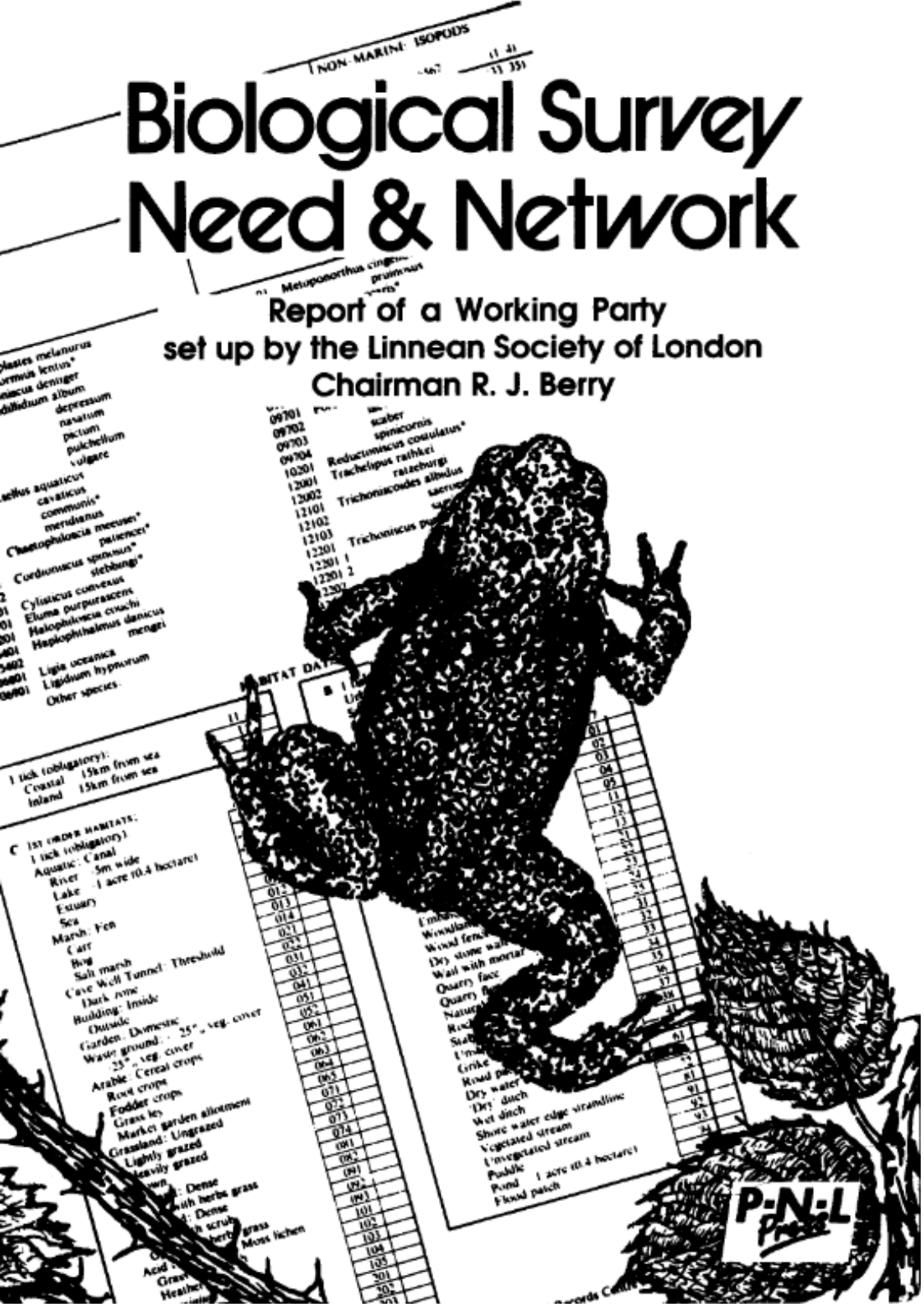
Biological Survey Need & Network

Report of a Working Party set up by the Linnean Society of London

Chairman R. J. Berry



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Introduction

THIS DOCUMENT is the result of concern about the state and lack of co-ordination of biological recording in the British Isles, expressed at two open meetings (at Leicester, 13-14 September 1984, organized by the Biological Curators' Group, and a follow-up in London, 7-18 April 1985) which led to the formation of a National Federation for Biological Recording and a request to the Linnean Society for a comprehensive review of biological recording (Appendix I

). The Linnean Society set up a Working Party (see Appendix II

) to inquire into the subject and make recommendations to the Council of the Society. The Working Party met on eight occasions, and its Report is attached herewith.

R.J. BERRY
Chairman

1. Nature and Aims of Biological Survey

1.1 BIOLOGICAL SURVEYS OF MANY TYPES are carried out in the UK. Most are undertaken for specific purposes, for example:

i. *Strategic:* i.e. use by others than the recorders, for conservation management or surveillance (including work by the conservation trusts and local natural history societies, by the Nature Conservancy Council in pursuit of its statutory responsibilities such as the identification of sites of special scientific interest), for planning (including land-use and environmental impact assessments), for water quality monitoring and for assessment of pest status.

ii. *Scientific (or fundamental):* identification of trends (including extinctions), fluctuations and successions in both individual species and communities. In addition to work in universities, research establishments and so on, this includes national censuses organized by scientific societies, mostly coordinated by the national Biological Records Centre (BRC) at Monks Wood (the most important exception being the ornithological data collected under the auspices of the British Trust for Ornithology). Also local surveys organized by conservation trusts or local natural history societies: some of these data may be sent to the BRC, but most are held in local or regional records centres (Appendix III).

iii. *'Aesthetic' reasons,* that is recording for its own sake. This is a motive (and potential resource) which should not be ignored. The strength of its influence is demonstrated by the hundreds of 'twitchers' who will travel long distances to record a rare bird, or the large numbers of members that natural history societies often attract to field meetings (Berry, 1988).

iv. *Education:* where a species or community is to be found when it is wanted for project work, class observation, etc.

1.2 Biological surveys result in the production of records. A biological record should incorporate four elements: a *species* or *habitat* identified by a person at a *location* at some point in *time.* The value of a record is likely to be enhanced by the inclusion of additional detail, such as age or density, or environmental (eg. climatic or edaphic) or historical information. Notwithstanding, historical species records lacking some of the basic information (for example, date and/or site) may still be useful.

i. All four elements require validation. The commonest source of error is probable in taxonomic identification. The recorder may not be a competent taxonomist, and his/her identification may require confirmation by an expert or by comparison with a voucher specimen. The responsibility for accepting the validity of a record must lie with the person who stores the primary data (or an agent appointed by that person).

ii. There is no distinction in principle between 'species' and 'site' recording; any apparent differences arise through the way(s) in which the basic records are used. However, in practice, data tend to be stored and retrieved in such a way as to produce a separation between 'species' and 'site' information.

1.3 The usefulness of biological records is not confined to the collectors of the data, nor to the purpose for which they were originally collected. To maximize the availability of data to all who might want them a number of 'biological record centres' act as clearing houses for data, each centre covering a particular county or region. The centres collect, collate and store biological records together with any preserved, printed or manuscript materials supporting them, from whatever source. They must be responsible for controlling the quality of the data collected, and they may also have the function of co-ordinating those making the observations in time, space and methodology so that the data collected are scientifically meaningful. In particular, they have a vital role to play in implementing, wherever practical, standard methodologies designed either for data-gathering, storage or dissemination, and which have been approved by an appropriate authority (e.g. the national Biological Records Centre or one of the learned societies). In carrying this out they will be contributing very significantly to the evolution of an integrated biological recording scheme.

1.4 Data collated in this way can be used for:

i. Preparation of local and national floras and faunas as guides to the biological diversity of an area or county including, wherever possible, the habitats in which the species occur, and associated species.
ii. Preparation of local and national distribution maps and their publication as atlases as a basis for biogeographical analysis.
iii. Identification and assessment of sites containing habitats of interest, for integration into strategic planning, for SSSI or other designation, or for purchase and/or management as protected areas.
iv. The identification and assessment of the status of rare or threatened taxa as the basis for determining conservation priorities locally, nationally and internationally. This information can be disseminated, with accompanying proposals, to those individuals, organizations and government departments in a position to make best use of it.
v. Monitoring changes in the distribution or population sizes of taxa or degradation of habitat to give early warning: (a) of threats to particular taxa or groups of taxa; (b) of threats to particular habitats.
vi. Plotting migration of mobile taxa such as birds and insects.
vii. Supporting taxonomic expertise.
viii. Providing information on the exact location of material exhibiting taxonomic diversity as a basis for chemical, genetic or autecological research.
ix. Providing information for historical and other research.
x. Formulating advice to Government on taxa to be included in the Schedules to the Wildlife and Countryside Act 1981, the Berne Convention and other legislation.

2. History of Biological Recording

2.1 A BRIEF LOOK AT THE HISTORICAL DEVELOPMENT of biological recording in Britain helps to understand the organizations and activities that exist today. The importance of a biological inventory has been recognised at least since the time of John Ray who wrote in 1660: "I design to put forward a compleat Phytologia Britannica". Since then amateur natural historians have contributed greatly to the knowledge of our flora and fauna (Allen, 1976).

2.2 However the first significant attempt at coordinating recording was the formation of a Central Committee for the Study of British Vegetation in 1904; this led directly to the establishment of the British Ecological Society in 1913. The Vegetation Committee was proposed by Tansley (1902) on the grounds that:

> *"Co-operation is necessary if any considerable results are to be obtained. It is much to be desired that the surveying part of the work should be taken up by active members of local natural history societies."*

He emphasised the potential:

> *"Scattered up and down the country are scores of men whose hobby is botany and whose acquaintance with their local floras is absolutely unequalled. Too often they carry with them to their graves knowledge which would be of the greatest value in helping to build up a picture of the vegetation of the country as a whole. Convince them of the interest of ecological survey work, and you would secure their co-operation in working out and mapping local floras from that point of view, which with the requisite general knowledge of methods and a certain amount of help and direction, they would do a hundred times better than a visiting botanist, with no knowledge of the locality." (Tansley, 1904).*

This remark is highly pertinent at the present time, because the under-utilization of the expertise of amateurs (largely due to the professionalisation of biology: Berry, 1983), has resulted in much survey work being done by Manpower Service Scheme teams and others on short-term contracts, with very variable results.

2.3 In 1947 the British Association Conference of Delegates of Corresponding Societies considered a proposal to produce "basic maps for the plotting, classification and correlation of natural history records". No action was taken because "maps of this type were being constructed for certain areas by the Council for the Promotion of Field Studies, and it was thought that the time was hardly appropriate for the Conference to take action until more evidence of the kind of map required was available."

