BIODIVERSITY DATA MANAGEMENT
(Document 4)

RESOURCE INVENTORY

in the context of the
Convention on Biological Diversity

WORLD CONSERVATION
MONITORING CENTRE

The mission of the
World Conservation Monitoring Centre is to provide
information on the status, security and
management of the Earth's biological diversity.

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United Nations Environment Programme

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1 GUIDE to the RESOURCE INVENTORY

1.1 Background

The ***Convention on Biological Diversity*** (CBD) was signed at the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992 by 154 nations and subsequently came into force in November 1993. Article 7 of the Convention is concerned with identification and monitoring activities to support Articles 8 to 10 (*in-situ* conservation, *ex-situ* conservation and sustainable use of components of biological diversity). Contracting parties are required to identify components of biological diversity important for its conservation and sustainable use (Article 7a); to identify activities likely to have adverse impacts (Article 7c); and to monitor the status of both components and threats (Articles 7b and 7c). Specifically Article 7d identifies the requirement to:

> *"Maintain and organise, by any mechanism, data derived from identification and monitoring activities".*

Having recognised this clearly identified need for management of data in support of national planning related to biodiversity, the United Nations Environment Program (UNEP), in collaboration with the World Conservation Monitoring Centre (WCMC), designed and submitted to the Global Environment Facility (GEF), a project proposal entitled *Biodiversity Data Management Capacitation in Developing Countries and Networking Biodiversity Information (BDM)*. This proposal was endorsed and subsequently a sub-project was established between UNEP and WCMC for *Development of Supporting Materials for Biodiversity Data Management and Exchange*.

The sub-project has produced an interlinked package of resource materials to assist in national capacity building. There are four principal components of this package:

Document 1. Data Flow Model
- to identify in a formal structure the relationships between components of biodiversity data, from acquisition through to use in national strategy development, planning, and monitoring for implementation of the CBD.

Document 2. Guidelines for a National Institutional Survey
- to provide guidance to countries in conducting a survey and assessment of the capacity of existing national institutions to support biodiversity information management.

Document 3. Guidelines for Information Management
- to facilitate the development of capacity for information management and exchange as required by the CBD.

Document 4. Resource Inventory
(This Document)

The Resource Inventory is the core output of the project. It provides a range of information and reference directories on software, hardware, methodologies, standards, common practices, data sources, key organisations, and exemplary projects related to biodiversity information management. These materials are to support the Data Flow Model and the Guidelines, and other national activities in information management undertaken in the context of the CBD.

The Resource Inventory is designed to be an aid to finding the additional technical information needed for the practical implementation of the Guidelines. As a result, the sections generally consist of a brief discussion of the issues, followed by key "where-to-find-it" information by way of references to the literature, and addresses of vendors and useful biodiversity organisations. It is a reference document which provides alternatives and sources, not all of which will be relevant to all national situations.

Please note that while every attempt has been made to ensure that addresses of vendors and organisations are correct and up-to-date (as of late 1994), these may change quickly, and commercial products, such a software packages may change vendor organisation or be discontinued without notice. In most case addresses have been given for North American or European main offices. Most commercial companies have offices and representatives in various regions of the world. A brief references by telephone or fax to the main office given will lead to a the most appropriate local contact. Many of the names of products listed are registered trademarks or business names in a number of countries. The listing of specific commercial products in the directories does not indicate any endorsement by UNEP or WCMC, or that any verification of product quality of performance has been undertaken. The information is provided as an aid to locating the sources of advice and alternative supporting products. The normal precautions on the selection of technology and services should always be taken, as outlined in Section 3.1.

It is suggested that this document be used as a starting point to develop a continuously updated **national** resource inventory.

1.2 How to Use the Resource Inventory

The current document is longer, more complex, and less restricted to a specific theme than Documents 1-3. This reflects an ambitious attempt to present a wide range of background and reference material on biodiversity information management in a single document.

The Resource Inventory is not designed to be read from cover to cover; it is designed to be consulted when additional information is required on a particular issue, perhaps one that is touched on in Documents 1-3. The major aim of the document is to document the growing array of standards in biodiversity information management, and where these are yet to emerge, to provided pointers to further information sources, such as lead institutions, bibliographic references, and Internet addresses. To assist in this purpose, the document is split up into seven subsequent sections as described below:

- **Information System Development**
  A review of information system development methodologies, with special emphasis on the conduct of user needs assessments, the use of database development techniques, and issues relating to the framework (context) in which systems are developed.

- **Tools for Managing Data**
  A discussion of how to select hardware and software tools for efficient management of biodiversity data, plus in depth reviews of products which have proved popular or useful in a range of circumstances. The section is finished by a full discussion of the global communications network known as the Internet, complete with advice on how to get connected and make maximum use of its information offerings.

- **Data Management Standards**
  A review of standards in data management, covering the issues of documentation, quality and exchange for a range of different kinds of data. A discussion of environmental thesauri is also included to promote the use of standard terminologies as well as standard data management processes.

