Chapter (non-refereed)

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The Biological Records Centre: a pioneer in data gathering and retrieval

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INTRODUCTION

The establishment of the Nature Conservancy in 1949 brought unprecedented opportunities for the study and conservation of plant and animal species, and their communities (Sheail 1987). How well equipped were botanists and zoologists to discharge these responsibilities? Could they provide the kind of national perspective that would be required to determine priorities? Captain Cyril Diver, the Director-General of the Conservancy, wrote to the Botanical Society of the British Isles (BSBI) in March 1950, emphasising how it would be impossible to fulfil all the duties laid on the Conservancy without the full support and co-operation of the national biological societies. They were of obvious value in carrying out biological surveys, and in acting as a bush-telegraph in reporting threats to 'smaller species sites'.[1]

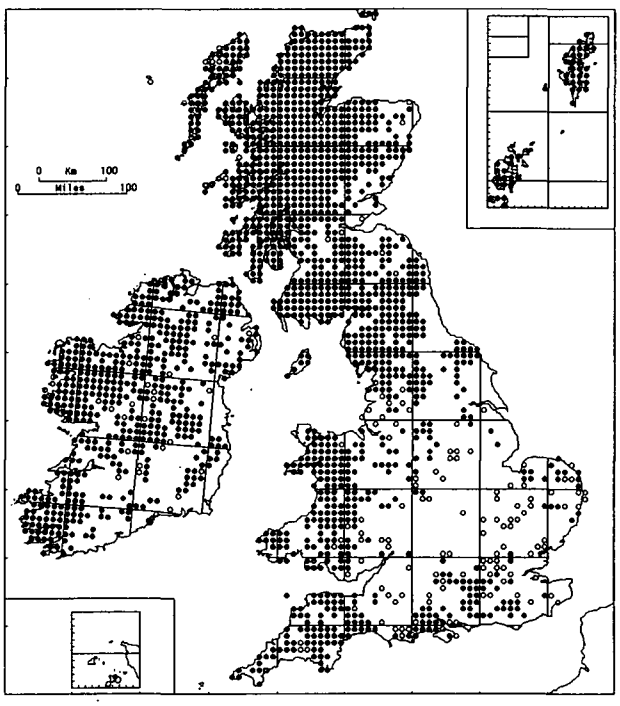
This paper outlines how that collaboration was developed, first in the form of the BSBI plant mapping scheme and then, under the aegis of the Nature Conservancy (and latterly the Natural Environment Research Council), at the Biological Records Centre, located at Monks Wood Experimental Station.

THE ATLAS OF THE BRITISH FLORA

In 1938, Diver had discussed the need to map the distribution of species, as a means to understanding the limiting factors in the ranges of species, in the context of a grandiose national atlas (Taylor 1940). However, the stimulus to Diver's 1950 correspondence was the decision to devote the BSBI Conference of 1950 to the 'Aims and methods in the study of the distribution of British plants'. The absence of any kind of national overview of the distribution of every plant species was an obvious embarrassment. Whilst much might be gleaned from the published literature and museum collections about rare plants, detailed and systematic field surveys would have to be organised to achieve the same level of detail for the more common species. A model already existed in the form of Eric Hultén's *Atlas of the distribution of vascular plants in northwest Europe* (Hultén 1950). The adoption of a National Grid by the Ordnance Survey opened up the possibilities of using, say, the 10 kilometre grid square, which appeared on every Ordnance Survey map, as the basic mapping unit for all species (Figure 1), whatever their degree of rarity.

The Conference concluded with a paper given by Professor A R Clapham, in which he put forward the idea of publishing an accurate, up-to-date and detailed atlas of British vascular plants, available for purchase in a convenient form and at a reasonable price. Whilst the biological vice-county system developed by Watson and Praeger had the advantage of being a familiar and established mapping unit, Clapham (1951) illustrated how its use often gave a misleading impression as to the continuity or otherwise of the distribution of many species.

A resolution encouraging the Council of the BSBI to 'discuss the possibility of preparing and producing a



• Post-1950

o Pre-1950

Figure 1. Distribution of *Drosera rotundifolia* showing the recorded occurrence of the species summarised by 10 km squares of the British and Irish National Grids

[1] Superscript numbers refer to manuscript sources – see p 19

series of maps of the British flora', was carried with acclamation, and a Maps Committee was formed. An approach to the Nuffield Foundation for a five-year grant of £10,000 was successful, and in April 1954 work began on mapping the distribution of British flowering plants and ferns, directed by Dr S M Walters and, from March 1959, Dr F H Perring, of the Botany School, Cambridge. Over 1.5 million records were contributed by about 1500 professional and amateur and volunteer workers. Records were received from all but seven of the 3651 10 km squares covering the whole of the British Isles. With the aid of data processing machinery, it proved possible to use punched cards, not only to collate the data for each species, but to make the final maps on a slightly modified commercial tabulator. It took less than one hour to place all the dots for a single species in their correct positions on the map (Nature Conservancy 1962; Perring & Walters 1962).

The original intention was to complete the collection of data by 1959, and for the maps to be ready for publication a year later. To the consternation of the Nature Conservancy, which met 70% of the eventual costs of £36,000 of the project, two extensions were required. In a sense, the project was a victim of its own success. More time was needed to edit the number of records which was much larger than expected. Both Clapham and Professor H Godwin of the Botany School, Cambridge, insisted that continued support should be given, not least because the project had reached a stage when the 'careful analytical and experimental research' could begin. Already the incidental publication of fragments of work in support of particular research investigations had attracted much attention, both in Britain and on the Continent. The Conservancy would gain much credit from association with the Survey.[2]

The *Atlas of the British flora* (Perring & Walters 1962) was eventually published for the BSBI by Thomas Nelson in 1962 at a cost of 5 guineas. Measuring 12 inches by 10 inches, it contained 406 pages of maps (four maps to the page) showing the distribution of about 1700 species. Intended as a factual document of sufficient accuracy to make it 'a valuable tool for biologists and all others whom it may happen to interest', the *Atlas* provided, for the first time, detailed information about the distribution of British plants on a uniform scale. It was also a pioneer in the use of data processing machinery for dealing with records at all stages, from their receipt until they appeared as symbols on a map.

THE FUTURE OF THE BSBI MAPPING SCHEME

Long before the survey was finished, recorders had begun to use the field record cards for a range of different purposes. Other organisms and areas might be mapped in a similar manner. The BSBI was, however, exceptional in being able to collect so many data. A total of 250 000 records a year had justified expenditure on data processing equipment. Few other bodies could support individually the levels of investment and organisation that would be required. In their submissions, supporting the second and final extension of grant aid, Clapham and Godwin emphasised how every effort should be made to avoid disbanding a survey so competently directed, and which had several years' experience and the goodwill of a large band of voluntary helpers. A permanent mapping centre should be established as part of 'the scientific equipment of the country'.[3]

At a meeting convened in Cambridge in November 1962, with Max Nicholson (Director-General of the Nature Conservancy) in the chair and representatives of all the main biological societies present, there was a majority strongly in favour of setting up such a permanent centre. Its first priority would be to advise on the methods of studying the population and distribution of organisms so as to build up a record of their diversity, abundance and range. The second would be to process and edit the information received, so as to make it available to all amateur and professional biologists (Nature Conservancy 1964).

By taking responsibility for such a centre, and providing a service in data processing and map production, the Nature Conservancy would acquire, in exchange, an invaluable store of information on the distribution of British plants and animals. At its meeting in July 1963, the Nature Conservancy committee agreed to the transfer of Perring and his staff to the recently opened Monks Wood Experimental Station, near Huntingdon.[4] The removal took place in April 1964 and, three years later, the unit became a fully integrated part of the Conservancy, which, by that time, had been absorbed as a Charter Committee of the Natural Environment Research Council.