In 1950 the Botanical Society of the British Isles set up a committee to map the

British flora which led to the launching of the Distribution Maps Scheme in 1954, with funding from the Nature Conservancy, and the publication of the *Atlas of the British Flora* in 1962 (see Allen, 1986: 153-58).
Despite this initiative, the indecision of the BA Conference has been repeated on many occasions. In the Foreword to the BTO *Atlas of Breeding Birds in Britain and Ireland* (1976), Ferguson-Lees recorded that

> *"For over two years, the possibility of an* Atlas of Breeding Birds *was discussed regularly .... There was a seemingly irreconcilable division of opinion between the optimists and enthusiasts on the one hand, and the pessimists and diffidents on the other, the latter believing that such a project was doomed to failure through inadequate coverage. Even the optimists said that, because of the uneven spread of observers, and their scarcity or absence in remoter areas, the best coverage that could be expected was 90% in England, 50% in Wales and a mere 25% in Scotland .... How wrong we all were."*

Some ornithologists also considered that the whole concept lacked sufficient scientific merit to justify it being undertaken at all, but in this direction the majority were agreed in regarding it as a potentially invaluable tool for conservation and of considerable importance as a permanent record, for future comparison of bird distributions at a time of great environmental change.

2.4 In 1964 the data and mapping machinery used in the preparation of the *Botanical Atlas* were transferred to Monks Wood in Huntingdonshire and formed the nucleus of the Biological Records Centre (BRC).[1] Its objectives were to set up and operate a computerised data bank of information on the occurrence of plants and animals in the British Isles; to maintain an archive of the original records from which the data bank was compiled; and to make these data available in a variety of forms, for research, monitoring, nature conservation, education and general information.

The main emphasis in the work of the BRC has been the co-ordination of over 60 national Biological Recording Schemes organised by national societies, formal study groups and individuals, to make surveys of particular groups of plants and animals. BRC's role has been to help establish the recording schemes, to provide record cards, to process and check the records and store them in the BRC data bank and archive, and to assist with the publication of the results. Mapping is carried out on a ten kilometre square basis. A series of atlases has been published, often in co-operation with national societies (Harding, 1985).

2.5 There have been many attempts to establish biological recording on a firmer footing (Greenwood, 1971). In the 1970s the then director of BRC, Dr Frank Perring encouraged the setting up of local record centres and attempted to establish a network of local centres which would be co-ordinated by BRC. In 1973

1 At that time part of the Nature Conservancy but now under the Institute of Terrestrial Ecology of NERC, with financial support by contract from the NCC.

BRC and the Department of Museum Studies of the University of Leicester organised the Leicester Conference on Environmental Record Centres which provided the opportunity for museums and other organisations to review progress in environmental recording, to exchange experience and to learn more about the requirements of the user community, particularly planners and conservationists. In arranging the conference on the eve of the reorganisation of Local Government, it was hoped that it might be possible to persuade the new local authorities to accept responsibility for biological recording during reorganization. To this end the conference passed a resolution that

> *"Environmental Record Centres should be set up and paid for by Local Authorities to cover areas based upon the existing Vice County system. They should have the same status as County Record Offices and they should be associated with them."*

Although two new centres were set up, only one (West Yorkshire) succeeded in obtaining additional finance and resources for this purpose (Lavin and Wilmore, 1977). In 1977 a meeting of record centre organisers took place at Monks Wood and in 1978 a *Handbook for Local Biological Record Centres* (Flood and Perring, 1978) was published. Overall, therefore, the conference failed in its objective.

There were parallel moves in Scotland. A conference in Dundee in 1975 led to the ongoing Biological Recording in Scotland Committee, which produces newsletters and co-ordinates recording schemes in Scotland (Somerville, 1977).

2.6 Subsequently, many local Nature Conservation Trusts with the support of the Nature Conservancy Council, World Wildlife Fund, and BP, acquired computers and began to computerise data relating to their reserves and sites of natural history interest. Many national societies embarked on new and expanded recording schemes and co-ordination between the various schemes soon became a major problem. Much of the initiative as far as local biological record centres were concerned was taken by museums and in particular by the Biology Curators' Group (BCG) in co-operation with the BRC. In 1980 BCG and BRC carried out a survey of local record centres (Harding and Greenwood, 1981; Greenwood and Harding, 1982). A new initiative in 1984 followed the recognition of the tremendous growth in resources being devoted to biological recording, due mainly to the availability of labour under the Government sponsored Manpower Services Commission.

2.7 The 1984 BCG Seminar *Biological Recording and the Use of Site Based Biological Information* (1985) confirmed the widely held view that "the present situation both nationally and locally for biological recording, storage and retrieval of data was unsatisfactory" and it drew attention to the problems arising from lack of finance, of central co-ordination and of standards. The seminar led directly to the setting up of an *ad hoc* group initiated by BRC and drawn from the Biology Curators' Group and other interested organisations, to find means of improving the situation. The group organized a *Biological Recording Forum* at Chelsea

Table l a: Longterm Freshwater Records

(modified from NERC, 1976a)

Organisation responsible	**Surveillance Scheme**	**Dates & Frequency of observations**
University of Aston, Applied Hydrobiology	Benthic invertebrates of the River Cole	Annually since 1950
New College, London, Botany Dept	Planktonic and other algae and zooplankton in Virginia Water	Weekly since 1958
University College of Wales, Cardiff, Botany Dept	Algae, bryophytes, macrophytes of certain rivers in South Wales particularly the Usk	Since 1958, at varying intervals of time
Severn Trent Water Authority	Species lists for the Bristol Avon River Authority Area and Biological Assessment of Pollution	Irregular survey 1935-71, 1950-75
South West Water Authority	Salmon in various Devon rivers	Since 1962, several censuses
Thames Water Authority	Plankton in Rivers Thames and Lee	Weekly or fortnightly since 1935
Welsh Water Authority	Salmon & Sea Trout and some other fish in South West Wales	Annually since 1952
Severn Trent Water Authority	Macro-invertebrates of the Trent	Bi-annually at c.600 sites since 1956
Severn Trent Water Authority	Freshwater fish in the Trent area	Irregularly since 1955
Wye River Authority (now Welsh National Development Water Authority)	Salmon counts on river Wye	Annually since 1903
Central Electricity Research Laboratory, Nottingham	Invertebrate communities in Lincolnshire	Species lists and numbers for 10 years (1960-69)
Field Studies Council	Brown trout and perch in Malham Tarn. Other taxa irregularly.	Angling returns for 25 years since 1947.
Freshwater Biological Association River Laboratory	Fish in River Rome, East Stoke	Since 1964
FBA Windermere	Physical, chemical and biological data on the Cumbrian lakes	Since 1930 or earlier
Ministry of Agriculture, Fisheries and Food	Salmon and Sea-trout. Continuing census of ascending and descending fish on the River Axe, Devon	Since 1960
Department of Agriculture and Fisheries for Scotland	Salmon 1) sample counts on all ascending and descending fish and population estimates of young fish in Girnock Burn, Aberdeenshire	Since 1966
	2) sample counts of all ascending and descending fish in North Esk, Angus	Since 1962
	3) sample counts of ascending and descending fish in River Meig, Ross-shire	Since 1957

College in London in April 1985 (Copp and Harding, 1985) attended by more than 100 people drawn from all sections of the biological recording community. At the Forum it was agreed to set up a formally constituted National Federation for Biological Recording which came into being at Cambridge in April 1986 at a seminar *Biological Recording in a Changing Landscape* **(Harding and Roberts,** 1986).

2.8 Recently, several attempts have been made to record habitat change through remote sensing. Of these the joint DoE/CC commissioned study by Huntings, `Monitoring Landscape Change', the NCC 'National Countryside Monitoring Scheme' (jointly funded by CC Scotland in Scotland) and the ITE study 'Landscape Changes in Britain' are probably the most significant. Each of these schemes has the aim of recording the extent and direction of landscape and habitat change but the methods employed differ. The principal sources of information in these studies have been aerial reconnaissance photography coupled with ground surveys. All three systems have relied on sampling, the NCMS based on samples of about 10%, DoE/CC on about 5%, while ITE use detailed surveys of 1 km x 1 km representative squares. The time scale of the two aerial photography studies was over several decades (1940s to 1970s/80s) but the ITE study covered a shorter time interval (1978-1984).

At the present level of sophistication of these remote sensing surveys it is not possible to identify the ecological quality of habitats (for example, the species-richness of meadows). Such work does, however, provide evidence of the habitats which are under threat and hence the sorts of communities or populations which are likely to be at risk. Future developments in the precision of remote sensing may increase the value for species or site monitoring. Ground surveys are able to provide better information on species-richness but demand considerable resources. As a consequence, such surveys have to be sample-based. Notwithstanding they can provide estimates of status and of change; representative sample squares provide evidence of general trends although the data are not amenable to statistical analysis unless the squares are located randomly.

A large number of habitats have been surveyed and recorded, albeit with different degrees of detail. For example, comprehensive inventories have been assembled of ancient woodlands, limestone pavements and heathlands while grasslands, peatlands, saltmarsh, shingle and coastlines have received less attention. Complete land surveys have been attempted by NCC but even at the lowest level which identifies only the broadest categories of habitat, the extent of coverage is uneven and very incomplete. It does, however, enable sites of potential interest to be identified and acts as a coarse net. The resources required for this sort **of** study are enormous and increase considerably as greater detail is required to determine the actual status of a site.

2.9 A NERC Working Party on 'Biological Surveillance' (1976a) identified a series of long-term schemes with value for detecting biological changes (Table 1). We have not attempted to revise this list, and there are many 'hidden' sets of data

Table 1 b: Longterm Terrestrial Records & National Surveys

(modified from NERC, 1976a)

Organisation Responsible	Scheme or Survey	Dates, frequency and nature of observations
Botanical Society of the British Isles	Atlas of the British Flora	Baseline Survey 1954-60. Rare species surveyed every 5 years, common species every 50 years.
British Lichen Society	Lichen mapping scheme	Mapping on 10km basis Started in 1965
British Bryological Society	Mapping scheme for mosses and liverworts	Mapping on 10km basis Started in 1965. 200 species maps completed
Forestry Commission	Censuses of forest and woodland	1924; 1947/9; 1965/67
	Censuses of hedgerow and park trees	1953
	Permanent forest plots	Started in 1913 (now number 1200). Recording growth and other data.
Forestry Commission and MAFF Pest Infestation Control Laboratory	National surveys of red and grey squirrel distribution	Eight censuses between 1930 and 1971
Nature Conservancy Council (contract with University of Lancaster)	National vegetation classification	Longterm programme started 1975 to catalogue vegetation types in Great Britain
British Trust for Ornithology and Irish Wild Bird Conservancy	Atlas of Breeding Birds	Species distribution mapping over 5 years. Atlas to be published in 1976. Resurvey planned in about 20 years.
British Trust for Ornithology	Common birds census	Annual census of 50 common species since 1965
	Nest records scheme; Bird ringing scheme	Started in 1959
	Census of individual species - heron, fulmar, great crested grebe, peregrine and black-headed gull	Carried out and repeated at various times since 1929
		Garden birds feeding survey
BTO in co-operation with Wildfowl Trust and RSPB	Birds of estuaries surveys	Monthly counts of waterfowl on major estuaries 1970-75
Royal Society for the Protection of Birds	Censuses - osprey, golden eagle,	Annually, osprey since 1954, golden eagle since 1971
	Red-throated diver, black-throated diver,	Since 1971
	Slavonian grebe	Since 1971
RSPB and Seabird Group	National seabird census (Operation Seafarer)	1969-70
	Beached birds survey	Since 1968, monthly records during winter months September - March. Occasional summer records
Wildfowl Trust	Wildfowl censuses:	Since 1949 month* counts
	1) Duck counts	September - March at 500 sites in Great Britain. Monthly counts of waterfowl on major estuaries 1970-75
	2) Goose census	Annually for several species
	International waterfowl census	Annually since 1971
	Wildfowl ringing	Started in 1950'
Institute of Terrestrial Ecology (NCC contract)	Organochlorine and PCB residues in birds and mammals	Started in 1964 for sparrowhawk but earlier eggshell samples have been obtained. Sample sites throughout Britain
Rothamsted Experimental Station	Rothamsted Insect Survey Phenological Survey	Daily sampling of moths since 1960, at 174 sites, aphids since 1964 at 20 sites
Royal Meteorological Society	Phenological Survey	Repoits cover period 1875-1948

which could give important information on change of stability'. For example, Rose and Hawksworth (1981) used published records of lichen occurrence in the London area from the early seventeenth century onwards to compare with a survey they carried out in the 1970s on the effect of the Clean Air Act. However, we call attention to the need for a register of long-term data sets and an assessment of the effort needed to maintain them.