- **Thematic Information Standards**
  This key section outlines a wide variety of classification systems, data definitions, database structures, minimum datasets, bibliographic, and other reference materials relating to the following thematic information areas: natural and managed habitats, protected areas, species, and threats.

- **Education and Training**
  An overview of current opportunities for education and training in biodiversity information management, including commercial (product-related) suppliers. The section includes an extensive list of relevant training institutions and funding bodies.

- **Information Sources**
  A review of information sources relevant to biodiversity information management covering a wide range of formats and media. Particular emphasis is placed on electronic data sources provided in CD-ROM, on-line databases, Internet, and metadatabase form, plus traditional library sources. Extensive bibliographic and periodicals sections are also included.

- **Reference Materials**
  Lists of addresses, acronyms and abbreviations, and non-standard terms, supporting not only the contents of this document, but others in the series (ie Documents 1-3).

Each section is closed by a list of references cited within the text. However, a fuller range of references for each section is included in the Bibliography and Periodicals sections of **Information Sources** (Section 7.3 and 7.4 respectively).

It should be noted that all cited organisations, acronyms and non-standard terms should be described in the Address List, Acronyms and Abbreviations, and Glossary sections of **Reference Materials** (Section 8.2, 8.3, and 8.4 respectively). Further, those organisations in the address list marked with a "*" receive additional description in Profiles of Key Organisations, Section 8.1.

An example of the use of the Resource Inventory might be the following: a reader of *Guidelines for Information Management* (Document 3) encounters the acronym "TNC"; they look this up in Acronyms and Abbreviations, Section 8.3, and discover that the term stands for the institution "The Nature Conservancy"; they then look up this organisation in the Address List, Section 8.2, and find its address and related contact details; finally they notice that the organisation is marked by a "*", and may browse the relevant entry in Profiles of Key Organisations, Section 8.1.

Alternatively, a reader of *Guidelines for a National Institutional Survey* (Document 2), may encounter a reference to the use of the dBASE relational database management system; they can look this product up in Database Management Systems, Section 3.2.2, and find a description of dBASE plus a range of other similar systems for comparison.

2 INFORMATION SYSTEM DEVELOPMENT

2.1 Development Methodologies

The information system development process is a complex and broad subject about which many books have been written. Comprehensive discussion of the process and alternatives can be found in general texts, such as Flaaten (1989) or Jordan and Machesky (1990). Descriptions of a number of important system development methodologies can be found in Olle *et al* (1982, 1983), and comparative analyses of some of them in Maddison *et al* (1983) and Fitzgerald *et al* (1985). Cutts (1991) provides an excellent guide to general systems analysis and development, with clear examples.

As noted in *Guidelines for Information Management* (Document 3), modern system development methodologies have been well established in industrial areas and largely fall into two categories: *structured development life cycle* methodologies which follow a sequence of steps from project initiation through to implementation with minimal iteration, and *prototyping* methodologies which progressively and iteratively develop the system. Both methodologies may utilise Computer Assisted Software Engineering (CASE) tools (see Section 2.3.2).

More information on structured methodologies can be found in Edwards (1983) and DeMarco (1979). The DeMarco reference is considered the classic description of structured programming techniques and is particulary good on the topic of data flow diagrams and process models.

Some excellent guidelines have been prepared covering information systems development, backup and storage, data and hardware security, and how to prepare users guides in the context of a **developing country**. These have been tested and refined in practice in a Kenyan government department. While not specific to biodiversity, such guidelines may be useful as a model in developing methodologies.

The key document to obtain is entitled *Model Software Development Standard*, and is available at nominal cost from Mark Nicholson at Thunder and Associates (see Address List, Section 8.2).

Prototyping methodologies are well documented in DeMarco (1979), Yourdon (1975) and Connell and Shatner (1989). The last of these references provides exercises and self teaching aids on various topics in systems development.

System development issues more specific to the needs of natural history museums and botanical gardens are discussed in Cooley *et al* (1993). Prominence is this report is given to the need for agreement on standardised data models in the biodiversity community.

The Smithsonian Institution's National Museum of Natural History has recently assessed their computer needs and priorities for collections and research information management and is described in Cooley (1992). The NMNH followed a process of assessment and system planning similar to the one described in Cooley *et al* (1993).

2.2 Establishing User Needs

2.2.1 Overview

The usual result of a user needs survey for an information systems project is a document termed the "functional specification". This document lists essential datasets and describes the processes necessary to convert these into the information requested by users. The functional specification should be independent of hardware or software issues, indeed, free from any kind of implementation details.

The process leading to the production of the functional specification will depend greatly upon the particular circumstances of the project. However, Stein (1994) suggests some key outputs which should result:

- clear definition of intended users
- precise information needs of these users
- list of relevant datasets which are currently available, expected soon, or which can be developed in a cost effective manner.

In small scale projects, particularly those with a strong academic bias, it may be possible for the information system developers to answer these questions themselves. However, where projects involving a wide range of users across different sectors of the biodiversity domain, a period of close consultation between developers and users is essential.