BIOLOGICAL RECORDS CENTRE, 1964–1973

Progress reports were submitted to the biannual meetings of an Advisory Sub-Committee, responsible to the Conservancy's Scientific Policy Committee. Clapham (who had been secretary of the BSBI's Map Committee) was chairman until 1968, when he was succeeded by Dr H C Gilson. At its first meeting, ' no positive agreement' was reached as to what the centre should be called. The word 'Information' was rejected as too general. Biological Data Centre was considered, but, at the second meeting, Perring's suggestion of the Biological Records Centre (BRC) was accepted.[5]

The meeting of the Advisory Sub-Committee in October 1966 concluded with a discussion as to how the work of the Centre might attract more publicity. A small silhouette of a frog was adopted as a motif on cards, maps and notices. The first Newsletter was issued in April 1967.[6] It was not long before the BRC was one of the best-known components of the Nature Conservancy. As well as visitors to the Centre, staff seemed to spend more and more time away,

discussing and lecturing about matters concerning recording.

As anticipated, a high priority was given to processing the data provided by national biological societies.[7] The British Bryological Society was one of the first societies to use the Centre's expertise. Every October, records would be received, from which the next set of maps was prepared for the *Transactions of the British Bryological Society*. Maps of nearly 150 species were published over the period 1963–71. The British Conchological Society and BRC published the first *Atlas of freshwater and terrestrial Mollusca* in 1976.

The obvious incompleteness of the maps produced for the various societies had a stimulative effect. Some 500 additional records were received, following the publication of a set of interim maps for the British Deer Society. Some groups were so difficult to identify in the field that the production of a guide or key was essential. As organiser, Dr D V Alford produced a series of such guides for the 300 recorders who took part in a bumblebee distribution map scheme launched by the International Bee Research Association. By the early 1970s, the volume of work carried out for the British Trust for Ornithology (BTO) and Wildfowl Trust was so great as to justify each having a member of staff outposted to BRC. From 1965 onwards, the Centre was responsible for determining the totals of the number of birds of each species ringed and recovered under the BTO schemes. Once verified, the 80-column punched cards were duplicated, a set being kept at the Centre for analysis. The other set was sent to Paris, where all the European bird-ringing data were collated. In February 1968, a scheme was launched to produce an *Atlas of breeding birds* by the British Trust for Ornithology and the Irish Wildbird Conservancy, using the 10 km square as the basis for recording.[8]

Botanical recording

Following the publication of the *Atlas of the British flora*, two major tasks remained. For what were called 'technical and tactical reasons', the *Atlas* had omitted maps of a number of difficult genera, including *Alchemilla, Euphrasia, Hieracium, Sorbus* and *Rubus*. These genera were included, together with a number of interesting examples of maps of subspecies, varieties and hybrids, in a *Critical supplement*, eventually published in April 1968 (Perring & Sell 1968).[9] Sales compared well with those of the original *Atlas*, with 955 copies, representing 40% of the print run, sold in the first six months. The 500 maps were accompanied by taxonomic notes, and phytogeographical comments on each taxon or group of taxa, as well as an account of how each map was compiled.

The second urgent task was to review the status of the 400 rarest species in the British flora which had been identified by the letter 'A' in the *Atlas*. Two sets of lists were prepared. The first set comprised those species found in fewer than nine 10 km squares, and the second those occurring in nine to 15 10 km squares. The lists, comprising 300 species in all, were distributed in October 1967 and 1968 respectively to the recorders of the BSBI, the Conservancy's regional staff, and other interested persons, who were asked to provide up-to-date information on each population (Perring 1970). The detailed replies obtained from the majority of respondents, and any further records, formed the basis of a new set of maps that were used in the preparation of scientific evidence in support of a Wild Plants Protection Bill in 1968. However, the Bill was not passed by Parliament (Perring & Farrell 1977).

At last, there was a more rigorous basis upon which to assess the increase or, more usually, decline of species (Table 1). At a Conference organised by the BSBI on the 'Flora of a changing Britain'. Perring (1970) described how a third of the localities of the 278 rarest species had been destroyed. About 7% of the native flora of about 1500 species might be threatened with extinction. Priority was given to the preparation of the British equivalent to the *Red Data Book* produced by the International Union for the Conservation of Nature, listing all the rare and declining species of flowering plants and ferns, and giving information about their former distribution, their present rate, and possible causes for decline. Such a book would alert the conservation movement and landowners to the precarious state of some species, particularly those 80 species now confined to only one or two populations. However, the *Red Data Book* was not published until 1977 (Perring & Farrell 1977).

Table 1. Number of squares and localities for the 278 rarest British plant species (Perring 1971)

	Squares	%	Localities	%
Historical period	3390	100	4595	100
1930–50	1673	49	1902	41
1960 onwards	1176	35	1425	31

Zoological recording

Right from the start, the question was posed as to how far BRC should go in initiating its own surveys. There were some groups, and most notably insects, where no suitable society existed to undertake a mapping scheme. Zoological recording was started at BRC as soon as the Centre was set up, and a common species recording scheme was launched in 1967 to cover 19 groups of animals (excluding birds and marine organisms). The scheme, which covered 530 species that the general naturalist could be expected to record with accuracy, never prospered and was soon abandoned.

It was not until John Heath joined BRC in 1967 that recognised zoological expertise was resident at BRC. As had been the case with botanical recording, it was essential that the zoological staff at BRC would

be closely involved with national and regional societies. Heath was a well-respected amateur lepidopterist who had many contacts with amateurs and professionals in the British Isles and abroad. His approach to organising the collection of data for many groups of insects (and other invertebrates) was characteristically optimistic and ambitious.

The Lepidoptera distribution maps scheme was launched in 1967 with an advisory committee of five external professional and amateur lepidopterists, chaired by Sir George Varley. This committee met three times before transforming into a similar role for the insect distribution maps scheme, but it seems not to have met after December 1969. In a progress report for 1971, Heath (1971) listed the following groups covered by the insect distribution maps scheme: Lepidoptera, Odonata, Orthoptera, Hymenoptera – Bombidae and Formicidae, Siphonaptera, and Diptera – Tipulidae. By this time, BRC was also involved with national schemes covering vertebrates and various non-insect invertebrate groups (Table 2).

The Lepidoptera scheme got off to 'a very encouraging start', with publicity in newspapers, journals, and through societies and exhibitions. By the end of 1968, 900 recorders had returned 3700 field cards and 25 000 individual record cards from 1200 10 km squares. As early as 1970, BRC was able to publish part 1 of the *Provisional atlas of the insects of the British Isles* (Heath 1970) which covered the native butterflies, and in 1973 part 2, covering 100 species of larger moths, was published (Heath & Skelton 1973).

The international dimension

Right from the start, the horizons of the BRC were worldwide. Under the aegis of the United Kingdom's contribution to the International Biological Programme (Conservation of Terrestrial Communities), the BRC took part in a Check Sheet Survey to collect information on sites of biological importance in the world. The intention was to estimate how far major natural and semi-natural ecosystems were adequately protected, and what further steps were required to meet that end.

