

## Experimental design/sampling regime

The UK Butterfly Monitoring Scheme (UKBMS) records data from over 1,000 sites annually throughout the UK. On the majority of these sites, butterfly numbers are estimated by counting along a fixed linear transect known as a 'Pollard walk'<sup>1</sup>. Population abundance is estimated for some species on some sites using other standardised methods such as timed counts or egg /larval web counts.

*All-species transects:* In brief, a fixed-route line transect is established at a site and all butterflies are recorded along the route on a regular (weekly) basis under set weather conditions<sup>#</sup>. Transect routes are chosen to sample evenly the habitat types and management activity on sites. Care is taken in choosing a transect route as it must then remain fixed to enable butterfly sightings to be compared from year to year. Transects are typically about 2-4km long, taking between 45 minutes and two hours to walk, and are divided into sections corresponding to different habitat or management units. The number of all species of butterfly are recorded in a fixed width band (typically 5m wide) along the transect each week from the beginning of April until the end of September yielding, ideally, 26 counts per year.

**<sup>#</sup>Transect walks are undertaken between 10.45am and 3.45pm and only when weather conditions are suitable for butterfly activity: dry conditions, wind speed less than Beaufort windspeed scale 5, and temperature 13°C or greater if there is at least 60% sunshine, or more than 17°C if overcast.**

*Single-species transects:* Single species transects follow the all-species transect methodology described above but are only recorded on one week or more throughout the flight period of the focal species

*Timed counts and egg/larval web counts:* Timed counts involve recording the abundance of a particular species over a set period of time and within a set area. Like the fixed transects, timed counts are carried out only between 10.45am and 15.45 pm and when the weather meets the set criterion. Egg and larval web counts involve recording the number of eggs or larval webs of a species (e.g. Marsh Fritillary) from a given area of suitable habitat.

<sup>1</sup>Pollard, E. & Yates, T.J. (1993). *Monitoring Butterflies for Ecology and Conservation*. Chapman and Hall, London.

## Data collection methods

Data are recorded in the field on standard recording forms. Records are subsequently entered into a bespoke software programme, Transect Walker (available for free download on the UKBMS website). Data is inputted either directly by the recorder or by the transect coordinator for the region under which a particular transect falls. Each transect coordinator is responsible for gathering all the data for all sites within their region at the end of each monitoring season. Transect Walker files are uploaded into an Oracle database which holds all records.

## Analytical methods

After data has been validated, a statistical model (a General Additive Model, 'GAM') is used to impute missing values and to calculate a site index<sup>2</sup>.

All site indices data from all sampling methods is combined to derive a national annual index for each species – a Collated Index. Because not all sites are monitored each year, a statistical model (log-linear regression) is needed to estimate missing values and to produce indices and trends<sup>3</sup>. The model takes into account the fact that for a particular butterfly species, some years are better than others (a year effect), typically due to the weather, and some sites support larger populations than others (a site effect). The Collated Index for each species is updated annually with the inclusion of additional monitoring data and thus previous years' indices may slightly alter over time as past data is received and incorporated into the analysis. Collated indices have been calculated for butterfly species that have been recorded from five or more sites per year.

<sup>2</sup>Rothery, P. & Roy, D.B (2001). **Application of generalized additive models to butterfly transect count data.** *Journal of Applied Statistics* (28): pp897-909

<sup>3</sup>Moss, D. & Pollard, E (1993). **Calculation of collated indices of abundance of butterflies based on monitored sites.** *Ecological Entomology* (18): pp77-83

### **Nature and units of recorded values**

Site indices are a relative rather than an absolute measure of the size of a population, and have been shown to relate closely to other, more intensive, measures of population size such as mark, release, recapture (MRR) methods<sup>1</sup>. The site index can be thought of as a relative measure of the actual population size, being a more or less constant proportion of the number of butterflies present. The proportion seen is likely to vary according to species; some butterfly species, such as Marbled White are conspicuous, whereas others such as Dingy Skipper are much less easy to see.

Collated Indices are presented as the logarithm of the Collated Indices -  $\text{Log}_{10}$  Collated Index (LCI). For each species these are scaled so that the average index over the whole series is equal to 2 enabling a relative measure of the population size over time.

<sup>1</sup>Pollard, E. & Yates, T.J. (1993). **Monitoring Butterflies for Ecology and Conservation.** Chapman and Hall, London.

### **Quality control**

Automatic checks are applied within the Transect Walker program to alert recorders to potential data entry errors, e.g. abnormally high counts of a species or a record of species outside of its recognised flight period. The recorder is given the option to proceed with the record or to alter it appropriately. Each site data belongs to a region for which a transect coordinator is responsible. The regional coordinator has good knowledge of the sites they receive records for and checks the records for any questionable records. Following these preliminary validation checks, the data undergoes a series of further automated and manual validation procedures including queries to check for records of species that are: recorded out of their known distribution range (using data from Butterfly Conservation's Butterflies for the New Millennium (BNM) and existing UKBMS data), recorded out of their normal flight period, recorded for the first time at a site, have extreme abundances or abundances that are markedly different to normal for a given site at a given time of year.

### **Format of stored data**

The Collated Indices are stored as a CSV file. The following gives a description of each column:

*Species*: this is the scientific name for each butterfly species following the Fauna Europaea website (version 2.2) [www.fauna-eu.org](http://www.fauna-eu.org) accessed 27-09-2010.

*Common name*: the vernacular names of butterfly species following Emmet and Heath (1990) the Moths and Butterflies of Great Britain and Ireland Volume 7 part 1, Harley books, Colchester.

*Year*: the year for which the Collated Index has been calculated for a given species

*No. Sites*: the number of sites producing site indices contributing to the Collated Index for that species in that year

*Collated Index*: the Collated Index for a given species in a given year

*Time period*: the time period for which data has been used to produce the Collated Indices