One reason for consultation is to encourage a sense of participation in the development process by users. A second reason is that the information needs of a diverse set of users cannot be "guessed" reliably by information system developers. A third reason is that users may not always be aware of the potential possibilities and limitations of information technology, and the consultative process therefore serves as a useful educational exercise.

As indicated earlier, methods of establishing user needs vary greatly between projects. During this phase techniques such as data modelling (which results in entity relationship diagrams) and prototyping are often used to formalise and structure the information obtained. An example of the results of such a formal process (for Birdlife International) can be found in Van Dijkhuizen (1994), and an example of a less formal functional specification (for the UNEP Office of Harmonization of Environmental Information) in Crain (1992). Sections 2.1 and 2.3 of this document provide information on these formal techniques.

The information required to establish the user needs can be elicited through a number of means, including structured interviews, focus groups, workshops and "structured walk-throughs". The process is often facilitated by the use of external consultants experienced in data modelling and in analysing user needs. However, a formal assessment may begin with a workshop attended by representatives of all major user groups and the development team. The purpose of this workshop is for the developers to explain how information systems can be applied to the key information handling problems experienced by users, and what steps are necessary to achieve this.

During the workshop it is wise to consider the issue of information sharing, and in particular, to agree formal mechanisms for data exchange. These may take the form of *Memoranda of Understanding* between organisations, or the allocation of *custodianship* to particular organisations for particular datasets.

Following the workshop, more detailed consultations take place between specific users and members of the development team. Consultations may take the form of interviews during which the user is requested to outline gaps in their data portfolio, and make specific requests for new datasets and data processing capabilities. In response, representatives of the development team may probe the operational procedures of the user's organisation to judge how best to implement their requests. A series of consultations may be necessary with each participating organisation.

On the basis of the interview notes, and given full knowledge of the human and technical resources at their disposal, the development team should now be in a position to draft a functional specification of the required information system. An indication of the importance of this exercise is provided by Richardson (1994), who claims that this step "*took 80% of the time of the start-up phase*" of the Environmental Resources Information Network (ERIN) information system in Australia, and that "*great self-control was needed not to be 'busy' purchasing hardware, software, and data until these matters were settled*".

Most standard text books on information systems development devote a chapter to user needs assessment, as do more specific books on GIS implementation. Two examples are Powers and Cheney (1990) and Aronoff (1989). A useful guide to establishing needs for GIS can also be found in Wiggins and French (1992) and guidelines for the requirements phase for general information systems development in the *Model Software Development Standard* referenced in Section 2.1.

2.2.2 Examples

Good examples of properly conducted user needs assessments in biodiversity are rare, since this stage of the systems development process is often hurried or ignored. However, two good examples are presented below which illustrate many of the essential concepts.

Indira Gandhi Conservation Monitoring Centre (IGCMC), WWF-India

The IGCMC was originally conceived in 1989 with the primary purpose of providing a central monitoring role. Since then, there has been further thinking on how IGCMC should contribute to the conservation of nature and natural resources of India. Through a purpose of informal dialogue with other like-minded institutions and concerned agencies, provision of services to users via project-based activities and the very recent inauguration programme, IGCMC has tested the viability of its original purpose. It now sees the Centre coordinating, facilitating and integrating the extensive data already available in India and providing timely, accurate, usable and readily available information to its potential users. A revised mission statement has been prepared to reflect this new thinking.

However, before a tactical programme was developed to implement the revised mission statement, it was necessary to obtain the views and inputs of the network of cooperating institutions and agencies supporting the development of IGCMC. This was achieved during a special two day workshop in January 1995 attended by fellow NGOs, plus leading institutes and concerned government agencies.

The specific purpose of the workshop was to clarify the role and future direction of IGCMC, finalise its broad action plan, and explore options for becoming a self-sustaining organisation. Issues such as data accessibility and exchange, custodianship, and dissemination were discussed.

The workshop provided a forum for identifying the major custodians of India's biodiversity information, clearing the way for discussions between technical members of cooperating organisations and the IGCMC development team.

World Bird Database (WBDB), BirdLife International
Birdlife International is currently developing a large database intended to hold information, at a global scale, on bird species, sites, habitats, and conservation issues. The information will be used to support its own research and advocacy programme, and also those of its partner organisations in other countries.

The main users of the intended database are the staff of Birdlife and its partners. User needs were determined by means of regular consultations between the development team (in this case led by a specially recruited consultant with experience in biodiversity information system design), and staff of the major Birdlife programmes, which include:

- globally threatened species
- species of regional conservation concern
- Important Bird Areas (IBAs).

Initially, group consultations were held in which the major objectives of the database were decided by a broad spectrum of users. Following this, specific interest groups were consulted consecutively by the consultant, each one being requested to set out their mission, operational practices, and information holdings and requirements.

The task of the consultant was to design a system capable of managing the various information sources in an efficient manner, that would be scalable in the future, and would perform the analyses requested by its users. As consultation proceeded (a process which took six months in total), draft functional specifications were circulated to invite critical comment.