Plants

An exhibition of data processing equipment, organised by Perring, at the International Botanical Congress in Edinburgh in 1964, drew attention to the very ambitious mapping projects that could now be contemplated. A scheme to map the whole of Europe had become more feasible. The imminent publication of the first volume of *Flora Europaea* would provide a common basis for nomenclature and taxonomy (Tutin *et al.* 1964). The availability of a complete set of maps for Europe on a 1:1 000 000 scale, bearing the Universal Transverse Mercator Grid, meant there was a common mapping unit, especially as the same grid was also being used on large-scale maps within individual countries (Perring 1967).

Table 2. A chronological list of the national biological recording schemes operated by BRC in 1990

Schemes established before BRC	**Date of origin**
Vascular plants	1954
Myxomycetes	1957
Siphonaptera	before 1960
Coleoptera: Atomariinae and Ptiliidae	before 1960
Bryophytes	1960
Non-marine Mollusca	1961
Schemes established 1964 to 1973	
Amphibians and reptiles	1964
Aculeate Hymenoptera	1964
Butterflies (and Macro-Lepidoptera)	1967
Spiders	1968
Orthoptera, Dermaptera, Dictyoptera	1968
Odonata	1968
Non-marine Isopoda	1968
Pseudoscorpiones	1970
Diplopoda	1970
Chilopoda	1970
Coleoptera: Elmidae	1970
: Staphylinidae	1970
Diptera: Tipulinae	1970
: Dixidae	1970
: Sciomyzidae	about 1970
Mammals	1971
Marine algae	1971
Coleoptera: Coccinellidae	1973
Schemes established 1974 to 1990	
Opiliones	1974
Coleoptera: Carabidae	1974
Tricladida, freshwater flatworms	1976
Diptera: larger Brachycera	1976
Cladocera	1977
Neuroptera, Mecoptera, Megaloptera	1977
Diptera: Syrphidae	1977
: Conopidae	1977
: Sepsidae	1977
Characeae	1979
Freshwater Oligochaeta	1979
Hemiptera: Auchenorhyncha	1979
Coleoptera: aquatic beetles	1979
Trichoptera	1980
Coleoptera: Chrysomelidae and Bruchidae	1980
: Scolytidae	1980
Diptera: Culicidae	1981
Lepidoptera: Incurvarioidea	1982
Coleoptera: Elateroidea	1982
: Cerambycidae	1982
Hemiptera: aquatic Heteroptera	1983
: terrestrial Heteroptera	1984
Gasteromycetes	1985
Coleoptera: Scarabaeoidea	1986
: Cleroidea, Lymexyloidea and Heteromera	1986
: Cantharoidea and Buprestoidea	1986
: Curculionoidea (part)	1986
Tricladida: terrestrial flatworms	1987
Hymenoptera: Symphyta	1987
Plant galls	1989

A working party was set up, with a view to compiling trial maps for ten species, using the 50 km squares of the Universal Transverse Mercator Grid as the mapping unit. Progress was sufficiently encouraging for the decision to be taken, during the 4th Flora Europaea Symposium in Denmark, in August 1965,

to proceed with mapping all the species included in the *Flora Europaea*. The secretariat was to be located in Helsinki, and Perring was elected to the co-ordinating committee. The first volumes covering the Pteridophyta and the Pinaceae to Ephedraceae were published in 1972 and 1973 respectively[10] (Jalas & Suominen 1972, 1973).

Invertebrates

At a meeting in Paris in October 1967, Professor Jean Leclercq read a paper to the Société de Biogeographie, in which he set out a proposal to map the insects of Europe. At the same meeting, Heath described the data collection and processing methods used by the BRC. A meeting at Monks Wood in the following March, attended by four members from Leclercq's department at Gembloux in Belgium, agreed on the design of field cards and an 80-column individual records card for a mapping scheme that would use the base maps already available from the Flora Europaea mapping scheme. Preliminary notices of the European Invertebrate Survey were published and sent out by direct mailing, the BRC and Gembloux meeting the costs jointly.[11] The first invertebrate symposium was held in Saarbrucken in July 1972, and a second in August 1973 at Monks Wood, at which 62 delegates from 23 countries adopted a constitution and appointed a permanent committee, with Heath as secretary-general (Heath 1975).

Technological changes

Whilst much of the Centre's attention had to be given to co-ordinating the collection of data, it was equally important that the information, once received, was handled, stored and retrieved efficiently. Not only were distribution records and analysis tending to become more complex, but the number of enquiries increased.

The specially modified ICL 40-column tabulator, with associated punch and sorter, using a base map specially drawn to fit the tabulator, had proved an inexpensive and convenient system for plotting the maps of the botanical *Atlas*. At its second meeting, the Advisory Sub-Committee recommended the purchase of 80-column equipment, including an interpreting punch and a pattern select sorter. However, by the time this further equipment was installed, it was clear that the days of such a system were numbered. As a letter from ICL made clear, it would soon be impossible to obtain maintenance and spare parts as the machinery become obsolete.[12]

The benefits to be gained from adopting a computer-based system were obvious. Once the basic records were held in computer store, updating could take place continuously and, with suitable subroutines, it would be possible to map associations between two or more species, or list those occurring in a single square or group of squares. To oversee the conversion of the system based on 40-column cards to a fully computerised system, Miss Diana Scott, from the Royal Aircraft Establishment, was appointed as Data Processing Officer. In 1970, a Teletype computer terminal was installed, linked by telephone line to the Atlas-2 computer at the Computer Aided Design (CAD) Centre at Cambridge. The first stage of the conversion to computers involved the transfer of 1.5 million existing plant records from the 40-column cards to magnetic tape. The cards had to be transported to London in batches of 300 000, where the data were transferred on to magnetic tapes at the Law Society's Computer Centre. These tapes were then copied by London University's Computing Services on to the special tapes used by the Atlas computer. They were then rewritten in a condensed form, and indexed for easy retrieval of the data. The last batch of cards was dispatched for processing in June 1971.

Where might technical innovation end? As Perring (1970) remarked, it was important not to allow the sophistication of the machinery to blind users to the primary objectives of collecting data. Experience over 15 years indicated that nearly all the questions asked of the databank were either species- or locality-orientated. Irrespective of what else the technology might be used for, it was essential that these questions could be answered easily and cheaply.

BIOLOGICAL RECORDS CENTRE 1973–1989

In 1973 the Nature Conservancy was split to form two independent organisations, the Nature Conservancy Council (NCC) and the Institute of Terrestrial Ecology (ITE) (Natural Environment Research Council 1973). The separation of what were ostensibly the conservation and the research branches of the former Nature Conservancy created an inevitable problem over the most appropriate location for the Biological Records Centre. After a period of some uncertainty, BRC remained at Monks Wood, as part of the new ITE, within the Natural Environment Research Council.

In the general restructuring of funding systems in the Civil Service (the Rothschild Principle), the new Institute was commissioned to conduct research on contract to NCC. One of the areas of commissioned work was the BRC programme. Every year since 1974, NCC has supported the general operation of BRC with contract funds, although the percentage of the full costs of BRC covered by NCC's funding has steadily decreased over the years. However, in addition to direct funding to ITE to support the work of BRC, NCC has itself employed staff to work at BRC on specific projects, such as the BSBI monitoring scheme and the bryophyte atlas project. The contract between NCC and ITE supporting BRC recognises that the Centre is a joint responsibility to which both organisations allocate resources.

Since 'the split' in 1973, the work of BRC has changed and developed in response to altered circumstances and priorities, rapid developments

in technology, and changes in staff. BRC has also undergone a succession of administrative changes since 1973 as ITE and NERC have developed new management structures. In 1989 BRC became the largest component in ITE's Environmental Information Centre (Wyatt 1992).

