1. Definitions of IUCN categories

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.

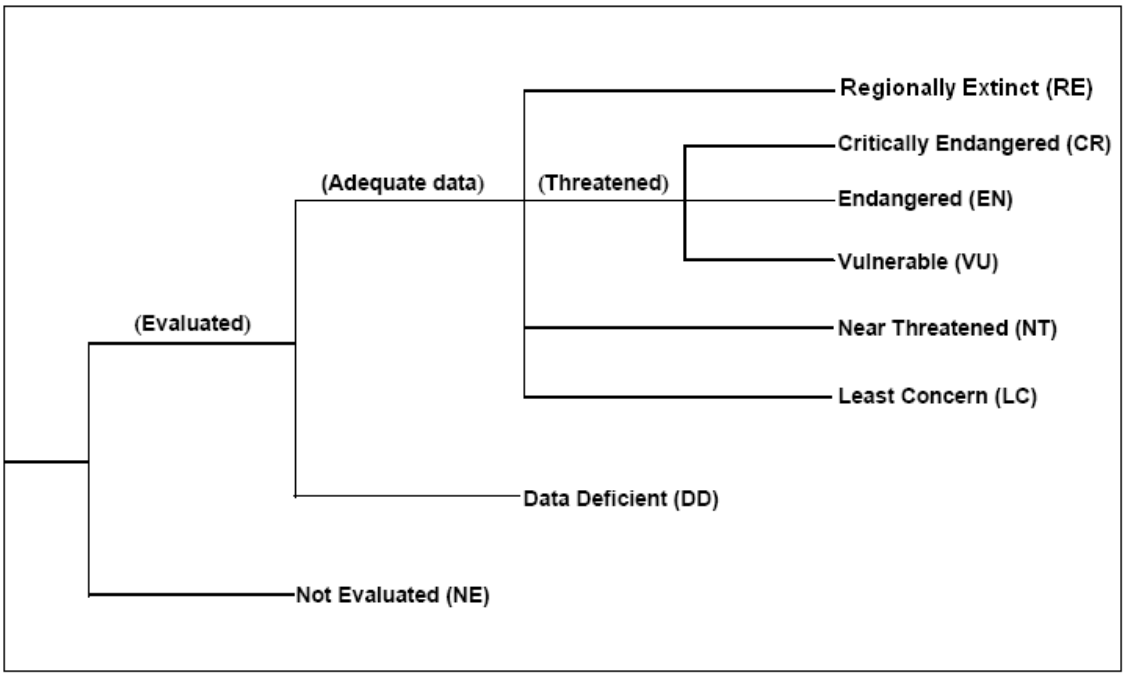

Figure 1. Hierarchical relationship of IUCN Red List categories, adapted from IUCN (2001).

3.5 IUCN criteria

The revised IUCN criteria have been designed for global application and for a wide range of organisms. Not all the criteria are applicable to reviewing the threat status of British butterflies. The full IUCN threat criteria (Version 3.1, IUCN, 2001) for Critically Endangered, Endangered and Vulnerable are given in Appendix 1, but the state of knowledge and nature of the available data on British butterflies enabled us to assess taxa quantitatively against just two IUCN criteria: A, population reduction, and B, small geographic range.

For criterion A, assessments were carried out under A2 because for all species that have experienced decline the causes of reduction may not have ceased OR may not be understood, OR may not be reversible. Population declines were assessed over a 10-year period rather than over three generations, 10 years being the longer time period. Population reductions were inferred on the basis of criterion A2b, 'an index of abundance appropriate to the taxon', and A2c, 'a decline in the area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality'. For this assessment application of criterion A2c was limited to consideration of the decline in AOO. Thresholds of decline in AOO were calculated that reflect the specified decline in population level for the different categories. These thresholds of decline in AOO, which were designed to take account of data limitations and are further explained in Section 3.6.1, are summarised in Table 1.

Table 1. The threshold population decline values used to produce the categorisation under A2, and thresholds for the AOO 25-year decline chosen to reflect these population declines.