2.10 The accumulation of data with geographical links led the Department of the Environment to set up in 1985 a Committee of Enquiry into the handling of geographic information (Chorley, 1987). This committee recommended a much more rapid digitisation of Ordnance Survey maps so that environmental (and biological) data could be more easily and conveniently related geographically, and that a Centre for Geographic Information be established "to provide a focus and forum for common interest groups in the geographical information area, undertake promotional activities and review progress and submit proposals for developing national policy".

2.11 International Perspective. Because the history of biological recording outside the UK has, in general, been comparatively recent, the complex situation in this country, as described above, tends to be rather specific to the UK. The sheer number of amateur naturalists involved in biological recording in the UK has perhaps been one of the main reasons why the need for a more co-ordinated biological recording system has emerged. This does not mean, however, that no other countries are yet experiencing the same difficulties as ourselves. In the USA, for example, Morse and Henifin (1981) report that:

> *"Although there is currently considerable ad hoc and informal information exchange in plant systematics and plant conservation, the lack of a well-defined and well-organized plant information network of national scope has contributed to the increase in several problem areas in current floristics and plant conservation work... Without centralized review and co-ordination, it is difficult to set priorities for information needs... National co-ordination could increase continuity and decrease duplication between ongoing state and national programs."*

Similar problems are now occurring in many other countries. The IUCN's Conservation Monitoring Centre maintains a database on the world's threatened fauna and flora, and is increasingly approached for advice on biological database design and methodologies to facilitate data exchange not just to meet local needs but to meet international needs as well. This has stimulated the IUCN to explore ways forward, often with other organizations such as the Taxonomic Databases Working Group (a consortium representing the world's major herbaria; SCOPE; UNESCO; the Centre for Plant Conservation (based at the Arnold Arboretum, USA); CORINE (part of the EEC Environmental Programme) and the Council of Europe's Division on the Environment and Natural Resources). There is a recommendation prepared for the Committee of Ministers of the Council for Europe to extend these activities (Appendix IV

).

There is tremendous scope for much closer liaison to be established between UK organisations and relevant international bodies, to tackle the difficulties of creating a co-ordinated system for national biological recording. The UK must be prepared to look beyond its own frontiers for additional advice and experience in this field.

2.12 One fruitful development has been a recognition of the importance of various International Transfer Formats[1] (ITF), and a number of organizations are collaborating in identifying and defining these.

Rather than attempt to design one all-purpose ITF to serve the data exchange needs of all biological databases, and which would probably be impossible to design because of its complexity, a set of International Transfer Formats have begun to be prepared to help meet the needs of selected biological databases which share common objectives. The work, so far, has concentrated largely upon botanical databases and, in the case of IUCN, those associated with conservation and botanic gardens.

1 Mackinder and Synge (1986) give the rationale for this: "It is absurd to try to standardize hardware - the market is far too volatile for that. It is also a mistake to try to standardize software as this limits the choice of hardware. In most cases, we do not believe it is wise to standardize internal data formats, the way the information is stored by the computer, as this in turn depends closely on the software. We are convinced that the point of standardization should be data transfer formats. This is the format used in which one organization transfers data to another on tape or diskette or down the telephone line. Internal codes would be expanded into their full form, thus removing the need for standard sets of codes on items like genera, plant families and so on. This then removes the need for international agreement on codes for these items, agreement that in the past has proved impractical to achieve."

3. Users of Biological Records

3.1 BIOLOGICAL RECORDS ARE CONSULTED by a very wide range of groups. Several of these require biological information in order to carry out their functions. For example:

i. The Nature Conservancy Council needs data on sites and species to carry out its responsibilities for nature conservation in Great Britain.

ii. Local planning authorities need site and species data in sufficient detail to cover all sites of significant, actual or potential nature conservation value within their area, so that appropriate policies can be included in Local Plans and so that environmental needs can be taken into account in planning decisions. These require for each site: area, habitat(s) present and their state, dominant and rare species. Knowledge of the abundance and distribution of species is also needed.

iii. International agencies such is the IUCN Conservation Monitoring Centre (based in the UK) also need at intervals quite detailed data on the status of individual taxa at national level in order to meet one of its obligations: to provide an overview on the status of fauna and flora worldwide. Since it is not realistic for the IUCN-CMC to gather this raw data itself, its dependence upon national records is very considerable indeed. Without such data, IUCN would be unable to ensure that the international priorities it recognizes are sufficiently accurate, and this in turn, would affect the effectiveness of the long-term conservation strategies it has an obligation to design and implement.

iv. Voluntary bodies need data on which to base their strategies. For example, local conservation trusts need to choose sites which they will seek to protect, either by purchase or lease, or by other means. They can only do this if they have access to sufficient data to allow sites to be compared.

v. Utilities (e.g. CEGB) and commercial concerns need data to assess, and minimise, the impact of their activities on the natural environment. For example, BP used detailed environmental data when proposing and planning oil extraction activities in the New Forest.

vi. Water authorities need data to carry out their statutory responsibility to 'further conservation', and also, when damage is caused by consented discharges, data are required on the status of flora and fauna immediately prior to the discharges. The Control of Pollution Act, 1974 requires water authorities to restore the biota to this state.

vii. The Forestry Commission require data to 'further conservation' under their statutory obligations.

The need for data is likely to increase with the increasing demand for environmental impact statements, and with increasing public awareness of environmental and conservation issues.

3.2 The obligations of Local Authorities are made explicit in the Department of Environment Circular 108/77, which requires that they lake full account of natural resource conservation in formulating structure and local plans, in considering individual planning applications, in managing their own estates, and in devising schemes for their own developments."

Briefly, the duties (excluding education) of Local Authorities (LAs) in the UK which imply a need for biological data are:

Strategic planning: preparation of plans covering areas of a few km^2 to a few hundred km^2. Such plans, which are revised periodically (every 5 or 10 years) establish the context for future planning decisions and guide development by identifying what development will be permitted in each area;

Development control: granting (or refusing) permission to change the use of land, such as undertaking building development, mineral extraction, etc.;

Direct land management: Local Authorities have considerable land holdings with actual or potential nature conservation value;

Power to designate Local Nature Reserves.

LAs have a very considerable influence on use and management of land through these powers. Although LAs can only rarely influence farming practices, they are a primary influence on other major land uses and changes thereof, such as building, transport, quarrying, etc. Through their preparation of local plans they have the opportunity to safeguard sites from changes in land use by recognizing sites of wildlife value and stating that there will be a presumption in favour of protecting such sites. Policy statements on nature conservation and lists and maps of sites are now frequent components of local plans.

3.3 In order to plan effectively for nature conservation, LAs need to be able to answer the following questions:

What is the total available 'resource': how much of each habitat type exists within their area, which species are to be found in the area and how common and widespread is each?

Which are the important sites for nature conservation in local, regional and national contexts?

How important is Site X in relation to others (locally, regionally, nationally)? Which features of Site X are of particular importance?

Are there areas where there is little wildlife habitat and so where habitat creation is needed?

To answer these questions at least the following information is needed:

Maps showing location and extent of wildlife habitat, with quantitative estimates of area covered by each habitat;

Sufficient data about sites to enable them to be compared. This requires knowledge of what habitats occur on each site and their quality, and at least some species information (dominants, rare species, etc.);

Distribution and abundance of species, to allow comparison of sites and protection of rare species.

3.4 A number of local authorities have appointed ecologists, usually as members of the planning department, and collect their own data. The most ambitious of these developments was the Ecology Unit of the Greater London Council; after the abolition of the GLC, this became the Greater London Ecology Unit, supported by 23 of the 33 individual London boroughs. Duties of the Unit include provision of strategic and site-specific advice on matters relating to ecology and nature conservation (Greater London Council, 1984)

3.5 The Nature Conservancy Council recognize a need within their own organisation for three major elements of information:

the distribution, abundance and quality of habitats and the status of species;

the functional aspects of ecology and the nature of the processes which affect the distribution, abundance and quality of habitats, features and species;

and

the significance of site management procedures for maintenance enhancement of the quality of sites.

4. Technical Problems

4.1 THE ABSENCE OF NATIONAL CO-ORDINATION of biological recording has led to the setting up of surveys and the establishment of records centres with a wide variety of objectives, capabilities and uses. The main criticism of these efforts must be that there is no unified approach to problems of common concern. A plethora of recording formats exists and standards for the acceptance and control of data vary greatly. Surveys (for example by NCC, County Trusts, local authority ecologists or water authorities) are usually conducted for one specific end product - a site evaluation report, as assessment of biotic quality, or to document the occurrence of selected taxa or habitats. Records centres range from those which have some permanence (for example at Leicester) which are computerised and draw in data from a wide variety of sources, to those which were established with temporary MSC funding or by volunteers and which have few recent data and little means of validating them.

4.2 The incompleteness of data sets is often seen as a problem, particularly in mapping the distribution of species. However, perfection is rarely obtainable and too few judgements (particularly in site evaluation and nature conservation) are based on comprehensive, up-to-date knowledge. Common approaches to sampling methodologies and the selection of 'indicator' or 'key' taxa could reduce the apparent subjectiveness of many biological records. Agreed approaches to the problems of the confidentiality of records, and the security of records deposited in data archives, also need to be established.