In the period immediately after 1973, BRC effectively lost its previously developing role as a data processing unit for the Nature Conservancy and, by the end of the 1970s, BRC was seen largely as a species distribution mapping unit. Partly in response to requests from NCC for information on species occurring at sites, such as National Nature Reserves and Sites of Special Scientific Interest, in 1981 a decision was made to incorporate more detailed site information into the computerised database (Table 3, Figure 2). Most recording schemes had already been collecting site-relatable information at least for the less common species. The early 1980s saw not only an intensive phase of computerisation of new data, in a site-relatable form, but also a renewal of contact with recording schemes to encourage them to record in more detail and for purposes additional to the publication of national distribution maps. In particular, the foundations were laid for the use of the BRC database as a tool for exploring biogeographical associations and, ultimately, to tackle the challenge of predicting changes in species populations and ranges in response to environmental changes.

These developments took place at a time when several new staff were joining BRC: Dorothy Greene and Paul Harding in 1979, Chris Preston in 1980 and Brian Eversham in 1983. Franklyn Perring had left BRC at the end of 1978, to be succeeded by John Heath. He retired in January 1982, and Paul Harding became head of the Centre.

Botanical recording

The large resource of data on vascular plants (approximately 1.5 million records) which formed the nucleus of BRC in 1964 has been augmented and updated in largely opportunistic ways, particularly during the last ten years. In addition, two new projects (BSBI monitoring scheme and the database

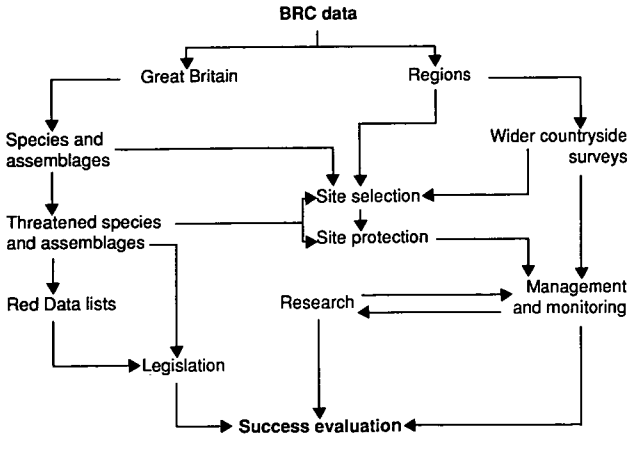


Figure 2. The application of site-relatable data, held by BRC, to nature conservation

Table 3. Biological Records Centre – data fields

Site relatable data (almost all data computerised since 1981)		
Taxonomic	1.1	Order/genus/species/infra-specific taxon
Geographical	2.1	Country
	2.2	Vice-county
	2.3	Grid reference (10 km, 1 km, or 100 m square)
	2.4	Locality
	2.5	Site status (eg NNR/SSSI/NT/ Trust NR)
Temporal	3.1	Date (day/month/year or date period)
Personal	4.1	Recorder/collector
	4.2	Determiner
	4.3	Record compiler
Other (optional)	5.1	Altitude
	5.2	Habitat (land use/vegetation type, microsite)
	5.3	Record source (field/museum/ literature)
		5.3.1 Location of voucher material
		5.3.2 Reference to bibliography
	5.4	Species status (native, naturalised, etc)

and atlas of aquatic plants) have added to the database in a more directed fashion. Work on other botanical groups has involved myxomycetes, marine algae, lichens, charophytes and bryophytes, with new databases being established at BRC for all but the lichens.

Vascular plants – updating species

Many of the records contributed to the BSBI *Atlas* provided detailed information on localities, recorders and dates, and there has been a rolling programme to incorporate these more detailed records into the BRC database. Most of the species concerned are uncommon, localised or taxonomically difficult. This work has been expanded to incorporate more recent records from specialists and vice-county recorders, from recent publications, especially local floras, and from herbaria.

Requests for updated maps or data for individual species, for publications such as BSBI Handbooks and the British Ecological Society's *Biological Flora* series, or for research and ecological assessment, have justified the allocation of resources to updating the database for selected species. By 1989, maps of about 420 species and hybrids had been published in this way (Preston 1990).

An ambitious project to prepare a multi-volume *Flora of Great Britain and Ireland* was proposed by a consortium of experts in the early 1980s, and updated maps were prepared at BRC for most of the species expected to be included in the first volume of the *Flora*, before the whole project was abandoned by the originators.

Vascular plants – Red Data Book species

The maps published in the *Atlas of the British flora* drew attention to both rare and decreasing plant

species. From 1968 onwards, BRC made special efforts to encourage BSBI vice-county recorders to collect and submit localised records of such species. The data obtained were summarised in the first *British Red Data Book* (Perring & Farrell 1977, 1983), and a separate dataset on rare vascular plants has subsequently been maintained by NCC and BRC.

Vascular plants – BSBI monitoring scheme

Data summarised in the *Atlas of the British flora* are at least 30 years out of date. Dots in the *Atlas* show post-1930 or, at best, post-1950 records. New editions of the *Atlas* (in 1976, 1982 and 1990) have done little to remedy the lack of recent information, except for about 320 rare taxa.

As part of a phased project to compile a completely new and updated atlas, the BSBI initiated a study of more recent changes. This study surveyed a sample of one in nine of the 10 km squares of the National Grids in Britain and Ireland (Ellis 1986). The project was intended to identify species which are changing their distribution and to establish a baseline for monitoring changes regularly, independent of the proposed larger *Atlas* project. The project is described by Rich (1992). The scheme resulted in nearly 1 million records which have been added to the BRC database.

Vascular plants – database and atlas of aquatic plants

Work on the preparation of the BSBI Handbook on *Potamogeton* and allied genera started Chris Preston's interest in this neglected group of plants, and in aquatic macrophytes generally. In 1989 funding was obtained from the Water Research Centre to help support a new project to compile a database of aquatic plants, eventually leading to an atlas. The project is planned in two phases, the first 18 months being devoted to work on floating and submerged species, with the subsequent two years on emergent species.

Myxomycetes

Summarised (10 km square) data for selected species of myxomycetes (slime-moulds) were computerised for Bruce Ing and the British Mycological Society in 1980–81, and a *Provisional atlas* of 100 maps was published in 1982 (Ing 1982).

Marine algae

The British Phycological Society launched the marine algae recording scheme, in conjunction with BRC, in 1971. The resultant data were computerised in 1983–84 and, thanks to additional funding from NCC, a detailed site-relatable database was compiled at BRC incorporating records from NCC surveys. Distribution maps of a selection of 155 species were published in a *Provisional atlas* (Norton 1985).

Lichens

In 1963, the British Lichen Society launched its mapping scheme and subsequently became associated with BRC. In 1982, NERC published volume 1 of an *Atlas of the lichens of the British Isles* (Seaward & Hitch 1982) using hand-plotted maps provided by the Society. No data for lichens have been deposited at BRC and the British Lichen Society now operates its mapping scheme independently of BRC (see Hawksworth & Seaward 1990).

Charophytes

Stoneworts have been neglected by British botanists in recent years, but Jenny Moore of the Natural History Museum has made a special study of the group. She collaborated with the BRC data manager, Dorothy Greene, to prepare a computerised catalogue of the Museum's collection and a *Provisional atlas* for all available records (Moore & Greene 1983). Updated maps were prepared by Dorothy Greene for a BSBI Handbook to the group (Moore 1986).