The final stage of consultation involved the invitation of external comment from concerned organisations in the biodiversity data management sector, including WCMC and the International Waterfowl and Wetlands Research Bureau (IWRB). The resulting functional specification was documented in a full report with formal E-R diagrams (Van Dijkhuizen, 1994).

2.3 Database Development Techniques

2.3.1 Overview

Database development methodologies, such as the use of entity-relationship (E-R) diagrams and CASE tools, are now very well established and mature methodologies are available in many text books. The books by Date (1983, 1990) and Ullman (1982) are solid references to the history, terminology and theory of database management systems. Kroenke (1992) is a very comprehensive text. It provides a detailed description on the theoretical basis of databases. However, the consequence of this is that the text can be more academic than applied in its nature. Townsend (1992) is a good introductory book, especially useful for getting a simple, PC-based database designed and built. Helpful advice is provided for selecting the most appropriate DBMS software package. Oxborrow (1989) has good explanations of database concepts and introduces advanced concepts such as "distributed DBMS", "knowledge-based systems" and "object-oriented DBMS". The relational approach to data modelling was first introduced in Codd (1970). Codd (1979) provides a more accessible summary of the relational approach, together with some suggested extensions.

2.3.2 CASE Tools

Computer Aided Software Engineering (CASE) is reviewed well by Gane (1990) and the text by Powers and Cheney (1990) provides exercises and self-teaching aids on CASE and other related topics. Edward Yourdon publishes a useful newsletter, *The CASE Report*, six times per year, providing a means of staying up to date on new releases of CASE software.

2.3.3 Entity-Relationship Modelling

The books by Date (1983, 1990) are considered the classic references to the definition of data modelling and the use of E-R Diagrams. The original introduction of the Entity-Relationship concept is to be found in Chen (1976). Fidel (1987) puts the focus on the design stage of development. This book emphasises the entity-relationship model heavily. Gause (1989) is a helpful guide for the early stage of the design process. The use of E-R diagrams is illustrated with good examples. Howe (1983) suggests a different approach to Chen using "foreign keys" to reduce the number of relations in the resulting model. Verheijen (1982) describes E-R models with relationship-naming in both directions.

Relationship Notations

There are a number of different notations currently in use for representing the relationships between modelled objects. For instance, all of the examples in the figure below represent a simple one-to-many relationship between object A and object B.

Some notations (such as (i) and (ii)) are somewhat restrictive, partly for historical reasons. Notation (ii) was designed by Charles Bachman for the diagrammatic representation of Codasyl database descriptions. Other notations (such as (iii), (iv) and (v)) are capable of supporting different types of relationship, not just the simple one-to-many relationship. Notation (iii) is described in detail by Robinson (1981); notation (iv) is the standard used for the E-R diagrams in the reports of this project and is described by Rock-Evans (1981); notation (v) was designed by Chen (1976).

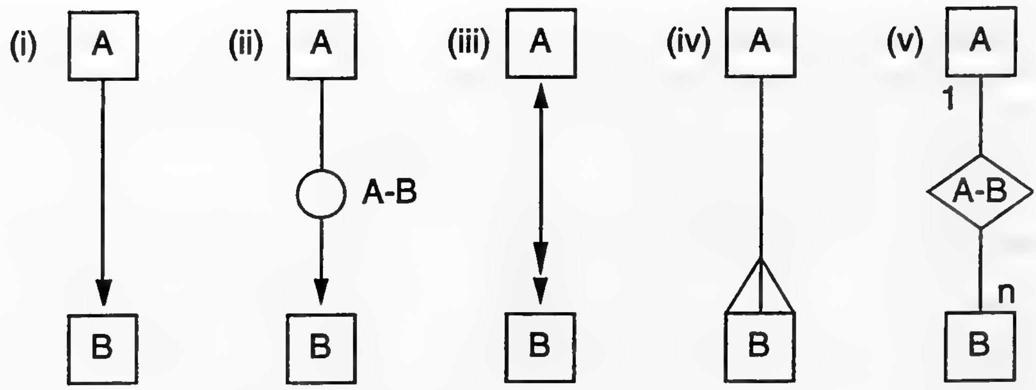

Figure 2.3.2: Different One-to-many Relationship Notations

2.3.4 Metadatabase Development

Metadata are defined as:

> *"Information regarding the location, source, content, or other specifics in relation to actual data".*

A *metadatabase* is thus a database that has been designed and implemented to hold the requisite metadata. A metadatabase operates in the exactly the same way as a "normal" database, although the underlying data model reflects a quite different content. The definition of "metadata" given above is deliberately non-specific; the level and detail at which metadata is collected and recorded is entirely flexible and is determined by the designer of the metadatabase.

At the highest level, a metadatabase can essentially be a "catalog" of organisations, for example the United Nations Environment Programme (UNEP) HEM-Disk (Harmonization of Environmental Measurements) (UNEP, 1994) and European Environment Agency (EEA) Catalog of Data Sources (CDS) (Pinborg 1992). These catalogues can record detailed operational details of the organisations (postal address, telephone numbers etc) and describe, in broad terms, the data management areas of the organisations.