4.3 One fundamental problem that cannot be easily resolved is that of taxonomic expertise. 'Popular' groups such as birds, mammals, butterflies and flowering plants all have several thousand individuals nationally who are able to identify them reliably, but other ecologically important groups, such as water beetles, solitary and social bees, or mosses, probably number their taxonomic devotees in tens or low hundreds. A very high percentage of all the data regarded as 'biological records' originate with a small number of mainly volunteer specialists. This applies equally to records centres and to organisations such as NCC. Specially commissioned surveys by professionals are often small scale, limited in their coverage (geographically and/or taxonomically) and the resultant data are usually not readily available to anyone other than the primary user.

4.4 The extent to which biological recording can be extended and improved is heavily dependent on the continued recruitment of taxonomic expertise, most of it as volunteers. Records centres and county trusts play a particularly important role here because they are foci for the providing of new expertise.

4.5 These problems are by no means limited to the UK. Any country undertaking biological recording faces the same situation. Even if a single recording scheme can be adopted successfully on a national level, the need for compatibility at an international level may still exist. In an attempt to address this issue IUCN's Conservation Monitoring Centre has recently begun to examine the feasibility of designing and proposing standard international methodologies to cover selected aspects of biological recording, and so facilitate data exchange (e.g. the 'Plant Existence Categorisation Scheme' 1986[1]) Close collaboration needs to be maintained between national record centres and international developments of this kind if such standard methodologies are to become useful tools. For a fuller discussion of technical problems see Appendix V.

1 Designed by the IUCN-CMC Threatened Plant Unit in collaboration with the Legume database ILDIS and an UNESCO/Smithsonian Institution project on protected area inventory databases. This scheme presents an outline for recording the relationship between a plant and a place, describing its Origin, Certainty of Occurrence, Endemism and IUCN Conservation status.

5. The Current Situation

5.1 THERE IS A CLEAR NEED FOR INFORMATION about the distribution and importance of species and habitats (Section 3). Harding and Greenwood (1981) list 60 local or regional biological records centres covering much of the country (updated list given as Appendix III), so it might be considered that this need is effectively met. However, there are two major problems:

(i) There are no data on habitat distribution and frequency for the British Isles as a whole, although there are various sets of data which contribute towards a full UK pattern. [1]

(ii) There is much duplication and misdirection of effort in biological recording at the moment, together with considerable variation, inadequacy and incompleteness in the data that are available. This is the result of shortage of resources, the number of individuals or organizations involved and the lack of any authoritative co-ordinating authority.

5.2 The requirement for a national recording framework has already been noted (Section 2.6). The success of the County (or Regional) Conservation Trust movement, encouraged by the provision of Comart computers has contributed towards such a framework, but the scheme of an agreement between local centres feeding into the national centre at Monk's Wood has never been implemented. Copp (1984) suggests three reasons for this:

(i) Despite the absence of assured funding, some centres have flourished, especially those adopted by Local Authorities or under joint Authority and Conservation Trust auspices. Notwithstanding, few are fulfilling all the roles expected of them (Appendix VI). There has been a major upsurge in activity due to Manpower Service Commission money, but that support is now being reduced. More seriously, many centres depend on the devoted energies of single individuals. Loss of continuity is a major threat to a centre's credibility

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1 Notably the distribution of species in the major taxonomic groups, summarized for publication on a rather coarse (10 km^2) basis nationally, and in finer detail (e.g. 2 km^2) within a county; lists of actual and proposed nature reserves held by the NCC; the National Vegetation Classification, due for completion in the near future (Piggott, 1984; Malloch, 1985); and a land classification devised by the Institute of Terrestrial Ecology (Bunce and Heal, 1984). Estimation of the total quantities and distribution of major habitats have been made in a survey commissioned by DoE/CC and published under the title *Monitoring Landscape Change.* These studies also attempt to assess recent changes in the extent of habitats. More detailed studies of changes in habitats as a result of post-war developments in agricultural practices are being conducted by NCC in England and Wales, and with support from the Countryside Commission for Scotland in Scotland.

and damaging to any activities based on the centre. Even the big metropolitan-based databanks are not safe from local government changes which could affect their financing.

(ii) The national Biological Records Centre (BRC) at Monks Wood has changed its emphasis from distribution mapping towards detailed site records (Harding and Greene, 1984). However, most of the data from comprehensive site surveys are not submitted to the BRC. It is not uncommon to find that local conservation trusts, museum record centres and planning departments have all had field survey teams covering the same area, which may also have been visited by NCC or even National Trust surveyors; each of these groups may set up a quasi-record centre fulfilling its own needs.

iii) The BRC was based on national recording schemes and, being created before many of the local centres, made no provision for automatic feeding of records to or from these centres.

In essence, there is no national records depository. The Rural Archives DataBase at the University of Essex aspires to such a role, but has not the capacity to interpret or correlate raw data. For national data on the biogeography of particular species, BRC is unique, but for most purposes, biological records are needed at the local or regional level. But there is therefore a requirement for records to be fed from national to local centres (and *vice versa),* or used at a centre distant from the one where the raw data are held. NCC, in addition to supporting BRC in order to meet its own requirements for species data, has also developed databases related to sites, in particular SSSIs, as well as specialized databases on habitats and taxonomic groups such as rare plants and invertebrates. It is pertinent to note that in a complementary field to biological recording, the Chorley Committee recommended establishing a national Centre for Geographic Information (Section 2.8). In addition, there is in existence a scheme (albeit much simpler) for co-ordinating Geological Records Centres (Cooper, 1980).

5.3 Biological recording has usually been regarded as a low-cost activity, although contractors have been prepared to pay quite large sums for data (for example, the London Wildlife Survey cost c. £160,000 (Section 3.4); the NCC contracted about £767,000 of survey work to outsiders in 1986-87 - this compares with in-house survey work of £820,000 in the same period out of a total of £2.3 million commissioned research). The need for - and hence the value of - biological data will grow with the pace of land-use changes already referred to, and also the implementation of the European Community's directive on Environmental Impact Assessment, due to come into effect shortly. However, there is a major problem with what can be called the economics of information:

i. Information cannot be measured in quantitative units so we have an immediate problem of talking about the 'amount' of information.

ii. Information tends to be what economists call a 'public good': if I use the information it is no less available to you. Nor is it easy for me to prevent you having the information in a world of photocopiers, open access, etc. This

public good aspect does have one major implication. Without going into the economic theory, public good type products tend to be undersupplied in markets. Thus, if we simply let the amount of information be determined by what users are willing to pay for it, they will bring forth an 'under supply'. This is usually (though not universally) regarded as the justification for the public provision of information, or some measure of public support.

iii. Information may not be immediately useful, but if it is not collected, the value of future information may be lessened. Thus, we might measure a species abundance in one year but have no idea how its incidence and abundance has changed compared to previous years. If environmental recording (i.e. information relating to land use, topography, micro-climate, etc.) is limited in a similar way, we may have no idea how any changes are correlated with land-use change, and so on. This uncertainty about future demand gives rise to what economists call an 'option value', a value of information which reduces future uncertainty. Here again, option value is a definite part of total economic value, but markets will generally not reflect that value. Markets will therefore undersupply the amount of information.

5.4 How do the costs and benefits compare? We are unable to compare them in any detailed way (as could be done if a fully fledged cost-benefit study were to be carried out), but the very process of revealing the costs and listing the benefits, quantified where possible, would be highly instructive. There are currently many uncertainties. For example, data deposited, with a local record centre or with BRC, may be sought by individuals or organizations willing to pay for information in either its basic form or with an interpretation involving comparison or judgments relating to species or sites; data collected by volunteers and deposited in 'public' data banks may be in the public domain so that their sale is not possible. Interpretation of data could be charged for, but that charge brings its own legal implications. Suggestions have been made that biological records may be subject to copyright, probably on the identification part of the record. There is a mesh of legal queries which need to be resolved.

5.5 No organization or individual has right of access to data held by other organizations or individuals unless those data are deposited in the public domain (e.g. museums, libraries and national archives) or have been commissioned. In theory this means that BRC works on an untenable premise because it obtains most of its records from voluntary sources. Similarly afflicted are all other organizations which do not rely solely on in-house or commissioned data collections, e.g. NCC Invertebrate Site Register, many local records centres, national and local biological societies and probably local Nature Conservation Trusts. The Chorley Committee recommended for geographical data that

> *"unaggregated spatial data held by Government Departments should be made available to other uses provided that the costs of doing so are borne by the users and that there are no overriding security, privacy or commercial considerations" (Chorley,* 1987).

5.6 Many of the findings of this Working Group coincide closely with needs identified by the NCC in its strategy document *Nature Conservation in Great Britain* (NCC, 1984). In this document the NCC has recognized the following problems:

> *"survey knowledge of wildlife resources is still patchy and inadequate overall, despite increased effort in recent years, and this shortcoming limits the urgent SSSI renotification programme; slowness in establishing computerised conservation databases must be accounted a failure within the conservation movement as a whole, but of NCC in particular".*

The strategy also identified as future objectives:

- to set up a monitoring system to detect and measure changes in SSSIs, but which will also extend to the wider countryside;
- to develop a monitoring programme to measure changes to wildlife and physical features in the wider environment;
- to expand survey and monitoring through voluntary assistance along established lines, e.g. special mapping and site recording, with scheme organisers;
- to urge government to accept recording of wildlife and human impacts as part of national environment resource stock-taking (cf. geological and soil surveys and climatological recording);
- to make the best use of existing information, the conservation bodies should analyse their technical data needs and develop appropriate retrieval systems; expertise on computing hardware and software should be shared and data pooled as far as possible.

The Working Party's recommendations reinforce the NCC's own conclusions.

5.7 We estimate that a coordinated national recording network could operate at less or approximately the same total cost as at present is spent on recording by a multiplicity of bodies. In other words, we believe that the proposed national network could be self-financing if it could channel the information currently commissioned from a wide variety of people. It would, however, require initial funds to set up the network.

6. Conclusions

6.1 THERE IS EVIDENCE OF A CONSIDERABLE and growing need for biological records from Planning Authorities, as well as from statutory bodies such as NCC and the Water Authorities. There is also a requirement for:

(a) surveys to identify rare and declining species and habitats; this is a statutory duty of the Nature Conservancy Council and a significant activity of Local `Authority Planning Departments;

(b) repeat surveys to detect changes in the distribution and abundance of both species and habitats; these will include routine data collections to serve as ground truth calibrations for surveillance carried out by remote sensing;

(c) detailed information on particular sites as essential input to planning decisions, both in devising local structure or strategic plans, and in evidence to development proposal enquiries;

(d) advice on the biological consequences of proposed or potential land-use changes.

6.2 It is necessary to distinguish between the collection of biological records *per se* (which requires taxonomic expertise); the acceptance (or vetting) of the records and their incorporation into a data-base; and the interpretation, correlation and dissemination of the information contained in the primary and related databases. These three activities require different skills.