Bryophytes

The launching of the bryophyte recording scheme in 1960, by the British Bryological Society (BBS), predates BRC, but the scheme has been closely associated with the Centre since 1964. The methods used by BBS were modelled on those used by the BSBI for the *Atlas of the British flora*, but, with many fewer recorders, the collection of data inevitably took longer. Maps of 224 species were published in the BBS journal between 1963 and 1978 and a *Provisional atlas* (Smith 1978) covering 104 species was published by NERC.

The original scheme had been based on the compilation of 'master cards', holding summary data for each 10 km square, but by the mid-1980s technological advances and the requirement for site-relatable data encouraged BRC to input fully detailed records to the database. By the end of 1989, the 770 000 records collected by the BBS had been computerised and the first of three volumes of the *Atlas of bryophytes* (covering liverworts) is complete (Hill, Preston & Smith 1991). The preparation of a *Red Data Book* for bryophytes has been started by N F Stewart (of Plantlife, formerly the Conservation Association of Botanical Societies), using the database at BRC.

Zoological recording

Zoological recording started at BRC soon after it was set up in 1964, with schemes for reptiles and amphibia, and for mammals, being initiated, but invertebrate recording started 'from cold' in 1967 and within a few years many national schemes were in operation (Table 2). By 1989 there were 45 schemes covering nearly 10 000 species of terrestrial and freshwater invertebrates and with 1.25 million records of 3000 species compiled in the database. Work on vertebrates has always been seen as important and able to attract a strong (but sometimes inexpert) response from the general public. An *Atlas of mammals*, based on over 100 000 records, will be published in 1992. However, it is the macro-Lepidoptera (especially butterflies) which have been the cornerstone of BRC's work on invertebrates.

A summary of the progress of each of the zoological schemes or datasets is not practicable in this paper,

but, by way of examples, we have selected three groups for their different approaches and results. A list of the zoological data holdings forms Table 4.

Butterflies

It has already been noted that maps of butterflies were published in 1970 and these maps were updated for publication in Howarth (1973). By 1982, when Heath retired, a large number of records had been contributed to the scheme and were summarised as 10 km square records and held on computer for mapping. As part of the move to compile site-relatable data on computer, it was decided to use the original records contributed by recorders to compile a new database (Harding & Greene 1984) which was summarised in the *Atlas of the butterflies of Britain and Ireland* (Heath, Pollard & Thomas 1984). That decision has resulted in what is certainly the most intensively used zoological dataset, with a steady flow of requests for data for research or survey of an individual species and for county-based surveys.

Table 4. Computerised zoological data holdings at BRC (1990)

Marine invertebrates	
Dinoflagellates	27 200
Terrestrial and freshwater invertebrates	
Tricladida (freshwater flatworms)	1 400
Hirudinea (leeches)	4 400
Opiliones (harvestmen)	11 200
Cladocera (water-fleas)	4 000
Amphipoda	500
Decapoda (freshwater crayfish)	2 300
Non-marine Isopoda	
Asellota (waterslaters)	500
Oniscidea (woodlice)	27 000
Diplopoda (millipedes)	17 000
Chilopoda (centipedes)	16 000
Orthoptera, Dermaptera and Dictyoptera (grasshoppers and crickets, earwigs, etc)	22 000
Odonata (dragonflies)	98 500
Rhopalocera (butterflies)	238 900
Macro-Heterocera (macro-moths)	394 500
Carabidae (ground beetles)	46 000
Staphylinidae (rove beetles)	8 600
Coccinellidae (ladybirds)	9 300
Aculeate Hymenoptera	
Apidae (social bees)	8 500
various (solitary bees and wasps)	900
Brachycera (horseflies, etc)	19 600
Syrphidae (hoverflies)	40 900
Dixidae (meniscus midges)	1 400
Dolichopodidae and Empidoidea	500
Sepsidae	6 000
Muscidae (cattle-visiting flies)	2 000
Non-marine Mollusca (slugs and snails)	144 000
Vertebrates	
Freshwater fish	1 800
Amphibians and reptiles	2 300
Birds	284 000
Mammals	110 000
Total	1 551 200

The butterfly monitoring scheme launched in 1976 was previously independent of BRC, but in 1989 it became part of the BRC project and its database has now been incorporated with that of BRC. The work of the scheme is described by Pollard, Hall and Bibby (1986), and by Pollard (1992) and Yates (1992) in this volume.

Dragonflies

The Odonata were one of the groups covered by the original insects distribution mapping scheme set up in 1968. The scheme was slow to show results, but, by 1977, post-1960 coverage of about 20% of 10 km squares had been achieved and maps were published in a new field guide (Hammond 1977) and as a *Provisional atlas* (Heath 1978). Under a new volunteer organiser, David Chelmick, and with the new field guide, the scheme prospered and many new recorders were recruited. In 1981 the organisation of the scheme passed to Bob Merritt who, with dynamic enthusiasm and commitment, encouraged the scheme to collect detailed site-relatable records. The results of this scheme up to 1988 are summarised in the forthcoming *Atlas* (Merritt, Moore & Eversham 1992). Subsequently the scheme has concentrated on collecting even more detailed information in the key sites project, which aims to establish proof of breeding and to estimate numbers of individual species at sites.

Woodlice

Three recording schemes were launched in 1970 covering woodlice (terrestrial Isopoda), centipedes (Chilopoda) and millipedes (Diplopoda). These schemes set out to collect information on the habitat preferences of species, as well as detailed distribution data, using a hierarchical habitat classification designed specially for these soil and litter organisms.

With a core of 20 or fewer regular contributors, the woodlice scheme collected 27 000 records of 34 native and naturalised species over a period of 13 years. Identifications were carefully controlled by the organisers and, as a result of checking and returning identified specimens to recorders, regular newsletters and annual field meetings, it was possible to build up a team with experience in field craft and identification. The results of the survey were published with maps and habitat analyses for each species (Harding & Sutton 1985) and subsequent analyses have been undertaken (Sutton & Harding 1989; Harding *et al.* 1991).

The international dimension

As a pioneer in the collation of national biological survey data and in the use of computers in handling those data, BRC has had a role in the formation of comparable data centres in other European countries and elsewhere. That role has usually been passive, by providing a working example, with specialists from every continent visiting the Centre to examine its methods and facilities.

One of the stated objectives of the European Invertebrate Survey (EIS) had been to promote and

encourage the establishment and activities of national centres for distribution studies of invertebrates and, in the period since EIS was formally constituted in 1973, data centres have been set up in several European countries. In reality, most of these centres owe their existence more to the efforts of individuals and national organisations than to any initiatives on the part of EIS.

Without a permanent secretariat or funding, EIS was unlikely to prosper in the increasingly difficult financial climate of the 1970s and 1980s. The organisation has survived, albeit in an altered form, and is best regarded as an *ad hoc* assemblage of specialists from individual countries with an involvement in species distribution studies and invertebrate conservation. Under the guidance of its current president, Dr M C D Speight, EIS has focused its attention on providing specialist advice on invertebrates to the standing committee to the Berne Convention (Council of Europe 1990).

For some years, the Council of Europe has provided a focus for thinking on databanks in wildlife conservation and on the need for standards, particularly in species nomenclature for legislative purposes in the context of cross-national information exchange. Three 'colloquys' around the theme of computer applications in nature conservation were held at Strasbourg, in 1983, 1985 and 1986, with Harding representing BRC at the last. A catalogue of databanks in the field of nature conservation was published (Council of Europe 1985); information was gathered in 1987 to update that catalogue, but was never collated or published. A select committee of the Council of Europe, chaired by Harding, advised on the need for a nomenclatural database of European vertebrates, as a first step towards a series of such databases (Council of Europe paper PE-R-BD (87) 3 rev.) (Harding 1990c). No further action has been taken on any of these aspects because the relevant section of the Council has been unable to allocate resources for either meetings or consultancies.