Catalog-type metadatabases such as the Consortium for International Earth Science Information Network (CIESIN) Catalog Service (Burley, 1994) can additionally hold information on the specific datasets that the organisations manage.

The metadatabase constructed by UNEP-GRID (Global Resource Information Database) (UNEP, 1992) provides no information about the organisation directly to the user. The metadata is confined to the two levels of **dataset** and **member** of dataset.

At the lowest level, a metadatabase holds complete information of the data structures of a database. This kind of information is commonly referred to as a "data dictionary". This kind of information is too detailed to be held except within an organisation. An example of such a metadatabase is the one developed by the World Conservation Monitoring Centre (WCMC). This internal metadatabase holds information on the tables within the centre, such as the width of fields and the datatypes that they contain, (eg "integer", "character").

Countries have the option of either constructing a metadatabase of their own or contributing to a pre-existing database, or doing both.

In order to facilitate the national and international exchange of datasets and assist an institution in querying the metadata obtained during the institutional survey, countries may decide to construct a metadatabase of their biodiversity information holdings. This should be viewed as an adjunct to the institutional capacity survey, not a necessary and integral part of it. Many such initiatives are currently being developed around the world, and countries are strongly advised to follow the recommendations below if they wish their metadata to be nationally and internationally compatible.

The metadatabase will concern itself with the actual **information** that an institution manages (and very brief background details about the institution such as its address and title) and not with the resources that it uses to manage that information.

Metadatabase and Data Dictionary tools
The terms "metadatabase" and "data dictionary" are frequently used interchangeably. If a distinction between the two is to be made, then a data dictionary is usually a record of the data definitions for a database (data structures etc); a metadatabase is broader in its scope (see definition of "metadata" at the beginning of this section).

A standard mode of operation for data dictionaries is defined by the Information Resources Dictionary System (IRDS) (Malamud, 1989). IRDS has been adopted as a standard by the American National Standards Institute (ANSI) and is also being developed as an international standard by the International Organization for Standardization (ISO). IRDS defines a set of standard operations on meta-data. These standard operations, such as retrieving the definition of an element, allow a consistent method for accessing meta-data as well as allowing the migration of data definitions from one dictionary to another.

The key advantage of an IRDS-based environment is the extensibility of the data dictionary. If a user wishes to store definitions for a new type of information, say "projects", IRDS can be extended to include information about this new type of information.

Vinden (1990) describes the three principal software tools that give full data dictionary facilities as: *Cullinet Data Dictionary*, *IBM Data Dictionary* and *Datamanager Data Dictionary*. Vinden also mentions other software with lower functionality:- *M204 Data Dictionary, ADR Data Dictionary, TIS Directory, Nomad 2, Data Catalogue 2* and *Predict*.

Metadatabases, due to their more custom-built nature, do not exist as "off-the-shelf" software tools. Generally, each metadatabase developed has unique requirements that needs unique functionality and for this reason the developer generally uses low level programming languages (eg C, Fortran), hypertext environments (eg FolioViews, NCSA Mosaic), or database software (eg Oracle, SQL Server, FoxPro).

Metadatabase Formats

In order to facilitate the exchange of data it is important that the metadatabase format (ie the structure of data entries) and terminology conforms to internationally accepted standards. This will facilitate both cooperation and data-sharing between similarly-oriented national institutions and their counterparts in neighbouring countries, and with organisations with international (as opposed to national) scopes. Further details of currently accepted metadatabase formats and that proposed by WCMC are given in Document 3, currently under development as part of this series.

The syntax used is based on that defined by the U.S National Aeronautics and Space Administration (NASA) in its *Directory Interchange Format* (DIF - see WDC 1991). This syntax allows the contents of the metadatabase to be output into a standard digital text report which can then be unambiguously understood by other organisations using the same format. By following the syntax precisely, (ie putting in field titles and field values exactly as defined, separated by colons ':' etc) we provide the possibility for an organisation to "auto-ingest" metadata. Thus, rather than the metadata exchange being manually typed into the system, the ASCII metadata file can be read in electronically.

2.4 Framework Issues

2.4.1 Custodianship and Information Access

An important key to effective management of biodiversity data is to have the data held by that institution which is best qualified to ensure its quality and ready availability. "Custodianship" is the means by which responsibility for a dataset is assigned to and accepted by the most appropriate agency. It provides a mechanism to ensure that each information holding is established, maintained and made available by that agency best able to do so. Custodianship implies responsibilities towards data acquisition, management and documentation, as well as a role in determining the conditions under which information is accessed and used.

Responsibility for each dataset must be clear and unambiguous. One agency must be the designated custodian for the dataset as a whole, although entities within the dataset may be maintained by others. An example would be a species-site dataset held in a protected-area management agency, where the species authority files within that dataset could be maintained by national collection management agencies such as museums and herbaria.