Threat categories	IUCN criteria for A2 - population decline over 10 years	AOO 25-year decline that corresponds to the population decline thresholds for categories
CR	≥ 80%	≥ 84.0%
EN	50 - 79%	62.6 - 83.9%
VU	30 - 49%	41.9 - 62.5%
NT	-	31.9 - 41.8%

For criterion B, species were only assessed against B2 – restricted area of occupancy. Thresholds of AOO for the categories and sub-criteria a-c are summarised in Table 2. Where a species had an AOO of less than 2000 km^2 and only met one of the sub-criteria a-c, it was assigned the category of Near Threatened.

Table 2. Summary of criteria used to produce categorisation under B2.

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

a. Severely fragmented or known to exist at only a single location (CR), ≤ 5 locations (EN) or ≤ 10 locations (VU).

b. Continuing decline, observed, inferred or projected, in any of the following:

(i) extent of occurrence;
(ii) area of occupancy;
(iii) area, extent and/or quality of habitat;
(iv) number of locations or subpopulations;
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:

(i) extent of occurrence;
(ii) area of occupancy;
(iii) number of locations or subpopulations;
(iv) number of mature individuals.

3.6 Application of IUCN criteria

3.6.1 Application of criteria A2 (reduction in population size)

A2b – Index of abundance

The 10-year population trends generated from the UKBMS dataset can be applied directly under criterion A2b. Data were used from 1995 to 2004. However, the dynamic nature of insect populations means that trends derived over the short 10-year period may be heavily biased by exceptional fluctuations in annual population indices and thus short-term trends do not always 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 longer time periods (long-term trends varied from 13 to 29 years). Thus, where the IUCN criteria were met for the 10-year population trend, this was interpreted in the context of the long-term trend. 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 Table 3.

A2c - Decline in area of occupancy

It has been assumed that a decline in AOO (recorded at a 2 km square resolution as recommended by IUCN) over a 10-year period will closely correspond to the decline in population level over that 10-year period. For this assessment, the change in AOO was obtained from BNM survey data using sub-sampling analysis to normalise survey effort. However, data limitations resulted in the change in AOO being calculated over a 25-year period (by comparing BNM survey data from 1970-1982 with 1995-2004), and data were

used at a 10 km square resolution. To take account of these limitations, thresholds of AOO 25-year decline at a 10 km square resolution were set to correspond with the IUCN thresholds of population decline over a 10-year period. The AOO 25-year decline thresholds were derived by modifying the IUCN population decline thresholds by the following method.

Spatial-scale adjustment of threshold values

Distribution trends measured at 10 km 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. Thomas and Abery (1995) found that for 12 butterfly species of intermediate rarity, losses were underestimated by 35% on average when plotted at the 10 km square scale compared with losses at the 2 km square scale. To account for this, the thresholds required to qualify for threat categories were initially set at 35% less than the IUCN population decline thresholds. This 35% rule has 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 A2c Critically Endangered threshold of 80% population decline was reduced by 35% to give a threshold of 52.0% decline in AOO at 10 km square resolution; the Endangered threshold of 50% reduced to give an AOO decline threshold of 32.5%; and the Vulnerable threshold of 30% reduced to give an AOO decline threshold of 19.5%.

Temporal-scale adjustment of threshold values

The threshold values were then further adjusted to take account of the AOO trend being calculated over a 25-year period as opposed to a 10-year period. The annual rate of change was calculated 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.

For the Critically Endangered AOO decline 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 10 km square level over 10 years) = 0.07077. Put back into the equation over 25 years this gives a threshold of 84.0% decline. Thus, a species meets the Critically Endangered criteria if its AOO 25-year trend is equal to or greater than a decline of 84.0%.

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

Table 1 summarises the final thresholds used to produce the categorisation under A2.

3.6.2 Application of criterion B2 (restricted area of occupancy)

BNM data from the period 1995 to 2004 were used to calculate of AOO for each species. AOO was calculated at a 2 km grid square level as is recommended by IUCN guidelines (IUCN, 2003). This geographical resolution provides a better estimate of the true AOO of a taxon than the coarser 10 km square resolution. If a taxon met any of the AOO threshold values but met only one of the three sub-criteria under B2 then it was classified as Near Threatened (See Table 2).