Ad hoc collaboration by specialists is still possible, but fails to realise the potential of international collaboration, because of a lack of resources. Projects such as *Atlas Florae Europaeae* continue, but largely as a result of the dogged persistence of a few activists. Only now is the *need* for a comprehensive overview of the European distribution of species being recognised by other scientists, particularly those concerned with research on the potential effects of climatic change.

The European Commission (EC) has yet to have an impact on biological recording although the CORINE project (Co-ordinated Environmental Information in the European Community) has shown that international data exchange is practicable in relation to biological information. As the EC takes a more active role in wildlife legislation (eg through the Habitats Directive and the proposed Environment Agency), it can be expected that the existence of national biological data centres, such as BRC, will provide a resource to be developed and utilised through international collaboration.

Technological changes

The period since 1973 has seen an almost universal explosion in the use and development of electronic data handling procedures, and, in particular, in the increasing improvement and sophistication of computers and software with resultant cost-effectiveness. The creation of ITE in 1973 saw a rapid expansion of scientific computing facilities throughout the Institute. A Digital PDP 11–10 computer was installed at Monks Wood in March 1974, and this offered new opportunities to update the data handling and map production capabilities of BRC.

However, it was not until the late 1970s that truly effective use was made of computerised data management technologies for both data banking and the production of output, especially distribution maps. The delay was due in part to the sheer size of the BRC dataset as a whole – it was too large to be handled efficiently on the PDP 11–10, although subsequent upgrades of the Monks Wood computer enabled work on individual datasets to be undertaken. Until 1978 all map production still relied on the modified IBM 870 Document Writing System, adapted to read 80-column punched cards, which was introduced in 1969. In 1977 the NERC-funded Experimental Cartography Unit collaborated with BRC to produce maps using their Laser-scan HRD2 high-resolution plotter, and the resultant maps (of 104 bryophytes) were published in a *Provisional atlas* (Smith 1978).

The close-down of the Atlas computer at the CAD Centre in Cambridge in 1977 led to data previously held there being transferred to a dual IBM 360/195 configuration at the Rutherford Laboratory of the then Science Research Council. For the first time, BRC data were held within a formal database management system – the G-EXEC package, developed by the Institute of Geological Sciences. By 1978, nearly 2 million records (including 1.35 million records of vascular plants from the provisional *Atlas* project) were managed under G-EXEC.

The period since 1978 has seen a steady development in the computing facilities available to BRC. The installation of a workstation in August 1979, connected to the renamed Rutherford Appleton Laboratory, enabled the BRC database to be accessed interactively and heralded a new phase in providing output to users in a variety of forms. In 1980 a new outline map of the British Isles was produced by NERC Computing Services staff and Barry Wyatt (then at ITE Bangor), which enabled the distribution of species to be plotted via the computer. The outline was first used to produce maps of sedges for a new handbook (Jermy, Chater & David 1982). The early/mid-1980s saw a period of computing stability during which a number of new datasets were added to the database and the com-

plexity of data (in a site-relatable form) was increased (Table 3).

A further migration of the BRC database began in November 1986 as part of major rationalisation and upgrading of computers by NERC Computing Services, which included the adoption of the ORACLE relational database as the standard within NERC for handling its corporate databases.

The migration of datasets from G-EXEC to ORACLE was completed in 1989, thereby placing the BRC database in a modern and flexible data management environment. Later that year a local area network was installed at Monks Wood which linked microcomputers and terminals to a newly installed MicroVAX cluster. Map production has been in-house at Monks Wood since 1989 using a laser printer (Figure 1).

The caution expressed by Perring (1970), that it was important not to be blinded by the sophistication of machinery, may have been justified at the time when computing was in its infancy. However, the equipping of BRC in recent years with appropriate computing power, output facilities, data management expertise and analytical methodologies has been crucial to the continued success of the Centre. It may seem surprising that it is only in its 25th year that BRC and ITE colleagues have been seriously able to address some of the biogeographical questions relating to species and to begin the 'careful analytical and experimental research' alluded to by Clapham and Godwin nearly 30 years earlier.[2]

Possible a new word of caution is needed: users of BRC's data should not be so blinded by the present opportunities to analyse and interpret existing datasets that the collection and processing of new data and the updating of existing data are neglected!

Local records centres

Formalised biological recording, organised at a local level (eg a county), took a new direction in the 1970s with several initiatives towards the formation of local records centres, mainly based at county or city museums (Stansfield 1973; Somerville 1977; Flood & Perring 1978). By 1980, there were at least 60 centres covering most English counties and parts of Wales and Scotland (Harding & Greenwood 1981). The coverage has not changed substantially in the last ten years, although a few centres have ceased to operate and others have been created or have become more securely established. Seventy centres were listed as being in operation in February 1987 (Berry 1988).

Although there is often close collaboration with BRC, there are no formal links with these local centres. As a result, no network or protocols for exchange of data exist, there is some duplication of effort, operating standards vary, and scarce resources are not being used to best effect. These problems were highlighted at a meeting convened by the Biology Curators' Group at Leicester in 1984 (Anon 1985) and subsequently by the National Federation for Biological Recording (NFBR) (Copp & Harding 1985) and by a Working Party convened by the Linnean Society of London (Berry 1988). Progress towards national policies in biological recording, up to May 1989, was reviewed by Harding (1990d), and subsequently a Co-ordinating Commission for Biological Recording, chaired by Sir John Burnett, has been formed to provide a focus for work towards a national network in biological recording throughout the UK.

A recent initiative by NCC, vigorously supported by NFBR, and partly financed by the World Wide Fund for Nature through the Royal Society for Nature Conservation (RSNC), provides the most tangible hope for simplifying the exchange of biological records, between centres at all levels. The RECORDER data management package developed by Dr S G Ball of NCC was released early in 1991 and will enable users to manipulate their data in a carefully designed and extensively tested computer system. RECORDER will not solve all the problems of the interface between local centres and national bodies such as BRC, and, of course, NCC and RSNC, but it will enable data to be stored and exchanged in standard forms.

The proliferation of home computers in Britain during the second half of the 1980s has led to many individual recorders, some scheme organisers, and some local records centres computerising data 'at source'. Early trials in acquiring data in this form, rather than in the traditional form of record cards, have been successful, and we look forward to increasing amounts of new data coming to BRC already computerised and checked for accuracy. BRC will be able to incorporate new data in this form, with greater ease and speed, leading to more efficient use of the existing, finite resources of manpower and equipment available at the Centre. However, need for discipline in adhering to agreed standards is even more important when magnetic media replace paper.

THE USE OF BRC DATA

The steady accumulation of computerised datasets over the last 25 years has enabled BRC to expand the range of uses to which data are put. Given the location of BRC within a research council, the application of those data to environmental research is seen as an essential function. Although many of the contributors of data regard national species distribution maps as the main product of BRC, it is the database which is the principal end-product of their efforts. BRC data are now being put to a wide range of uses. Many of these uses had been recognised from an early stage, but there had previously been insufficient resources, particularly of detailed data, to realise the full potential.

Five factors are important in reviewing the range of uses to which BRC data are being and could be put.

1. Data are now held in an accessible relational

database management system – ORACLE – which allows flexible access by a variety of criteria and search conditions.