Custodianship needs to be managed at multiple levels. At the national level, responsibility for broad themes should be allocated among the various government departments, eg topographic infrastructure such as national boundaries, topography, roads, rivers, etc to the central mapping agency, and so on. These agencies should build datasets to support decision making at that level, in consultation with key users. Datasets to support regional and local activities should be built by agencies, or regional offices of national agencies, at or close to those levels. All these activities need to be coordinated at various levels to ensure standards are adhered to, overlap and duplication are minimised, and local-scale datasets can be smoothly integrated and generalised to support national-level decision making.

All datasets required to support environmental assessment and decision making are complex and require the involvement and supervision of professionals. Key issues are sound design, development and adherence to standards and quality assurance, and provision of documentation and advice on appropriate uses.

Although there are major gaps, and not only in developing countries where the scientific and technological infrastructure is inadequate, there is a great deal of existing information on the environment. Unfortunately, much of it is largely inaccessible and contributes very little to environmental assessment and decision making. This is because the data are stored in obsolete or inaccessible forms, are poorly standardised and documented, or the institutional culture is unsympathetic to their wider access and use.

Decision makers and other end users are seldom able to use raw, unprocessed data. They require data relevant to some particular issue to be selectively extracted, integrated with other data, perhaps assessed by specialists, and summarised into information. The concept of custodianship also includes responsibility for being a source of advice on those modelling and analytical tools that are most appropriate to integrate and summarise data.

Custodians are responsible also for management of the various licensing agreements, which can become quite complex. Every effort should be made to develop relatively simple generic licences for data access and use within each jurisdiction. 'Memoranda of Understanding' and similar high-level mechanisms that would allow the unrestricted flow of information between agencies should be negotiated. Successful biodiversity management requires ready access to many datasets from a wide variety of institutions. There should be an absolute minimimum of administrative, cost and other impediments to the flow of information, consistent with protection of copyright, intellectual property and other legitimate custodian rights. Any obstacles to the free flow of information will inevitably inhibit responsible decision making and sound biodiversity management.

Consistent with protection of custodians' legitimate interests in the data, there should be a minimum of administrative, cost and other impediments to the free flow of data among agencies. In the past, agencies rarely devoted much attention to comprehensive dataset documentation. This is because datasets were usually built for one specific project by people who well understood the nature of the data and any deficiencies and caveats. At the end of the project, each dataset was usually archived, filed or (commonly) neglected. Dataset documentation has always been regarded as desirable, but has seldom been accorded a high priority because no one believed it would be of much real value.

Because datasets can and must be used for multiple purposes within the institution and as part of the overall national biodiversity information system, comprehensive documentation of datasets is increasingly being recognised, not only as an important obligation of data custodianship, but also as a strategic corporate asset. Dataset documentation must, therefore, be planned for and the necessary resources allocated.

2.4.2 Legal Issues

The transfer of information - for instance on resources, on government strategies, policies and legislation - may impinge on legal and conceptual views of sovereignty and security. The CBD is careful to try to minimise this issue with such words as "*Recognising the sovereign rights of nations over their natural resources...*", but the effective exchange of information on biodiversity resources and related technology can only occur in an atmosphere of mutual trust. The principle of mutual benefit must over-ride concerns of misuse of the information for strategic or political purposes.

The transfer of bio-technology information and other enabling technology, including software (whether between nations or within the country) may be restricted by copyright, patents and the like, and the *ownership* of technology may not always lie with government authorities, but with private sector companies.

While the details of the laws differ between countries, it is often the case that the provider of information - which turns out to be incorrect and causes harm as a result - may be held liable for the damage caused. This liability could fall on the providing agency or the designated custodian or both. This is especially true if there is "negligence", where, for instance, no reasonable attempt was made to ensure quality, or poor information management practices allowed information to be corrupted. The establishment of a network of expert custodians coupled with quality management procedures (eg meeting ISO-9000) in the national biodiversity information management process would likely eliminate any possibility of negligence, and greatly reduce the chances of being considered liable.

The spirit of the CBD encourages open and free access to biodiversity information. This may impinge on considerations of information "ownership" and copyright. The above issues are not unique to biodiversity, and are the subject of considerable discussion and debate in the literature. A useful references for further reading is Obermeyer (1994).

This book covers a number of important issues relevant to custodianship, access and legal issues surrounding spatial data - all of which are applicable more widely to biodiversity information in general. Chapter 9 deals with the question of the qualifications of GIS specialists and Chapter 10 (GIS in a Democratic Society) deals with such issues as, copyright, privacy and confidentiality, liability, data sharing and distribution etc.

Ayers (1994) deals well with issues regarding the professional conduct and liability of technology practitioners. For articles and books dealing with legal issues regarding data and information distribution, see Archer (1989), Clark (1981), Epstein (1990), McLean (1989), and Onsrud (1989).

2.5 References

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3 TOOLS for MANAGING DATA

3.1 Selection of Hardware and Software

3.1.1 Selection of Computer Software

There are many factors to be considered when buying software. In most applications it is more important than the hardware. Often, however, the hardware already exists and the software must be adapted to it.

Software may either be bought as an off-the-shelf product, providing you have or can get the hardware to match it, or a new package can be developed specifically for the application in mind (or perhaps modified from an existing package to meet the specific requirements). The arguments for and against both these approaches are discussed in FAO (1986).