3.7 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 the modified IUCN criteria using national data sources. For most taxa, three variables - population trend, based on the UKBMS log collated index; distribution (AOO) trend and AOO - were available for assessment against the quantitative thresholds in the IUCN criteria. Where these assessments resulted in different levels of threat, a precautionary approach was applied 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 a threat category, and those classified as Near Threatened, were considered to be unaffected by the presence of conspecific populations elsewhere. This 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).

4 Results: A new Red List of British Butterflies

The available data and assessment for all species are shown in Table 3 and a summary of overall results is shown in Figure 2.

The assessment shows that four species are considered Regionally Extinct in Great Britain, 19 species are threatened (including the Large Blue *Glaucopsyche arion*, which became extinct but has been reintroduced). Of these, two species - the Large Blue *Glaucopsyche arion* and the High Brown Fritillary *Argynnis adippe* - are Critically Endangered; and eight are Endangered. Eleven species are Near Threatened and only 28 species (45%) are classified as Least Concern.

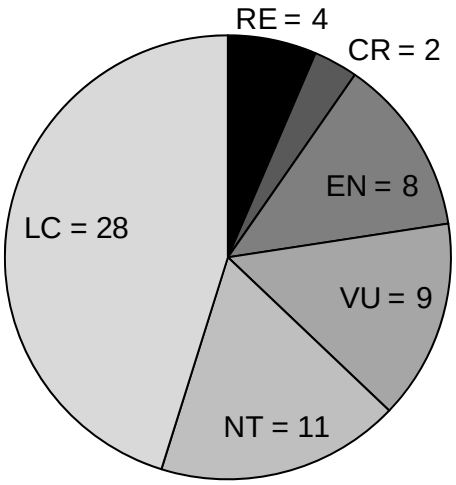

Figure 2. Summary of Red List assessment for British butterflies
(Key: RE = Regionally Extinct; CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern)

Table 3. Regional Red List assessment for butterflies in Great Britain

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Chequered Skipper	*Carterocephalus palaemon*	424	EN	-38%		–	–		**EN**	B2 ab(ii)	AOO highly restricted (<500km^2), severely fragmented and continuing decline of AOO
Small Skipper	*Thymelicus sylvestris*	60,680		4%		–	–		LC		
Essex Skipper	*Thymelicus lineola*	26,640		46%		–	–		LC		
Lulworth Skipper	*Thymelicus acteon*	252	NT	-15%		-13%	79%		**NT**	B2 b(iii)	AOO highly restricted (<500km^2) and continuing decline in quantity and quality of habitat, but not severely fragmented and no extreme fluctuations
Silver-spotted Skipper	*Hesperia comma*	672	NT	4%		1524%***	2%		**NT**	B2 a	AOO restricted (<2000km^2), severely fragmented, but no continuing decline (recent expansion) or extreme fluctuations
Large Skipper	*Ochlodes sylvanus*	54,136		-12%		12%	-38%*	VU	LC		VU downgraded to LC because 10-year population decline not supported by long-term trend or AOO trend
Dingy Skipper	*Erynnis tages*	8,668		-48%	VU	-37%**	-26%		**VU**	A2 c	AOO trend suggests a population decline of 30-49%
Grizzled Skipper	*Pyrgus malvae*	5,636		-49%	VU	-34%	-42%	VU	**VU**	A2 bc	AOO trend, and 10-year population trend suggest a population decline of 30-49%
Swallowtail	*Papilio machaon*	128	NT	-5%		–	–		**NT**	B2 b(iii)	AOO highly restricted (<500 km^2) and continuing decline in quantity and quality of habitat, but not severely fragmented and no extreme fluctuations
Wood White	*Leptidea sinapis*	944	VU	-65%	EN	-64%	10%		**EN**	A2 c	AOO trend suggests a population decline of 50-79%
Clouded Yellow	*Colias croceus*	26,368		144%		1117%	1877%		LC		Regular breeding migrant