6.3 We have no doubt that the best place for primary data to be received, checked and stored is in a centre local to the site of collection. A rudimentary network of record centres already exists (Harding and Greenwood, 1981), but co-ordination (and probably regulation) is required to ensure the completeness and effectiveness of this network. Records collected in national surveys should be stored in local centres, even if copies are held also in the national Biological Records Centre at Monks Wood. The organization of local records centres will vary from place to place, but it is essential that they should be overseen by trained personnel, and it is probably advantageous if they are located within or in close association with an institution such as a museum capable of curating records and providing voucher specimens. Well defined channels of communication (e.g. computer links) need to be established with the national data depository to facilitate data exchange.

6.4 An important function of national biological data is the ability to identify significant or rare situations (and, where repeated surveys are available, threatened situations). With the currently available data, this is possible for

species but rarely for habitats (unless 'indicator' species for particular habitats are available). The ITE land classification and the National Vegetation Classification provide pointers to the frequency of particular habitats (or plant associations, which approximates to the same thing), but these cannot be as precise as local surveys, nor are they able in themselves to record or warn of changes. A combination of synoptic classification (ITE, NVC, etc.) with remote sensing is probably a good way of measuring the latter, but it needs complementing with local surveys and site data.

6.5 There is no properly functioning network of biological recording. The nearest to a network is the arrangements made by national taxonomic societies (BTO, BSBI, etc.), many of them linked to the BRC at Monks Wood, to record species and in some cases, habitats) for particular species. Data are available for many key sites, particularly from NCC or local surveys, but there is no comprehensive set of information or even full catalogue of known holdings. Since a complete holding would be of considerable value at local, national and international levels for the reasons given in 6.1, we are fully convinced that benefits would come from establishing an efficient network. The possibility of co-ordination of amateur effort is well-illustrated by the sophisticated data collected by the BTO or (on a more specialized and limited scale) by such projects as the 'acid drops' scheme for measuring the acidity of rainfall (Baker, Thomson and Cape, 1986).

6.6 Such a network will require organization and control, funding, and an obligation on recording agencies to release data. Its nodes exist in the existing local biological records centres, although their capacities and taxonomic coverage vary considerably. An acute deficiency at the moment is the ability to transfer data between centres easily and routinely. If a functional network is to be established, we see no alternative to the provision of expert computing advice and possibly computing hardware to each recognized local/regional centre, and a central co-ordinating agency which will monitor and regulate the working of the network. The rudiments of this co-ordination exist at the moment in the National Federation for Biological Recording, the umbrella functions of the Royal Society for Nature Conservation, the national (and statutorily-defined) arrangements of the NCC to collect data, the national Biological Records Centre at Monks Wood, the nascent Ecological Data Unit of ITE, the Rural Archives Data Base housed at the University of Essex, the NCC/NGO liaison group on datahandling, and the activities of the Department of the Environment in its information holdings (to which should be added the interests of other national and government bodies, especially MAFF and DAFS), in addition to the IUCN Conservation Monitoring Centre, Council of Europe-EEC CORINE programme and the Taxonomic Database Working Group.

6.7 Most biological data are currently collected very cheaply. A biological recording network could be maintained relatively cheaply once it was operational. At the moment a considerable amount of the information is not easily available, and is therefore not used by those who require it. If the nation is to profit from its reservoir of recording talent and have the ability to make planning and

conservation decisions from a firm base, we believe that there must be a commitment to invest in the setting-up of an efficient network. There is urgency for this action if the way is to be prepared for the impending land-use changes in the UK as agricultural land is taken out of production (Potter, 1986). A parallel proposal for such a co-ordinated network exists in the geographical field (Chorley, 1987).

6.8 We suggest that there should be three elements to an effective biological recording system in the UK:

(a) A comprehensive and co-ordinated network of local Biological Recording Centres, which will receive, validate and store primary data.

(b) A national centre which will analyse and interpret data, presumably on a largely contract basis. This would seem to be an appropriate development for the Biological Records Centre at Monk's Wood, perhaps linked to the other interpretation and land-use units within the Institute of Terrestrial Ecology.

(c) A central data depository, preferably where biological data can be held together with environmental data sets. A possible site for this would be the Rural Areas Data Base at the University of Essex which is supported by DoE, NCC, Countryside Commission, MAFF and the Forestry Commission (among others).

6.9

a. We urge that a biological recording network be established as soon as possible. We recommend that a regulating commission be set up to include the NFBR, RSNC, NCC, ITE, IUCN-CMC and DoE to arrange for the necessary advice, hardware and training for local biological records centres, and to supervise the information flow between centres and for the national need.

b. We are conscious that the action recommended above has been hindered in the past by insufficient funding. Notwithstanding we believe that there is a clear national need for such a network and we draw attention to the recent report of the Advisory Council for Applied Research and Development on *Exploitable Areas of Science* (1986) which recognized that

"some areas of science are of potential importance not because of their relevance in terms of direct market applications, but because of other factors such as Government policy, legal constraints, public pressure, etc..."

ACARD identified the environment as one of these factors, and noted

"There is little doubt that public concern about environmental issues will increase in the next 10-20 years in the UK, rather than diminish. The scientific issues are complex, but such concerns require a reasoned scientific response to avoid the possibility of serious economic consequences and misguided solutions."

c. We do not believe that local initiative or private funding is likely to establish the national recording network that we recommend, but we are convinced

that there is a national need for such a network, and that investment to set this up would represent good value for money.

6.10 In the light of these conclusions we recommend a two-stage programme:

a. The setting up as soon as possible of a co-ordinating commission under the lead of the NCC or DoE to establish a functioning network of the existing local records centres. This will involve the provision of funds for the enhancement and development of computer links, which will enable records to be transferred to the two existing central agencies - the national Biological Records Centre at Monks Wood (part of the Ecological Data Unit of NERC's ITE) and the Rural Areas Data Base at Essex University. We envisage these latter two agencies developing further under the leadership of their respective controlling bodies, but this is outside our terms of reference (qv. Section 6.8).

b. A continuing supervisory body to regulate the ongoing functioning of the local record centres, and to deal with the practical problems that will have to be solved. We envisage this supervisory body will have close links to the Terrestrial and Freshwater Directorate of NERC, which has responsibility for BRC. We also believe that it should act as a link with the local recorders, in association with the existing links such as RSNC and the *habitat* newsletter of the Council for Environmental Conservation.

6.11 We have examined the topics remitted to us by the Council of the Linnean Society (Appendix I), and submit our Report to the Society. We hope that the Council will take an initiative to establish our proposed co-ordinating commission Section 6.10a) in association with the relevant national, statutory and voluntary agencies, and will want to be associated with the continuing survey of the biological resources of the United Kingdom, since that heritage is part of the historical justification for the Linnean Society.

7. Recommendations

7.1 ALTHOUGH CONSIDERABLE EFFORT is expended on biological survey and surveillance in the United Kingdom by voluntary, professional and statutory bodies, no effective system exists for the overall co-ordination of recording and monitoring of wildlife and habitat resources. There are compelling commercial and scientific reasons for establishing such a system. **Recommendation 1: that a co-ordinating commission be established as soon as possible, under the lead of an appropriate national body.**

7.2 We envisage three elements to continuing co-ordinated biological survey in the UK:

a) Local record centres based on the existing county or regional network which will have the responsibility to receive, validate and store all primary data, and which will promote and initiate survey within this area.

b) A national collative and interpretative unit responsible for database management, centred on the Institute of Terrestrial Ecology (which incorporates the Biological Records Centre at Monks Wood, partially supported by the `Nature Conservancy Council).

c) A central data store based on the Rural Data Archive at the University of Essex, which already holds a range of environmental data as well as biological records.

Recommendation 2: that the co-ordinating commission draw up a procedure for collaboration between these elements.

7.3 Recommendation 3: that a continuing supervisory body be established to oversee local records centres, with representation from statutory, voluntary and other appropriate bodies. An urgent task of this body will be to establish compatible transfer formats between data held in local centres and acceptable criteria of operation (and staffing) for recognition of local centres.

7.4 We believe that each local records centre should be largely self-financing (Section 5.7), but this will only be possible when they are fully operational because biological recording is a national requirement. **Recommendation 4: that the coordinating commission seek funding from central governmental agencies for adequate software development, for the initial establishment of a coherent computer network and for providing trained personnel.** With the information available to us, we are unable to estimate the amount of money required. ***A*** *first task of the co-ordinating commission will be an enquiry into the cost of establishing a national network.*

7.5 We believe that there is considerable taxonomic expertise in the major animal and plant groups available in most localities to sustain a viable national network, but there will be a continuing need to provide training and expert help. **Recommendation 5: that this training should be supervised initially by the co-ordinating commission, to foster improved competence in identification at the local level.** Involved in this task (and perhaps subsequently assuming responsibility for it) should be the Linnean Society, Systematics Association and Field Studies Council in association with the national biological societies (Botanical Society of the British Isles, British Trust for Ornithology, etc.) and with regular liaison with international taxonomic bodies.

7.6 Although local centres will be co-ordinated by a proposed supervisory body (Recommendation 3), **Recommendation 6: the standards for the operation of local centres be determined by the national interpretative unit.** In addition to its research and national interpretative role, this unit should,

a) Create and maintain a manual of recording procedure and an inventory of data holdings, including long-term data sets (Section 2.7).
b) Set appropriate standards, in collaboration with the appropriate international organizations, for data transfer formats, taxonomic codings, habitat classifications, etc.
c) Evaluate computer hardware and software (in liaison with IUCN's Conservation Monitoring Centre, where appropriate).
d) Disseminate information on research, legislation, etc.
e) Advise on particular recording problems.
f) Advise on copyright, data protection, and other legal problems.

7.7 We note that some biological data are required by Statute or Regulation (e.g. counts of seal numbers, biological indicators of water quality, status of species listed in the Schedules of the Wildlife and Countryside Act, etc.), and that there would be advantage in assembling these requirements into a central register. We further note that there are some legal uncertainties, such as the status in law of a biological record and its relationship to archive legislation, the status of records collected by members of centrally-funded employment schemes, the confidentiality of biological records under the Data Protection Act, etc. We believe that the proposed national interpretative unit is best placed to investigate such problems, and, if necessary, propose legislation.

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Appendix I

TOPICS TO BE EXPLORED (as identified in the request to the Linnean Society). These formed the terms of reference to the Working Party.

1. Why it is desirable to collect biological information in the United Kingdom and assess the function and effectiveness of the agencies involved.

2. The relationship between local and central government funding as it affects biological recording.

3. What each organization is doing and what is their commitment to staff, finance and other resources.

4. What kind of information is gathered, who gathers it, and who uses it.

5. The extent of duplication of effort between different agencies and how this can be avoided.

6. How information collected by national agencies can be more readily available to the public both locally and nationally.

7. How the quality of data gathered can be standardized, checked and improved.

8. To what extent national organizations can help local record centres and vice versa.

9. The number and geographical coverage of local record centres desirable to provide a local service and who should administer them.