Software can be run on a bewildering variety of different classes of computer. Because many software packages are written for a specific type of hardware, knowing which computers will be used to run the application will eliminate some software packages from consideration.

3.1.2 Selection of Computer Hardware

If hardware as well as software is being bought, then the best match between the system needs (and budget) and the various hardware options available needs to be determined. Establishing criteria for sizing applications is a complex process and is discussed at length in Bentley (1984). The following are some preliminary, basic questions that can be used to narrow down the hardware choices before moving on to the selection process discussed in the next section.

How many people need simultaneous access to the data ?

If the answer is one, a microcomputer (PC) is the best choice, unless a very large amount of data needs to be handled. Fairhead (1992) provides an excellent, comprehensive guide to the technical options available for PCs and discusses their practical implications for the user. For simultaneous access by more than one person, a workstation is a better choice.

How much data will need to be managed (hundreds or millions of records)?

If the plan is to store and manipulate a large volume of data, the options to consider include networks, minicomputers, and possibly client-server architecture. In the business world, mainframe computers would also be considered, but these are a very rare (or even, non-existent) choice in the biodiversity world. Mainframes and large mini-computers provide a processing power and speed of response that is generally not required and at a price that is generally beyond the budgets of biodiversity-related institutions. What *is* frequently required for biodiversity information is the ability to store and access very large amounts of data.

3.1.3 The Selection Process

The selection and purchase both of software and of hardware follows a similar path that can be broken down into the following 8 stages. These stages are discussed in more detail in Wright (1988).

Decide What is Required of the System
If necessary, obtain advice on realistic expectations from impartial organisations (eg institutions using computers to manage similar quantities and complexities of data).

Feasibility Study
In most cases, the development of a system to manage biodiversity information should not be breaking wholly new ground. Someone, somewhere will already have done something similar. If a formal feasibility study is needed, it might be a task best left for skilled systems analysts or other experts.

Prepare Specification
Success in selection is more likely if a detailed and accurate specification of the needs is produced. Specification guidelines and checklists can be found in various publications, including Standards guide, but at a minimum the following should be included:

- the system's objectives and functions
- the work load to be executed (volumes of transactions to be input, processed, output, stored)
- performance targets
- special requirements in hardware, software and support services
- operational requirements (availability targets etc).

Beware of giving an indication of the expected cost on the specification. If this is done, the quotations will likely be at or slightly below the price you have suggested and quotes will not be truly competitive.

Invitations to Tender
For first-time computer users there will usually be no shortage of potential vendors - though this will depend on the global location of the institution. Some countries may have a very restricted list of potential suppliers. Valid factors to be used in pre-selection include:

- country of origin of machine or software package
- reputation of supplier
- locality of supplier (local suppliers have obvious advantages).

Evaluate Tenders
Tenders submitted can be evaluated against an almost endless list of criteria, but the following criteria should be amongst those used:

- **Specification**
  Does the solution proposed fully meet the specification?

- **Price**
  Purchasers of computer products occasionally use this as their *only* criterion for selection, which is seldom useful for decision making.

- **Additional Functionality**
  Does the solution proposed have functionality that was not in the specification, but would nonetheless be useful? For example, does the user interface provide labour-saving tools?

- **Ease-of-Use**
  The more easily a product can be used, the better. Software products that require an expert programmer to keep them going will have limited appeal in the biodiversity community.

- **Follow-on Services**
  Does the supplier readily provide product upgrades, product maintenance and technical support? Will they make visits to your site to fix problems? Are these services free; if not, how much will they cost? What is the warranty period ? A clear indication of the cost of maintenance outside the warranty period must be obtained.

- **Product Reputation**
  Does the product already have a large market share? Is it well-known? A popular product does not guarantee that it is a good product, but it is a good indicator of value-for-money.

- **Vendor Reputation**
  Is the potential vendor well-known, with a solid reputation ? Small-scale vendors can give an excellent personal service that is responsive to the needs of the client and they should not be discounted solely on the grounds of small size. However, proceeding with an unknown, start-up vendor can be risky.

- **Product Durability**
  Does it appear that the proposed solution is going to rapidly become obsolete ? For example, a software proposal that is based on a hardware platform that is being superseded is not a good selection. A product that is inflexible and cannot be modified to address unforeseen requirements can also cause problems.

  Is the solution "expandable"? For example, can the proposed computer system be upgraded in the future to a faster CPU chip or have its memory expanded with the addition of memory chips? In the case of DBMS software, can the data tables be expanded far beyond their currently specified size?

- **Compatibility**
  Is the solution compatible with other products? For example, buying a Personal Computer that is IBM-compatible (as are more than 90% of current PC purchases) makes the subsequent purchase of hardware peripherals, software or exchange of data relatively straightforward. Buying DBMS software that uses SQL and DBF data

format will facilitate the exchange of data.

- **Performance**
  Analytical investigation of the comparative performance claimed. This is probably the hardest of these criteria to assess.