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Brimstone	*Gonepteryx rhamni*	52,436		-3%		22%	-11%		LC		
Black-veined White	*Aporia crataegi*								**RE**		Last record 1920s
Large White	*Pieris brassicae*	101,852		-7%		-28%	18%		LC		
Small White	*Pieris rapae*	103,012		-7%		15%	-34%	VU	LC		VU downgraded to LC because10-year population decline is not supported by long-term trend or AOO trend
Green-veined White	*Pieris napi*	120,932		-1%		11%	7%		LC		
Orange-tip	*Anthocharis cardamines*	86,376		7%		22%	-8%		LC		
Green Hairstreak	*Callophrys rubi*	14,152		-29%		-25%	-25%		LC		
Brown Hairstreak	*Thecla betulae*	3,704		-43%	VU	–	–		**VU**	A2 c	AOO trend suggests a population decline of 30-49%
Purple Hairstreak	*Neozephyrus quercus*	22,784		-15%		53%	-23%		LC		
White-letter Hairstreak	*Satyrium w-album*	9,220		-53%	VU	-71%*	-63%	EN	**EN**	A2 b	10-year population trend is between 50 and 79% decline. Although transect data for this species should be treated with caution, the 10-year trend is supported by a very severe, statistically significant long-term population trend
Black Hairstreak	*Satyrium pruni*	288	EN	-43%	VU	–	–		**EN**	B2 ab(ii)	AOO highly restricted (<500 km^2), severely fragmented and continuing decline in AOO
Small Copper	*Lycaena phlaeas*	60,936		-16%		-8%	-41%	VU	LC		VU downgraded to LC because 10-year population decline not supported by long-term trend or AOO trend

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Large Copper	*Lycaena dispar*								**RE**		Last record 1864. Reintroduction attempts failed
Small Blue	*Cupido minimus*	3,212		-38%	NT	-6%	121%		**NT**	A2 c	AOO trend is close to VU
Silver-studded Blue	*Plebeius argus*	1,660	VU	-43%	VU	-1%	-72%*	EN	**VU**	A2 c + B2ab (ii,v)	AOO restricted (<2000 km^2), population severely fragmented and declining, and decline in AOO. However, steep 10-year population decline not supported by long-term trend, hence EN downgraded to VU
Brown Argus	*Plebeius agestis*	17,528		16%		16%	-61%*	EN	LC		EN downgraded to LC because10-year population trend not supported by long-term trend or AOO trend
Northern Brown Argus	*Plebeius artaxerxes*	1,536	VU	18%		-10%	-30%	VU	**VU**	A2 b + B2 ab(v)	10-year population trend is between 30 and 49%. AOO restricted (<2000km^2), severely fragmented, and continuing decline
Common Blue	*Polyommatus icarus*	69,000		-15%		9%	-21%		LC		
Chalkhill Blue	*Polyommatus coridon*	3,468		-36%	NT	31%	-34%	VU	**NT**	A2 bc	VU downgraded to NT because10-year population decline not supported by long-term trend. AOO trend is close to VU
Adonis Blue	*Polyommatus bellargus*	1,820	NT	-19%		28%	63%		**NT**	B2 c(iv)	AOO restricted (<2000km^2) and extreme fluctuations in population size, but not declining (recent expansion) or severely fragmented
Mazarine Blue	*Polyommatus semi-argus*					–	–		**RE**		Last record 1904
Holly Blue	*Celastrina argiolus*	59,292		36%		281%	-30%	VU	LC		VU downgraded to LC because 10-year population trend part of natural cycle and not supported by long-term trend or AOO trend