2. There is now a wide range of detailed and good-quality data.
3. As part of ITE's Environmental Information Centre, BRC has access to other environmental datasets, to sophisticated spatial data handling technologies and to statistical expertise.
4. The requirement for authoritative and comprehensive environmental data has increased greatly in recent years; in particular, there is a pressing need to document the consequences of past changes and to predict the course of change in the future.
5. In common with most government-funded research institutions, BRC must develop the commercial application of its data.

The uses to which BRC are now being put can be summarised under four headings: information, monitoring, ecological analysis, and conservation and evaluation.

Information

Information on the occurrence of species is not only the basic feedback required by the voluntary contributors of data, but also the most tangible product of BRC, especially in the form of distribution maps. Maps have been produced for over 7000 species, many of which have been published in *Atlases* and taxonomic guides (Harding 1989) or in papers and books (see, for example, Preston 1990).

With an historical perspective in the data, derived from published records and preserved specimens in collections, it is possible to examine whether the range of an individual species, or of an assemblage of species, has changed. Several of the following papers pursue this aspect, 'Changes in British wildlife' being the theme of this Conference, and we return to the topic ourselves later. Assessments of change, such as those made for a few groups of invertebrates, reinforce the need for the continued collection of data. The distributions of species are not static, and information about change is required to assess the effects of man's management of the natural environment and the effectiveness of any measures being taken to control rates of change and to conserve species and sites.

Information is required not only at the national (UK) level, but there is increasing need to be aware of our island flora and fauna in a European and even global context. European species mapping projects exist for vascular plants, birds, mammals, reptiles, amphibians and some invertebrates. At present these projects function on a voluntary basis and depend on the enthusiasm and commitment of the co-ordinators and collaborators. However, it is not unreasonable to speculate whether Europe needs more than these projects can provide, and whether international collaboration on species recording should not follow the lead on site recording and documentation of the CORINE biotopes project described by Moss and Wyatt (1990).

Monitoring

Although BRC schemes are surveys and have no pretensions to monitor species or sites, the data collated by schemes provide baseline information on the occurrence of species. These data are then applicable to nationwide or regional projects to examine the effects of man on the natural environment, and the spatial and temporal components of BRC data can be used in analyses with similarly referenced datasets. In the case of the BSBI monitoring scheme (Rich 1992), the original data for the *Atlas*, collated in the 1950s, have been used in comparison with the recent data to examine changes, and the monitoring scheme itself provides a sample baseline for resurvey in future decades. The role of national species surveys in the context of monitoring for conservation is discussed by Harding (1990b).

As has been shown by the BSBI monitoring scheme, volunteers have proved themselves to be malleable to specific requests for information and to project-orientated surveys. The potential resource of experienced volunteers involved with national schemes, who could be directed to projects with a monitoring component, has yet to be exploited. Sampling frameworks are required which are representative of the national situation; the ITE land classification system (Bunce, Barr & Whittaker 1981) is one approach which offers opportunities in this context.

Ecological analysis

From the earliest days of the BSBI *Atlas* project, it was intended that the data from national distribution surveys would be used in analytical and experimental research. Little use was made of the BSBI *Atlas* data in any form of analysis although the data were used to provide a basis for the *Red Data Book* (Perring & Farrell 1977) and in the development of guidelines for the selection of Sites of Special Scientific Interest (NCC 1989).

Subsequently, data from some schemes have been used in a variety of analyses, in particular those schemes which were set up with objectives beyond obtaining an overview of the distribution of species, such as the three soil and litter fauna groups described earlier. The application of multivariate techniques to the analysis of BRC data has been developed particularly for water beetles and the ground beetles, as described by one of the posters (Luff *et al.* 1992).

Within ITE, analysis of BRC data is being directed in particular towards linking species data with other environmental datasets, such as climate, soils, land use, and habitat potential and availability. Such analyses are still at an early stage and are particularly concerned with modelling the possible consequences of climate changes. Other analyses are looking at patterns of species richness and the

ranges of individual species and habitat-associated assemblages of species. One particular area of interest is the distribution of butterflies, where there are opportunities of linking data from the national recording scheme with those from the butterfly monitoring scheme.

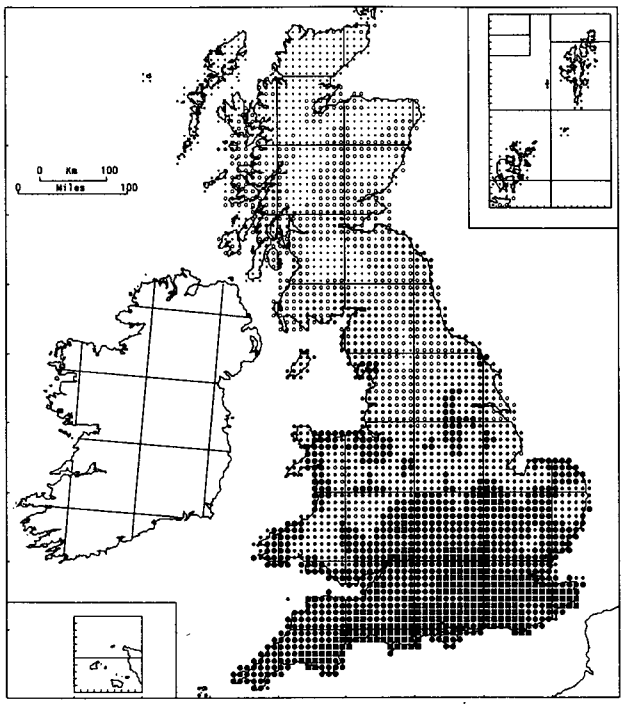
Conservation and evaluation

The requirements for data from biological recording in wildlife conservation and in site evaluation have many points in common. In particular, localised information from site surveys needs to be put in a national context – for example, to assess the rarity or the degree to which a species is threatened. The national distribution of species is used by NCC as an essential measure of the conservation value of individual species and of assemblages (NCC 1989), but the range of taxonomic groups used in the SSSI selection criteria is limited to those for which comprehensive distribution information was in the public domain. The categorisation by NCC's Invertebrate Site Register (ISR) of invertebrate species as nationally rare or scarce (Ball 1986) has been based on information collated independently of BRC, although for some groups data at BRC were incorporated in the ISR.

Knowledge of the distribution of species provides a basis for assessing the status of species and, with the on-going surveys of national recording schemes, changes in status can be assessed over time. The data from such schemes provide a basis for future surveys and for monitoring (Rich 1992; Harding 1990b). Several recording schemes have moved on from what was an initial mapping-orientated phase to collect more detailed information on numbers of individuals and evidence of breeding; such information is essential for mobile species such as butterflies and dragonflies.

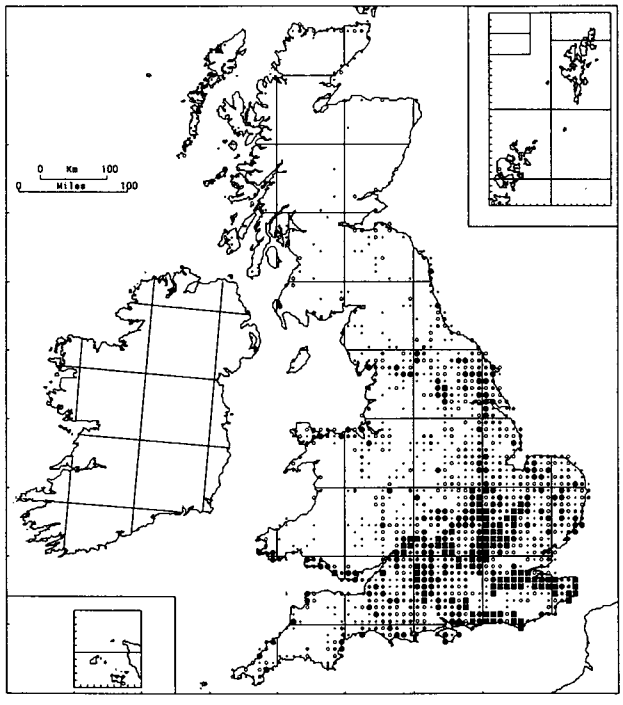
Site-relatable information in the database can be interrogated so that inventories of species occurring at sites can be compiled. The main difficulty with such an exercise is in defining the site itself for data retrieval. Geographical information systems allow the boundaries of sites to be held in digitised form and permit BRC records, referenced by geographical co-ordinates, to be related precisely to sites such as nature reserves and SSSIs. Trials in this procedure will be undertaken in collaboration with NCC in the near future.