10. The role of museums, including national, university and local authority in biological recording.

11. Sources of finance to support biological recording at all levels.

The review would be expected to make recommendations for the provision of a cost effective national and local service and would be expected to provide a document on which future decisions concerning biological recording could be made.

Appendix II

MEMBERSHIP OF THE WORKING PARTY

Professor R.J. Berry, University College London (Chairman)

Dr. F.A. Bisby, Southampton University (Botanical Secretary, Linnean Society)

Dr. R.A.D. Cameron, Birmingham University

Professor W.G. Chaloner, F.R.S., Royal Holloway & Bedford New College, London (President, Linnean Society)

Dr. Margaret Game, Greater London Ecology Unit

Dr. D.A. Goode, Greater London Ecology Unit

Mr. E. F. Greenwood, National Museums and Galleries on Merseyside (former Chairman, Biology Curators' Group)

Mr. P.T. Harding, Biological Records Centre, Institute of Terrestrial Ecology, Monks Wood Experimental Station

Dr. J.M. Hellawell, Nature Conservancy Council, Peterborough

Dr. P.C. Lack, British Trust for Ornithology, Tring

Miss Christine Leon, IUCN Conservation Monitoring Centre, Royal Botanic Gardens, Kew Dr. F. Perring, Royal Society for Nature Conservation, Lincoln

Mr. G. Starisfield, Leicester University (Chairman, National Federation for Biological Recording)

Dr. M.B. Usher, University of York (representing British Ecological Society)

Miss Claire Appleby, Wiltshire Biological Records Centre, Devizes
(Secretary)

Appendix III

LIST OF BIOLOGICAL RECORDS CENTRES (as at February 1987)

Aberdeen University Natural History Museum
Mr Kenneth Watt,
Aberdeen University Zoology Dept,
Tillydrone Ave, Aberdeen AB9 2TN
Tel: 0224 40241 x 6413

Angus District Records Centre,
Mr Norman K Atkinson, District Curator,
Montrose Museum & Art Gallery,
Pannure Place, Montrose, Angus DDIO 8HE
Tel: 0674 73232

Arran Biological Records
Mr D Warner,
Brodick Castle, Isle of
Arran, Tel: 0574 73232

Ayrshire Biological Records Centre
Mr Charles Woodward, Keeper of Geology,
The Dick Institute Museum, Elmbank Avenue, Kilmarnock, Ayrshire KA3 2TB
Tel: 0563 26401

Berkshire Biological Records Centre
Mr H H Carter, Keeper of Natural History,
Reading Museum & Art Gallery,
Blagrave Street, Reading RG1 1 QH
Tel: 0734 55911 x2242

Biological Records Centre for Lincolnshire & South Humberside
Mr M Johnson, Assistant Keeper of Natural History, Lincolnshire Museum,
Broadgate, Lincoln LN2 IHQ
Tel: 0522 30401

Bolton Museum & Art Gallery
Mr S Garland, Senior Keeper of Natural History,
Le Mans Crescent, Bolton, Lancs BLI 1 SA
Tel: 0204 22311 x379

The Borders Record Centre
Mr Mike Osborne,
Firbrae, Mellerstain, Gordon, Berwickshire TD3 6LG

Bristol Regional Environmental Records Centre,
Mr C J T Copp, Assistant Curator Nat. Hist. & Info. Tech.
City of Bristol Museum & Art Gallery,
Queens Road, Bristol BS8 IRL
Tel: 0272 295771 x215

Buckinghamshire Environmental Records Centre,
Mrs K M Rowland, Keeper of Natural History & Geology,
Buckinghamshire County Museum,
Church Street, Aylesbury,
Bucks HP20 2EP
Tel: 0298 82158

Caithness Records Centre
Mr Iain Smith, Caithness Museums Service,
Sinclair Terrace, Wick, Caithness KW1 5AB

Cambridgeshire Wildlife Trust
Ms Jacqui Green, Conservation Officer,
5 Fulbourn Manor, Fulbourn, Cambridge CBI 5BN
Tel: 0223 880788

Central Region Records Centre

Mr W Brackenridge,
Stirling Smith Art Gallery & Museum
Albert Place, Dumbarton Road, Stirling FK8 2RC
Tel: 0786 71917

Colchester & Essex Museum
Mr J J Heath, Keeper of Natural History
Museum Resource Centre, 14 Ryegate Road, Colchester, Essex COI 2YW
Tel: 0206 712481

Cornish Biological Records Unit
Mrs Stella Turk,
Trevenson House, Pool, Redruth, Cornwall TRI5 3RE
Tel: 0209 712203

Derby Museum & Art Gallery
Mr William Grange, Keeper of Natural History,
Dept of Natural History, The Strand, Derby DEI IBS
Tel: 0332 31111 x782

Doncaster Museum & Art Gallery, Biological Records Centre
Mr P Skidmore, Keeper,
Doncaster Museum & Art Gallery, Chequer Road, Doncaster DWI 2AE
Tel: 0302 73427

Dorset Environmental Records Centre Ms Glenys Roberts, Keeper of Records, Dorset County Museum, High West Street, Dorchester, Dorset DTI IXA
Tel: 0305 62735

Dundee Records Centre
Mr Richard Brinklow, Keeper of Natural History,
Dundee Museums & Art Galleries, Albert Square, Dundee DDI IDA,
Tel 0382 23141 x152

Epping Forest Conservation Centre Paul Moxey, Warden & Director of Studies, High Beach, Loughton, Essex ICIO 3AF Tel 01-508 7714 .

Essex Biological Records Centre, Mr Colin W Plant, Assistant Curator of Natural Sciences,
Passmore Edwards Museum, Museum Nature Reserve, Norman Road, East Ham, London E6 4HN
Tel: 01 470 4525

Falkirk District Biological Data Bank Mr J M Sanderson, Curator,
Falkirk District Museums, Hope Street, Falkirk FKI 5AU Tel: 0324 24911 x2202

Glasgow Records Centre
Mr Geoff Hancock, Keeper of Natural History, Art Gallery & Museum, Kelvingrove, Glasgow G3 8AG

Gloucestershire Trust for Nature Conservation
Dr Gordon McGlone,
Church House, Standish, Stonehouse, Glos GLIO 3EU
Tel: 045382 2761

Greater London Ecology Unit
Dr David Dawson & Dr Meg Game,
Berkshire House, 168-174 High Holborn, London WCIV 7AG

Gwent Biological Records Centre
Mr B Argyll Campbell, Senior Keeper of Natural History
Newport Museum & Art Gallery, John Frost Square, Newport, Gwent NP9 IHZ
Tel: 0633 840064

Hampshire County Museum Service Mrs Jan Grant, Keeper of Records & Documentation,
New Chilcomb House, Chilcomb Lane, Bar End, Winchester Hampshire S023 8RD
Tel: 0962 66242

Hancock Museum
Mr Peter S Davies,
Barras Bridge, Newcastle-Upon-Tyne NF2 4PT
Tel: 091 232 2359

Hereford City Museum & Art Gallery Mr J Cooter, Keeper,
Broad Street, Hereford HR4 9AU
Tel: 0432 268121 x 207/334

Inverness Records Centre
Highland Biological Recording Group Mr Stephan Moran, Assistant Curator (Natural Sciences),
Inverness Museum & Art Gallery, Castle Wynd, Inverness IV2 3ED
Tel: 0463 237114

Islay Field Centre
Dr Malcolm Ogilvie,
Port Charlotte, Isle of Islay, Argyll PA48 7XT

Isle of Wight Environmental Records Centre
Dr A Insole, Museums Service,
Ryde Library, George St, Ryde, Isle of Wight
Tel: 0983 615229

Kent Biological Records Centre
Mr E G Philp, Keeper of Natural History, Maidstone Museum & Art Gallery, St Faith's Street, Maidstone, Kent MEl4 1LH
Tel: 0622 54497

Leicestershire Museums Records Centre
Mr Ian M Evans, Assistant Director (Natural Sciences),
9 New Walk, Leicester, Leicestershire LEI 6TD
Tel: 0533 554100

Llysdinam Field Centre, UWIST
Doug Moncur,
Newbridge-on-Wye, Llandrindod Wells, Powys LDI 6NB
Tel: 059 789 308

Luton Museum
Mr F Hackety, Curator,
Wardown Park, Luton, Bedfordshire LU2 7HL
Tel: 0582 3941

Manx Museum, Library & Art Gallery
Dr L S Garrad, Assistant Keeper,
Douglas, Isle of Man
Tel: 0624 25125 & 75521

Museum Nan Eileen
Dr Frank Rennie,
Town Hall, Stornoway, Lewis, Western Isles PA87 2XF
Tel 0851 3773 x305

New Forest Biological Records
Mr & Mrs Welstead,
3 Kelvin Close, Hythe, Southampton SG4 5LG

Norfolk Biological Records Centre
Dr A G Irwin, Keeper of Natural History,
Natural History Department, Castle Museum, Norwich, Norfolk NR1 3JU
Tel: 0603 611277 x287

North Eastern Environmental Biological & Records Centre
Mr John Bainbridge Senior Museums Officer (Natural Science)
Sunderland Museum
Borough Road, Sunderland Tyne & Wear SRI IPF
Tel: 0783 41235

North Herts Museums Service
T J James, Keeper of Field Natural History, Natural History Dept, Old Fire Station, High St, Baldock, Herts SG7 6AR
Tel: 0462 894352

North West Biological Field Databank
Dr A S Gunn, Assistant Keeper of Botany, Merseyside County Museums, William Brown Street, Liverpool L3 8EN
Tel: 051 207 0001 x 5451

Nottingham Biological Records Centre
Mr Graham Walley, Curator of Natural History,
Nottingham Nat. Hist. Museum, Wollaton Hall, Nottingham NC8 2AE
Tel: 0602 281130

Orkney Field Club
County Library, Laing Street, Kirkwall, Orkney

Oxfordshire Biological Records Centre
Mr J M Campbell,
Oxfordshire County Museum, Woodstock, Oxford 0X7 ISN
Tel: 0933 811456

Pembrokeshire Biological Records Centre
The Curator, Scolton Manor Museum, Spittal, Haverfordwest, Dyfed SA62 5QL
Tel 0437 82328

Perth & Kinross District Records Centre
Mr M Taylor, Keeper of Natural Sciences
Perth Museum & Art Gallery, George Street, Perth
Tel: 0738 32488

Peterborough City Museum & Art Gallery
Dr Gordon R Chancellor,
Priestgate, Peterborough PEIILF
Tel: 0733 43329

Plymouth Biological Records Centre
Plymouth Wildlife Group
Mr David Curry, Keeper of Natural History,
City Museum, Drake Circus,
Plymouth PL4 8AJ
Tel: 0752 668000 x4376

Renfrewshire Records Centre
Mr David Mellor, Keeper of Natural History,
Paisley Museum High Street Paisley
Strathclyde PAI 2BA
Tel: 041 889 31 51