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Large Blue	*Glaucopsyche arion*	<10	CR			–	–		**CR**	B2 ac(iv)	Extinct in Britain 1979 but re-introduced since 1980s to c. 10 sites. Severely fragmented and extreme fluctuations in population size
Duke of Burgundy	*Hamearis lucina*	1,288	VU	-52%	VU	-28%	-58%*	EN	**EN**	A2 b	10-year population trend is between 50 and 79% decline
White Admiral	*Limenitis camilla*	6,004		-31%	NT	-62%**	-36%	VU	**VU**	A2 b	10-year population trend is between 30 and 49% decline
Purple Emperor	*Apatura iris*	1,040	NT	-52%	VU	-18%	33%		**NT**	A2 c + B2 b(ii)	VU downgraded to NT because AOO trend not reliable for this canopy dwelling species. AOO restricted (<2000 km^2) and continuing decline in AOO but not severely fragmented or with extreme fluctuations
Red Admiral	*Vanessa atalanta*	95,840		25%		350%***	-38%	VU	LC		Regular breeding migrant. VU downgraded to LC because 10-year decline not supported by long-term trend or AOO trend
Painted Lady	*Vanessa cardui*	77,580		32%		520%	118%		LC		Regular breeding migrant
Small Tortoiseshell	*Aglais urticae*	114,780		-3%		-15%	-34%	VU	LC		VU downgraded to LC because 10-year trend not supported by long-term trend or AOO trend. 10-year trend not statistically significant despite large sample size
Large Tortoiseshell	*Nymphalis polychloros*								**RE**		Last record in 1980s. Only vagrants since
Peacock	*Inachis io*	100,952		17%		90%**	-40%	VU	LC		VU downgraded to LC because 10-year trend not supported by long-term trend or AOO trend
Comma	*Polygonia c-album*	63,532		37%		305%***	64%		LC		

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Small Pearl-bordered Fritillary	*Boloria selene*	9,232		-34%	NT	-70%***	-10%		**NT**	A2 c	Decline in AOO close to VU
Pearl-bordered Fritillary	*Boloria euphrosyne*	2,668		-61%	VU	-66%**	-51%	EN	**EN**	A2 b	10-year population trend is between 50 and 79% decline
High Brown Fritillary	*Argynnis adippe*	552	VU	-79%	EN	-13%	-85%*	CR	**CR**	A2 b	10-year trend is statistically significant despite small sample size
Dark Green Fritillary	*Argynnis aglaja*	11,424		-30%		63%	-10%		LC		
Silver-washed Fritillary	*Argynnis paphia*	9,048		-29%		33%	-14%		LC		
Marsh Fritillary	*Euphydryas aurinia*	2,876		-46%	VU	-73%**	73%		**VU**	A2 c	AOO trend suggests population decline of 30-49%
Glanville Fritillary	*Melitaea cinxia*	132	EN	-17%		–	–		**EN**	B2 b(v)c(iv)	AOO highly restricted (<500 km^2), continuing decline and extreme fluctuations
Heath Fritillary	*Melitaea athalia*	168	EN	-25%		-73%**	-46%	VU	**EN**	B2 ab(ii,v)c(iv)	AOO highly restricted (<500 km^2), severely fragmented, continuing decline and extreme fluctuations
Speckled Wood	*Pararge aegeria*	74,332		31%		160%***	66%*		LC		
Wall	*Lasiommata megera*	37,600		-38%	NT	-65%**	-2%		**NT**	A2 c	AOO trend close to VU
Mountain Ringlet	*Erebia epiphron*	524	NT	-12%		–	–		**NT**	B2 b(ii)	AOO restricted (<2000km^2) and some evidence of continuing decline in AOO but not severely fragmented or with extreme fluctuations

		AOO km^2	Category under B2	AOO 25-year trend	Category under A2c	Long-term population trend * p<0.05 ** p<0.01 *** p<0.001	10-year population trend * p<0.05 ** p<0.01	Category under A2b	Overall assessment	Criteria for qualifying	Notes
Scotch Argus	*Erebia aethiops*	5,660		-10%		165%**	-1%		LC		
Marbled White	*Melanargia galathea*	22,260		11%		129%**	-15%		LC		
Grayling	*Hipparchia semele*	8,340		-45%	VU	-51%**	-41%**	VU	**VU**	A2 bc	AOO trend and 10-year population trend suggest a population decline of 30-49%
Gatekeeper	*Pyronia tithonus*	80,148		12%		-12%	-5%		LC		
Meadow Brown	*Maniola jurtina*	112,312		-4%		28%	-5%		LC		
Ringlet	*Aphantopus hyperantus*	62,952		16%		373%***	33%		LC		
Small Heath	*Coenonympha pamphilus*	48,660		-29%		-52%**	-29%		**NT**	A2 b	10-year population decline is very near VU. Supported by highly significant long-term trend
Large Heath	*Coenonympha tullia*	3,828		-43%	VU	-26%	58%		**VU**	A2 c	AOO trend suggests a population decline of 30-49%