The aggregation of information on species enables estimates of species richness to be made, at the level of individual sites, as a national overview for a taxonomic group (Figure 3) and as a national overview for a habitat assemblage (Figure 4). The selection of species can be varied to provide characteristic assemblages of species from a wide selection of taxonomic groups, eg the plants, birds and butterflies of wet heaths and moorland, or of ancient woodlands. The analysis of BRC data in these ways has only recently begun and has yet to be published.



■ 36+ species
● 24–35 species
• 15–23 species
o 9–14 species
· 1–8 species

Figure 3. Species richness map for butterflies in Britain. Data have been 'smoothed' over 30 x 30 km to reduce the patchiness caused by local variation in recorder effort



■ 5+ species
● 4 species
• 3 species
o 2 species
· 1 species

Figure 4. Biotope assemblage mapping – calcareous grassland molluscs. A map of the recorded coincident occurrence (at 10 km square level) of a suite of species characteristic of calcareous grasslands

Published *Atlases* of distribution maps (see Harding 1989) provide a first line of reference for those concerned with site evaluation and with site and species conservation. Early BRC *Atlases* were merely collections of maps, with little or no commentary (eg Perring & Walters 1962; Heath 1970, 1978), but recent *Atlases* have provided detailed information on the habitats of species, on ecology and behaviour, and even on characteristic habitat assemblages (eg Heath *et al.* 1984; Harding & Sutton 1985; Hill *et al.* 1991).

Conservation policy is directed towards the preservation and management of semi-natural biotopes and their species assemblages. The extent to which such areas (SSSIs and nature reserves) already contain, and can continue to support, a representative suite of the species occurring in Britain is uncertain. NCC's SSSI selection criteria (NCC 1989) advocate the selection of sites based on factors such as the occurrence of nationally scarce or threatened species of a few taxonomic groups (vascular plants, vertebrates, butterflies, dragonflies and molluscs). Biological recording, using a large volunteer labour force, could be directed towards improving knowledge of these selected sites, but concentration of effort in such areas is unlikely to detect dynamic changes in the wider occurrence of species. Local changes, especially loss of species, are noticed and may be reported at a local level, but it is only when local information from the wider countryside, as well as from protected sites, is aggregated at a national level that the overall situation can be assessed. In this way, awareness of the serious decline in woodland fritillary butterflies was brought into stark perspective by the *Atlas* (Heath *et al.* 1984).

In these times of rapid environmental changes, particularly in land use and pollution, and, of course, the predicted changes in climate, there is an ever more pressing need to continue to update information on the occurrence of species and to enlarge the range of species covered in the national database at BRC. Only with comprehensive and up-to-date information on the occurrence of species in the wider countryside will conservation policy-makers be able to assess the effectiveness of past policies and to develop new policies for changing circumstances.

It is encouraging to note that NCC has recently taken an initial step in this direction by placing staff at BRC to collate information on 320 species of scarce vascular plants so that the status of these species can be assessed in relation to conservation priorities, such as inclusion in a revised *Red Data Book*.

CONCLUSIONS

From the original idea, developed some 40 years ago, to utilise volunteer specialists for collecting field information on the occurrence of species and to publish the results as species distribution maps, the Biological Records Centre has developed into a unique and unrivalled database on the occurrence of

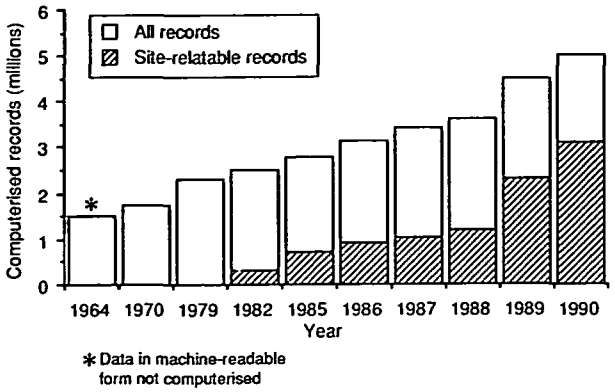


Figure 5. Biological Records Centre – growth of the computerised database

species in the British Isles. With its current data holdings of over 5 million records of more than 9000 species (Figure 5), and with on-going surveys covering some 16 000 species, BRC is a formidable data gathering and storage unit. The principles on which BRC has worked for 25 years have been a model for similar data centres elsewhere in Europe and in other continents.

The symbiotic relationship between professionals and amateurs which characterises the work of BRC is certainly unique within NERC and places the Council in the privileged position of collating data, through a spontaneous 'community programme', which can then be applied by the Council to its own research programmes and also be utilised in a variety of practical applications, such as nature conservation and environmental evaluation and monitoring.

It is almost certain that the existence of BRC, and the national recording schemes which it operates, have helped to fuel taxonomic research and ecological surveys by providing a focus for effort, by encouraging studies and the recruitment and training of new experts, and by providing a new realm of literature in the form of newsletters, *Atlases* and related publications. The milieu in which BRC operates extends far beyond its parent research council and NCC to include museums, national and local learned and natural history societies and specialist study groups, tertiary educational establishments, publishers, international agencies, and many more.

BRC has always had to walk the tightrope between the realities of its funding and resources, and the sometimes unrealistic, but not unreasonable, expectations of its volunteers. The precariousness of this balancing act has become increasingly acute in recent years as more schemes are reaching a stage when their data need to be processed, but when the resources available to BRC are, at best, static. Justifying the continuation of BRC in terms of the uses to which its data are put is essential, as is the ability to earn funding from commissions to supplement the steadily declining direct funding provided to NERC by the Government. It is no longer practical to consider BRC as part of 'the scientific equipment of the country' as was envisaged by Clapham and Godwin – a situation which will be familiar to anyone who has

followed the recent fortunes of our national museums.

The application of the database has come to the fore in recent years – to provide material for research publications, to provide site information for nature conservation and, of course, to provide new and updated information on species distributions to a wide variety of users, including the volunteers. Within ITE's new Environmental Information Centre, BRC will have a key role in providing spatially referenced data on species and assemblages. Although the requirements of the four bodies which succeeded the Nature Conservancy Council in April 1991 are as yet not clearly defined, it is to be expected that BRC will have a role in contributing to their information resources. General environmental awareness and statutory requirements for environmental assessments in relation to major development proposals are already leading to an increasing demand for information from BRC.

The challenge for the future will be to strike a balance between utilising the existing information, and acquiring new information to update and enlarge the database. New computer-based technologies must be exploited to the full so that the scarce resources of manpower can be used to best effect. In reviewing the last 25 years of BRC, we have been struck by the very real influences of technological advances, political decisions, and personalities on the work of the Centre. There is no reason to believe that subsequent years will not experience similar influences!

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