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large Insect Survey database, which currently has information covering 350 sites, 650 species, 1800 site years, and has involved the identification of over 3.5 million individual moths. The present network contains over 90 sampling sites.

Distribution records from this unique set of data have been made available to the Biological Records Centre for many years. Although only Macrolepidoptera are recorded consistently, other insect groups have been extracted from some of the samples. Samples are being provided currently for inclusion in the national Neuroptera recording scheme.

The data are used for a wide range of purposes, including fundamental studies of spatial dynamics (Taylor & Woiwod 1982); long-term studies at individual sites (Woiwod 1981; Riley 1990) and investigations into the environmental effects of land use change (Taylor, French & Woiwod 1978). Changes in populations of individual species can be mapped and followed on a national scale (Woiwod & Dancy 1987), and the database contains a wealth of information on insect phenology which will be important in assessing the effects of climatic change.

On the Rothamsted estate, one trap has run for over 50 years and provides a unique insight into the effects of changing farming practice and agricultural intensification on the insect fauna. There has been a notable decrease in the numbers of many species and an overall fall in moth populations of over 60%. The biggest changes occurred in the 1950s when many innovations took place in British agriculture, including the widespread introduction of herbicides and pesticides and the enlarging of fields to aid mechanisation (Taylor 1986; Woiwod 1987).

The mobility of organisms is very important in determining their ability to respond to changing environments, such as local habitat destruction and creation, or large-scale effects such as climatic change. Unfortunately, it is difficult to assess the relative mobility of insects directly, and little is presently known of this important aspect of insect ecology. A network of 26 traps is currently running on the Rothamsted farm for a new project on local movement and spatial variability designed to study some of these questions.

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The butterfly monitoring scheme

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BACKGROUND

The butterfly monitoring scheme was started in 1976, after three years of preliminary trials. It is a joint project, with the Institute of Terrestrial Ecology and the Nature Conservancy Council (NCC) both providing funds and resources. The scheme was set up with two aims:

- to provide information on the fluctuations of butterfly numbers from year to year, so that any underlying trends could be assessed;
- to detect changes from the overall trend at individual sites, caused by local factors, such as management.

The scheme has 14 years of data, with contributions from over 100 sites from the whole of Britain.

This is the only long-term monitoring scheme of its kind in Britain, and so it represents a collection of data of immense value to ecologists.

METHODS

The methods used were described by Pollard (1977), and instructions for independent recorders are available as a separate booklet. At each site, the recorder makes a series of counts, walking a fixed route, once a week from April to September, noting any butterflies seen within 5 m. To provide standardisation, walks are carried out only between 10:45 and 15:45 BST, and then only if the weather meets the specified criteria. The transect route is divided into sections, usually according to changes in habitat, so the scheme also provides valuable information on habitat preferences of different species, as well as an objective assessment of the effects of management on species.

ANALYSIS OF RESULTS

The results are analysed to provide information at a local, regional, or national level. At every site, the mean weekly count of each species is totalled to provide an annual index of abundance. This index of abundance is not a population estimate, but it has been shown to be related to population size (Pollard 1977). The annual indices of abundance from all the sites in different regions are then collated to give regional indices. Similarly, the indices from all sites, where a species is present, are collated to give a national picture of that species' fluctuations. The fluctuations of the regional or national indices (the regional or national trends) are used as a baseline for comparison with specific sites, to assess the effects of local management.

Recorders receive an annual report, and an account of the first ten years of the scheme was published by NCC (Pollard, Hall & Bibby 1986).

APPLICATIONS OF THE BUTTERFLY MONITORING SCHEME

The two aims with which the butterfly monitoring scheme was set up have been realised. The scheme has been able to detect when species begin to show any distinct regional or national trends. The scheme has also highlighted the effects of management (or lack of management) at several sites.

It is possible to use the data to document the arrival, and subsequent spread, of a species new to a site (eg the arrival of the small skipper (*Thymelicus sylvestris*) at Gibraltar Point in 1979, where it subsequently became established), and conversely to provide early warning of a species decline.

CLIMATE CHANGE

The butterfly monitoring scheme is ideally placed to assess the effects of any change in climate on butterfly species in Britain. Changes in the phenology of a species can be detected; for example, a warmer climate could lead to some species emerging earlier in the year, or to single-brooded species having two generations. The scheme can also detect if any species increase their range, and become established at sites further north. Changes in the range of some species have already been noticed (Pollard 1992). The effects of weather in exceptionally warm years, as in 1976 and 1989, are already providing clues as to how climate change could affect some species. For example, the drought in 1976 led to a sharp decline in the ringlet (*Aphantopus hyperantus*), from which it took six years to recover. Conversely, species such as the common blue (*Polyommatus icarus*) and the small copper (*Lycaena phlaeas*) were in very high numbers in the latter half of 1989. As the scheme continues, it will become possible to use past results with greater accuracy to predict future trends.

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