Royal Albert Memorial Museum
Mr David Bolton, Keeper of Natural History,
Queen Street, Exeter, Devon EX4 3RX Tel: 0392 56724

Scunthorpe Borough Museum & Art Gallery
Keeper of Natural Sciences,
Oswald Road, Scunthorpe, South Humberside DNI5 7BD
Tel: 0724 843533

Sheffield Ecology Unit
Mr D Whiteley, Curator,
Sheffield City Museum, Weston Park, Sheffield S10 2TP
Tel: 0742 27276

Shetland Museum
Mr Tom Watt, Assistant Curator,
Lower Hillhead, Lerwick, Shetland Isles ZE1 OEL
Tel: 0595 5057

Shropshire Biological Records Centre
Mr John Norton, Assistant Keeper,
Buttercross Museum, Old Street, Ludlow, Shropshire
Tel: 0584 3857

Somerset Trust Environmental Records Centre
Mr John Wilkins, Records Centre Manager,
c/o Fyne Court, Broomfield, Bridgewater, Somerset TA5 2EQ
Tel: 082345 587

Southend-on-Sea Museums Service
Mr J F Skinner,
Central Museum, Victoria Avenue,
Southend-on-Sea Essex
Tel: 0702 330214

St Albans City Museum
Phil Collins, Keeper of Natural History,
Hatfield Road, St Albans, Herts AL1 3RR
Tel: 0727 56679

Staffordshire Biological Records Centre
Mr Geoff Halfpenny, Curator of Natural History
City Museum & Art Gallery, Bethesda Street, Hanley, Stoke on Trent STI 4HS Tel: 0782 273173

Stirchley Grange Environmental Interpretive Centre
Telford, Shropshire

Suffolk Biological Records Centre
Mr Howard Mendell, Curator of Natural History
The Museum, High Street, Ipswich, Suffolk 1P1 3QH
Tel: 0473 213761/2

Townley Hall Art Gallery & Museums
Keeper of Natural History,
Townley Hall, Burnley, Lancs BB11 3RQ
Tel: 0282 24213

Ulster Museum
Dr D Erwin, Keeper of Botany & Zoology,
Botanic Gardens, Belfast BT9 5AB
Tel: 0232 668251/5

Warwickshire Biological Records Centre
Mrs Pam Copson, Keeper of Natural History
Warwickshire Museum, Market Place, Warwick CV4 4SA
Tel: 0926 493431

West Glamorgan Biological Records Dr P Makings,
University College Swansea, Dept. of Zoology, Singleton Park,
Swansea SA2 8PF

West Yorkshire Ecological Advisory & Information Service
Mr Jack Lavin, Cliffe Castle Museum,
Spring Gardens Lane, Keighley,
W Yorkshire BD20 1LJ
Tel: 0535 64184

Wiltshire Biological Records Centre Miss Claire Appleby, Biological Recorder, 41 Long Street, Devizes, Wilts SN10 1NS Tel 0380 77369

Worcestershire Biological Records Centre
JR Thoumine, The Museum, 1 Commandery Drive, Sidbury, Worcester WR1 2HU Tel 0905 355071

Yorkshire Museum Biological Records Centre
Dr P Howard, Keeper of Biology, The Yorkshire Museum, Museum Gardens, York Y01 2DR
Tel: 0904 29745

Appendix IV

RECOMMENDATION APPROVED BY the Ministerial Committee of the Council of Europe, April 1987.

HAVING REGARD to the resolutions of the European Ministerial Conferences on the Environment;
HAVING REGARD to the Convention on the Conservation of European Wildlife and Natural Habitats;
HAVING REGARD to the Resolution of *the* Committee of Ministers on the European network of biogenetic reserves (R (76) 17);
HAVING REGARD to the cooperation which has been developing between the Council of Europe and the European Economic Community in the context of the CORINE biotypes project;
REFERRING To the conclusions of the colloquies on computer applications in the field of nature conservation held in 1983, 1985 and 1986;
CONSIDERINGTHE urgent need to gather detailed information on the flora, fauna and biotopes of all regions of Europe in order to be in a position to:

- survey the natural resources of the environment,
- decide on appropriate management of all resources,
- promote the conservation and protection of the most valuable sites and biotopes, routinely monitor changes in the environment,
- evaluate and quantify the impact of proposed development plans and thatofnatural or man-linked accidents;

CONSIDERING THAT the technology of the future to manage all this information on the environment and resources management is the creation of computerised data banks;
CONSIDERING THE immense benefits of such data banks to the decision-makers, the scientists, the educators and the general public;

RECOMMENDS THAT the governments of member States take the appropriate steps to

1. speed up local inventories of biotopes providing detailed information on their flora and fauna together with data on present land uses;
2. intensify the collection of data on populations of wild flora and fauna species, specially those in red lists;
3. promote and support the development of local regional and national databanks to be used for land management, nature conservation, scientific research or education purposes so that these databanks be the base of natural habitat statistics and include specially indicators of change;
4. strengthen the co-operation and the coordination of local, national and international efforts for the development of a coherent network of databanks on all regions of Europe;
5. encourage reference to *Flora Europea for standard names to be used by all data banks dealing with the flora of Europe;*
6. promote and support the different efforts to elaborate and use by all data banks lists of standard names for the major groups of organisms of the fauna of Europe andmake plans for their periodic updating.

Appendix V

TECHNICAL PROBLEMS

1 Although a great deal of effort is expended in collecting biological records, the purposes for which they are accumulated are so diverse that there may be significant gaps if the records are used for a purpose other than the one for which they were collected. For example, an ecologist who is primarily interested in the inter-relationships of species within a community or habitat will be mostly concerned with assembling quantitative records of species at a given site or, at most, a limited number of prime habitats. By contrast, a worker whose concern is to understand the ecology of a given taxonomic group is likely to wish to know its distribution over a full range of sites in order to determine its rarity, and hence selectivity of habitat, thereby obtaining clues as to its needs and preferences. These, in turn, will be derived from other spatially distributed records, either of other species (food plants, prey species, hosts, etc.) and/or of physical, edaphic, climatic, or historical factors. The existence of parallel databases is an extremely valuable and powerful research tool. The mutual enhancement of the value of each individual compatible database is also self evident.

As we have seen (Section 1.2), the distinction between species and site recording is artificial since each habitat has its species and each species occupies habitats. Most recording in the past has been species-dominated simply because the interest of recorders has, of necessity, been limited to a relatively small taxonomic range. The biocoenotic approach is more appropriate when a team of specialists concentrates its efforts towards understanding the interrelationships of species within a habitat or site. As habitats have come under increasing pressure, so attention has turned towards the need to identify species-rich sites and their spatial distribution. The conservation requirement has focussed effort on drawing up site-related records but this shift has been one of emphasis rather than a fundamental change. Without species records it is impossible to assess the conservation importance of a site since the assemblages cannot be set in a wider context.

One must see site and species recording as complementary, each emphasizing one aspect of a two-dimensional matrix of species and sites. Continued record collection provides a third dimension, time, in which the status of populations and communities may be assembled, and monitored.

2 Incomplete data sets

(i) Until species become extinct or sites are irreparably damaged, records can always be added to. However, in the present context, incomplete records are those which the recorder regards as less extensive than he or she would normally expect or desire. This does not automatically mean that such incomplete records as do exist are valueless. Often it is not the incompleteness of the records which is the problem but rather the extent to which we are unaware of the deficiencies. A commonly-voiced criticism of preliminary or tentative species distribution maps is that they show the spatial distribution of the recorders, or their vacation proclivities, rather than the actual distribution of the organisms. This criticism can be met in some degree by the provision of a map showing the location of all sites from which records for an appropriate group of species, or higher taxon, have been obtained. Perhaps the most effective technique would be to indicate on each map those

areas from w hich no collections have been made and also areas w hich, although searched by a competent investigator, the species could not be found. Such maps w ould assist in assessing observed, though incomplete, distributions and could also stimulate further collection in **the** areas for w hich data are presently unavailable. Where genuine 'holes' are observed in distribution patterns further light may be throw n on problems of autecological needs of species.

(ii) Sometimes the utilization of incomplete species lists is deliberate: effort is concentrated on a limited number of 'indicator' or 'key' organisms. These may be selected because much is know n of their environmental requirements and so they are indicators of the prevailing environment. Yet others are key components of the ecosystem or the community and monitoring **the** status of these provides indirect assessments of the health of the w hole system. These species may act as sentinels, w arning of the approach of calamity w hen, as the most sensitive species, they are the first to be affected by environmental change. Certain species may accumulate pollutants in proportion to prevailing environmental concentrations thereby providing evidence of ambient levels or of integrated responses under fluctuating concentrations. In all these cases the key or indicator species is representative of the community or biocoenosis and provides a 'signal' amongst the 'noise' generated by the complex of many different changes show n by other components. Good indicators provide a high return on effort: rarely is it possible or practicable to monitor or record all the species present. However, it has to be admitted that ideal indicators are rare and some compromise has to be struck. Sensitive indicators of change often have a very restricted distribution w hile ubiquitous species are usually so resilient that they are the least suitable to act as sentinels.

(iii) The study of temporal change in populations or communities is one of the major purposes for w hich biological recording is undertaken. Extensive temporal records are rare (Hellaw ell, 1971) and often their existence is fortuitous, having been acquired incidentally during other investigations. How ever, such data may permit unequivocal demonstrations of change.

3 Incompatible methodology

A major difficulty in recording over periods of time is that of ensuring consistency in methodology, a problem compounded by general scientific progress (improvements in technique) and increasing costs of any labour-intensive activity. The field component of biological recording is a typical example. There is no intrinsic reason w hy lack of continuity in recorders (limited in any case to professional or actual life-span) should cause difficulties provided that the methodology is fully documented and the taxonomic competence of successors is adequate.

Rarely can much be done retrospectively to remedy inadequacies in records although auxiliary habitat data (physical or chemical measurements) may be calibrated. Difficulties In ensuring consistency in time series are essentially no different from the problems of obtaining a uniform standard betw een many spatially separate recorders at any given time. In fact, the balance of probabilities almost certainly favours continuity in time for a single recording scheme rather than in space betw een collaborators simply because the records and supplementary material (voucher specimens, sampling equipment) are physically in one place, and inertia or tradition fosters a conservative approach.

Often, little can be done to recover 'missing' information, such as inadequate or incomplete site location. Errors in identification may be corrected if voucher material has been preserved and there are good reasons for believing that the mis-identities w ere consistent. As in the case of incomplete geographical coverage, an incomplete time series may still prove useful provided that the limitations can be identified and the certainties established. Where these are know n, even provisional analyses of the data may provide

useful pointers to further work or sometimes helpful working hypotheses. Inevitably, value judgments have to be made and these may vary with the purpose of the study. This poses the question "Is an extensive data-set, having many uncertainties and various unknown levels of accuracy more useful than a limited one, the pedigree of which is fully known?" Perhaps all one can say is that, provided the deficiencies are recognized and are declared or can be assessed, then any data-set is better than none. It is axiomatic that one cannot assess unknown deficiencies in any system.