Table 4. The new Red List of British butterflies

		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. B2 ac(iv)
High Brown Fritillary	*Argynnis adippe*	**CR**	A2 b
Chequered Skipper	*Carterocephalus palaemon*	**EN**	B2 ab(ii)
Wood White	*Leptidea sinapis*	**EN**	A2 c
White-letter Hairstreak	*Satyrium w-album*	**EN**	A2 b
Black Hairstreak	*Satyrium pruni*	**EN**	B2 ab(ii)
Duke of Burgundy	*Hamearis lucina*	**EN**	A2 b
Pearl-bordered Fritillary	*Boloria euphrosyne*	**EN**	A2 b
Glanville Fritillary	*Melitaea cinxia*	**EN**	B2 b(v)c(iv)
Heath Fritillary	*Melitaea athalia*	**EN**	B2 ab(ii,v)c (iv)
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 + B2ab(ii,v)
Northern Brown Argus	*Plebeius artaxerxes*	**VU**	A2 b + B2 ab(v)
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 b(iii)
Silver-spotted Skipper	*Hesperia comma*	**NT**	B2 a
Swallowtail	*Papilio machaon*	**NT**	B2 b(iii)
Small Blue	*Cupido minimus*	**NT**	A2 c
Chalkhill Blue	*Polyommatus coridon*	**NT**	A2 b,c

		Overall assessment	Criteria for qualifying
Adonis Blue	*Polyommatus bellargus*	**NT**	B2 c(iv)
Purple Emperor	*Apatura iris*	**NT**	A2 c + B2 b(ii)
Small Pearl-bordered Fritillary	*Boloria selene*	**NT**	A2 c
Wall	*Lasiommata megera*	**NT**	A2 c
Mountain Ringlet	*Erebia epiphron*	**NT**	B2 b(ii)
Small Heath	*Coenonympha pamphilus*	**NT**	A2 b

5 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 in Great Britain, with 39% of permanently resident species either Regionally Extinct or threatened (CR, EN or VU). In comparison, other recent GB assessments found that approximately 20% of vascular plants (Cheffings *et al*, 2005) were classified as extinct or threatened, and 29% of birds (Eaton *et al*, 2005) were classified as threatened.

A comparison with previous British butterfly assessments (Table 5) 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, 17 species qualify as threatened or as Near Threatened 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. Many butterfly species have continued to decline since the original assessment in 1987, with these declines highlighted in population and distribution trends long before they would have been picked up by classification based on rarity (AOO) alone. The early-identification of such declines brings substantial conservation advantages.

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 Great Britain.

Table 5. Comparison of current assessment with previous British butterfly Red List 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 (*i.e.* all categories apart from LC and Out of Danger)	**11**	**19**	**34**

6 Acknowledgements

It would not have been possible to assess the threat status of Britain's butterflies without the efforts of thousands of skilled and dedicated volunteer recorders. We are deeply indebted to them and to the organisations that have supported butterfly recording and monitoring, especially the Bernard Sunley Charitable Foundation, Centre for Ecology and Hydrology, Esmée Fairbairn Foundation, Joint Nature Conservation Committee, Vincent Wildlife Trust and the multi-agency consortium (led by Defra) that funds the UKBMS. Dr Jim Asher of Butterfly Conservation and Dr David Roy of the Centre for Ecology and Hydrology both made substantial contributions to the development of methods and analysis of trends utilised in this assessment. We are grateful to JNCC for funding the report and to Deborah Procter and Anna Robinson (both of JNCC) for providing comments on the text.