It is doubtful whether many, if any, workers actually plan to initiate a recording programme which they hope will be followed in perpetuity. However, some attempt needs to be made in all recording schemes to include certain essential information which will allow future users of the records to assess their worth. This entails looking at the scheme critically in order to assess what questions an observer in the future may need to ask regarding the reliability of the data, the competence of the identification or the general worth of the records. One cannot anticipate all the uses to which data may be put nor the, as yet unknown, future questions which will need to be answered. But experiences with inadequate data-sets, the shortcomings of which could easily have been remedied at the time, ought to provide sufficient stimulus to prevent the worst deficiencies and at least ensure that what is recorded for posterity is recorded properly.

Clearly, where area-based methodologies have already become widely accepted at national or local level then compatibility with international ones may not be easy, and sometimes impossible. This is where "International Transfer Formats" (Section 2.9) are important. These are designed to side-step the obstacles of incompatible methodologies as well as incompatible hard- and soft-ware and so help to meet the data exchange needs of biological databases which share common objectives. The concept behind any ITF enables it to be applied at any geographical level and so facilitate easy data exchange between computerised databases.

4 Confidentiality

Records of rare or commercially valuable species may need to be confidential to avoid destruction or loss by collectors. These records may also have to be kept from enthusiastic naturalists to avoid undue disturbance of the site or species. On the other hand, site owners or occupiers and public bodies need to be informed of the existence of rare and vulnerable species or of sensitive sites in order to protect them. It may also be necessary to manage sites positively to safeguard them or their valuable species, and in order to determine the management policy and gain the necessary support, the identity of the rarity will almost certainly have to be divulged.

This problem may become particularly acute at public planning enquiries. Evidence that site is important for undiscloseable reasons is unlikely to be convincing and it is unlikely that the evidence could be given in camera. Disclosure may assist in protecting the site only to draw attention to the existence of a rarity and thus attract unwanted attention. Many may feel that, on balance, it would be preferable not to reveal the true situation since sites which support rarities are likely to be important in more general terms. However, wardening protection such as RSNC's Orchid Wardening Scheme or the RSPB's Operation Osprey may be used to protect the site of rare species while giving the public opportunity to visit and be educated about the site's importance.

The contribution of rarities to assessments of the status of sites or habitats is probably less significant than it once was, since the emphasis is now much more on the whole community, but the value of any site must be enhanced by the presence of rare or declining species. The concept of what constitutes rarity varies, especially between local and general rarity, and, of course, there is no actual threshold of rarity; it tends to be arbitrarily defined (as, for example, occurring only in an arbitrary number of 10 km squares). How-

ever it is defined, the need to record occurrences of rare or declining species is crucial in order to protect or manage sites where they live. This well illustrates the value of biological recording in providing objective assessments of rarity, in establishing the location of rarities, and in monitoring the status of populations and the effectiveness of legislation or management in protecting them or enhancing their numbers.

5 Quality control

Some of the problems associated with inadequate or poor records have been touched upon above. Others are, perhaps, less obvious but can be seen in comparisons of recent attempts to measure habitat change nationwide. The intention of such surveys is to follow changes in the extent and quality of natural habitats and landscape features. The picture which emerges is coloured by older definitions of land use. For example, should an orchard be recorded as a 'plantation', as 'horticulture' or as 'arable land'? Or again, is an area of derelict urban land, where buildings have been demolished and the site levelled, still 'built land' or is it 'bare ground' or 'waste ground'? Similarly, attempts to provide unambiguous categories for different sorts of grassland are fraught with difficulties. Distinctions regarding boundaries between habitats are equally difficult. These problems are less important when small numbers of investigations are involved but could cause difficulties in national surveys employing many individuals. In such cases, finesse may have to be sacrificed for certainty, otherwise doubt may be cast over the validity of the exercise. As before, the issue boils down to making value judgments and accepting the limitations which are inherent in the technique.

Habitat descriptions may enhance the value of species-centred records by providing evidence of autecological needs. Again, the precision of the description will influence the value of the record: 'wood' is less helpful than 'edge of chalk beechwood, steep south-facing slope'. Where site-related, time-invariant data are held one might extract the fact that the site is on chalk and associated with beechwoods, but this presupposes adequate cross-linking of data. In any case, provision of two corroborative records, from species and from the site, gives a degree of data validation at little extra cost in effort. Once again, the existence of standardised site or habitat description is an essential prerequisite for an effective system in a nationwide context.

Site-related records need quality control with respect to site boundaries and consistency in naming and assigning grid-references. Precision of location may depend on the species and on the absolute size of the site. When a species is confined to one area within a very large site, is it adequate merely to provide the name of the whole site, for example a large lake or forest? For monitoring purposes, the boundary of the distribution of species or of populations may be critical, so that exact site records are essential.

6 Taxonomic expertise

Species-centred records are vulnerable with respect to mis-identification, and to changes in possible identification (e.g. splitting of species, or change of name). The intensity of the problem varies considerable with the taxonomic group involved; some species are very easily mis-identified and decisions have to be made regarding which species records have to be authenticated in some way. For most recording schemes it is possible to draw up lists of species for which expert confirmation is required. This does not solve the reciprocal mis-identification of rare species as common ones, but little, if anything, can be done to rectify this. This problem of quality control of species records is relatively small in well-known and popular groups since records tend to be more extensive and rarities are already known. For less popular taxonomic groups keys are often unavailable, experts are scarce and geographical cover is restricted. The species which are readily confused may be known from existing keys but given a paucity of records it may be difficult to know how frequently

mis-identification may occur and which future records are likely to be suspect. Once a reasonable body of information exists on a group, a degree of quality control of species records can be achieved.

Taxonomic competence is fundamental to all biological recording of species and communities and an important adjunct to habitat descriptions. The importance of taxonomy and the tendency for it to become a neglected aspect of ecological work has long been recognized (NERC, 1976b) but little material progress has been made. Fortunately, there are many groups for which good keys exist and many less commonly studied taxa are catered for, albeit in publications which may be out of print or otherwise difficult to obtain. Keys compiled by and for specialists may be unsuitable for amateur recorders even when they are able to gain access to them. Obviously it is rarely possible to produce simple, infallible keys to extremely difficult groups but even for the more popular groups there are good and bad keys. Recently, the features which make for good keys have been more generally recognized and many keys have been subjected to appraisal and to testing by non-experts and consequent revision before being released generally. The Field Studies Council has taken the lead in this with its AIDGAP scheme (Aids to Identification in Difficult Groups of Animals and Plants) (Tilling, 1984).

The extent to which biological recording can be extended to cover more taxonomic groups is heavily dependent on the availability of suitable keys. There is no central coordination of this work; museums, research institutions, learned societies and individuals have been responsible for the publication of keys to various groups of organisms. From time to time keys to keys have been produced, a task which could usefully be assumed by a single competent, central authority so that potential biological recorders who need assistance have an evident starting place. There may also be a need to encourage the production of illustrated field keys designed for the enthusiastic amateur.

Where biological recording centres are associated with museums or academic institutions, offers of help with taxonomy and, in particular, assistance in verification of difficult species or groups could be encouraged to great advantage. This presupposes adequate staffing with experts (or, at least, good generalists) who would be able to redirect difficulties to the relevant authority. In order to avoid overburdening the expert taxonomist, some filter mechanism is required, analogous to the general-practitioner/consultant system in medicine.

Finally, some keys (for example those produced by the Freshwater Biological Association) include distribution maps and so draw attention to biological recording. This is to be welcomed since it provides some indication of the extent of records and could stimulate more recording. It also encourages recorders to verify identifications which appears to be well outside the normal (or provisional) range for particular species. Details of three such keys are listed in the references (Jermy, Chater and David, 1982; Page, 1982; Moore, 1986).

At national level it will undoubtedly prove important to be consistent in the use of Latin names, i.e. to be aware of the adoption of internationally agreed nomenclatures as standards. In the case of plants, especially, it is quite possible for any one taxon to have any number of different Latin names given to it over a period of time, all of which might be taxonomically justifiable. The Council of Europe's recommendation (April 1987) (Appendix IV) addresses this point.

Appendix VI

MINIMAL CRITERIA FOR BIOLOGICAL RECORDS CENTRES

1. Primary functions of biological records centres:

a) to collect, and/or promote the collection of biological and environmental data
b) to validate, or arrange for the validation of all data (see *Quality control* [1] *)*
c) to collate data from a wide variety of sources
d) integrate biological and environmental data and thereby maximise their use
e) to analyse, correlate and otherwise interpret the data
f) to disseminate data in a wide variety of forms to meet the widely differing requirements of the users (see *Data Supply* [2] *)*
g) to promote the use of the data (see *Data Supply* [2])

2. Scope of data to be held by biological records centres

a) species - distribution abundance, conservation, status, etc
b) sites - location, conservation status, management, ownership, etc.
c) habitats - distribution, composition, conservation status, etc
d) the wider countryside - land use, landscape, geology, soils, altitude, etc
e) bibliography
f) casework
g) register of naturalists and other experts
h) register of research

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1 *Quality Control* - Biological records centres must:
a) ensure the validity of data by liaison where appropriate with specialist organisations
b) ensure the preservation of voucher material where appropriate
c) ensure that site definition is unambiguous - name, size, shape, location
d) identify gaps in taxonomic and geographic coverage and actively promote recording in these areas.

2 *Data Supply* - biological records centres should encourage the broadest use of their data. In particular they should:
a) provide information for planning (parish, district, county and national level), conservation, education, research, amateur naturalists, recreation, commercial (agriculture, forestry, developers, industry)
b) extract subsets of data for varied spatial units (parish, district, land ownership)
c) transfer data to and from BRC
d) transfer data to and from NCC
e) produce county species distribution maps/atlases at various scales
f) carry out environmental monitoring (habitat and species losses and gains, land use changes, etc.)
g) issue regular newsletters to provide feedback for recorders and to promote the data amongst users.

3. Minimum needs of biological records centres

a) trained personnel
b) office space & equipment
c) microcomputers
d) software - database, wordprocessor, graphics
e) hardware - digitising tablet and pen/cursor, printer, plotter, modem
f) basic library of books and maps
g) adequate budget-for salaries, expenses and 'on-costs' (100% of salaries), for travel to conferences and informal meetings.

4. National co-ordination

Local records centres have a duty/responsibility:

a) to contribute to a national network and to accord with standards set nationally (i.e. agree on and conform to certain standard formats e.g. habitat classification, taxonomic system, data transfer format)
b) to liaise with others e.g. national bodies, local NFISs, other LRBCs
c) to participate in national projects
d) to implement national policies and practices
e) to exchange experiences and ideas with other LRBCs throughout the country

There is also a reciprocal responsibility for national organisations to communicate national developments to local records centres and to feed data from national surveys backtorecords centres local to the site of collection.

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