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Annex 1. IUCN (2001) criteria version 3.1

Critically Endangered (CR)

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:

    (a) direct observation;
    (b) an index of abundance appropriate to the taxon;
    (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat;
    (d) actual or potential levels of exploitation;
    (e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either
B1 (extent of occurrence)
OR
B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a–c:

    (a) Severely fragmented or known to exist at only a single location;
    (b) Continuing decline, observed, inferred or projected, in any of the following:
        (i) extent of occurrence;
        (ii) area of occupancy;
        (iii) area, extent and/or quality of habitat;
        (iv) number of locations or subpopulations;
        (v) number of mature individuals.

(c) Extreme fluctuations in any of the following:
  (i) extent of occurrence
  (ii) area of occupancy
  (iii) number of locations or subpopulations
  (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a–c:

(a) Severely fragmented or known to exist at only a single location.
(b) Continuing decline, observed, inferred or projected, in any of the following:
  (i) extent of occurrence;
  (ii) area of occupancy;
  (iii) area, extent and/or quality of habitat;
  (iv) number of locations or subpopulations;
  (v) number of mature individuals.
(c) Extreme fluctuations in any of the following:
  (i) extent of occurrence;
  (ii) area of occupancy;
  (iii) number of locations or subpopulations;
  (iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
(a) Population structure in the form of one of the following:
  (i) no subpopulation estimated to contain more than 50 mature individuals, OR
  (ii) at least 90% of mature individuals in one subpopulation.
(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

Endangered (EN)

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
(a) direct observation;

(b) an index of abundance appropriate to the taxon;
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat;
(d) actual or potential levels of exploitation;
(e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a–c:

(a) Severely fragmented or known to exist at no more than five locations.
(b) Continuing decline, observed, inferred or projected, in any of the following:
  (i) extent of occurrence;
  (ii) area of occupancy;
  (iii) area, extent and/or quality of habitat;
  (iv) number of locations or subpopulations;
  (v) number of mature individuals.
(c) Extreme fluctuations in any of the following:
  (i) extent of occurrence;
  (ii) area of occupancy;
  (iii) number of locations or subpopulations;
  (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a–c:

(a) Severely fragmented or known to exist at no more than five locations.
(b) Continuing decline, observed, inferred or projected, in any of the following:
  (i) extent of occurrence;
  (ii) area of occupancy;
  (iii) area, extent and/or quality of habitat;
  (iv) number of locations or subpopulations;

(v) number of mature individuals.

(c) Extreme fluctuations in any of the following:
(i) extent of occurrence;
(ii) area of occupancy;
(iii) an observed number of locations or subpopulations;
(iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:

1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future),

OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

(a) Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 250 mature individuals,
OR
(ii) at least 95% of mature individuals in one subpopulation.
(b) Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

Vulnerable (VU)

A. Reduction in population size based on any of the following:

1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
(a) direct observation;
(b) an index of abundance appropriate to the taxon;
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat;
(d) actual or potential levels of exploitation;
(e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a–c:
   - (a) Severely fragmented or known to exist at no more than 10 locations.
   - (b) Continuing decline, observed, inferred or projected, in any of the following:
     - (i) extent of occurrence;
     - (ii) area of occupancy;
     - (iv) area, extent and/or quality of habitat;
     - (iv) number of locations or subpopulations;
     - (v) number of mature individuals.
   - (c) Extreme fluctuations in any of the following:
     - (i) extent of occurrence;
     - (ii) area of occupancy;
     - (iii) number of locations or subpopulations;
     - (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a–c:
   - (a) Severely fragmented or known to exist at no more than 10 locations.
   - (b) Continuing decline, observed, inferred or projected, in any of the following:
     - (i) extent of occurrence;
     - (ii) area of occupancy;
     - (v) area, extent and/or quality of habitat;
     - (iv) number of locations or subpopulations;
     - (v) number of mature individuals.
   - (c) Extreme fluctuations in any of the following:
     - (i) extent of occurrence;
     - (ii) area of occupancy;
     - (iii) number of locations or subpopulations;
     - (vi) number of mature individuals.

B. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):
   (a) Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
      (ii) all mature individuals are in one subpopulation.
   (b) Extreme fluctuations in number of mature individuals.

C. Population very small or restricted in the form of either of the following:

1. Population size estimated to number fewer than 1000 mature individuals.

2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.