  Performance of both software and hardware products are frequently estimated in computer publications in terms of comparative "benchmarks". These are lists of values that are intended to objectively give a rating for the performance of a product in a specific test. For example, the time in seconds for a DBMS to retrieve a data item from a standard test database could be quoted; the shorter the time, then the faster the DBMS. Fairhead (1992) provides a list of standard benchmarks, along with a brief description of what they measure and how the test is done.

  Benchmarks need to be measured with all other factors, other than the product being benchmarked, standardised. For example, if DBMS software is being compared, then the test has to be conducted with the software installed on the same computer system.

  Anderson (1993) published a review of 14 DBMS packages for the PC Windows environment. The article presents a table of benchmark performance tests on the DBMS packages. Anderson considers that it is impossible to benchmark database managers satisfactorily. Because different database managers all have a different implementation of database management tools, the same query may be easy for one and hard for another. Choose a different query and the reverse may apply. However, his message is: do not attach major significance to small performance differences. Its major differences, by factors of 100% or more, that probably say something about the inherent performance of the product.

  PC Direct (1994) reviews several different PCs and comments that machines with similar configurations often perform very differently. To help the confused purchaser, the magazine review includes a comprehensive set of benchtests for both Dos and Windows that give benchmark test results as a ratio compared to the 1.00 score assigned to their chosen benchmark machine. If a computer system is twice as fast as the benchmark machine in the test, a figure of 2.00 would be assigned.

  However, benchmarks are notoriously unreliable in providing an objectively complete assessment. It can be very hard to standardise the testing environment or to chose tests that do not unfairly favour or discriminate. Benchmarks published for a product in an advertisement are often optimistic and may not reflect the particular requirements of the intended application. If product reliability and speed is a critical consideration, the purchaser may have to test the software/hardware himself.

- **Short-listing**
  Based on the tender documents. This process should result in a short list of 3 to 5 proposals that are outwardly satisfactory.

- **Acceptance Test**
  The final opportunity to ensure that the system to be delivered meets the specification in its essential points.

3.2 Software Tools

3.2.1 Overview

This section is intended to provide guidance on how to select and purchase specific software tools. Each of the following sub-sections is therefore divided into two parts dealing with selection criteria and software listings respectively. A standard template was used to describe software products, although some flexibility was required in describing particular products. The software template is presented below:

Product Name	Name (plus acronym) of the package.
Publisher	Contact details for further enquiries.
Category	Category/sub-category of software, eg database management system; spreadsheet; general statistics package.
Configuration	Operating system/environment for which the package is intended (eg DOS, MS Windows, Mac, UNIX, NeXT). Minimum hardware requirement where known.
Languages	Availability and description of programming languages supplied.
Version	Most recent version.
Users	Approximate number of licensed users worldwide.
Availability	Software license arrangements (hardware key, full edit work station, read-only etc); documentation and support.
Description	General descriptive information on the software. Taken from several sources, including promotional materials from manufacturers, magazine reviews, and standard software listings.

Note that in the case of database management systems and spreadsheet packages, the functionality of different products is also presented in tabular form.

3.2.2 Database Management Systems

All databases - whether they are simple card index programs or full blown professional development systems - store records of information in computer disk files, rather like record cards in a filing cabinet.

All database management systems provide a way of entering new records and changing existing ones through screen forms - usually you can design your own layouts. They will also let you search for specific records and let you sort records into different orders. Finally, all databases let your design reports in which you can print details of the records you have selected in the order you want them.

Flatfile databases are the simplest (and are often included as a part of integrated packages like Microsoft Office[1]) and are best suited to applications such as mailing lists. If you want to go further you will need to be able to link (or 'relate') data held in a number of different files. Most databases today are "relational" in one form or another and the majority follow a non-programmed approach by getting the user to complete on-screen forms or choose menu options.

The most sophisticated databases are programmable. They allow you to handle more advanced data structures and tailor the resulting database to your own needs. The drawback is that they are difficult to learn to program.

Selection Criteria
Some of the most important options to consider when deciding which DBMS to select are described below.

- **Flat File vs Relational**
  A flat file database is the simplest form of design, allowing the user to work with only one table at a time. This means that you can not link data from more than one table using a flat file database.

  Relational databases can combine data from two or more tables. The linking between tables is usually done via key values.

- **Data Validation**
  This is the process of ensuring - as far as possible - that information held on the database is correct. This is usually done when data is edited or entered via a form by checking it against other data and format rules.

- **File Import/Export Formats**
  Occasionally you will need to transfer data between databases or receive data from somebody who uses a different database. Most databases support ASCII files (with fields delimited by special characters like tabs or commas), but these do not contain any formatting information or identify different field types.

  If you want to preserve the special formatting information held in a database file your database will need to support imports and exports to a range of different applications. The most important file type to support is DBF - the format used by dBASE, the product that originally popularised the use of database applications on personal computers.

- **Form Designers**
  A form is a screen display with fixed captions plus areas for variable (database) data to be displayed. Forms can be used to allow an operator to enter new data or edit existing data. You can think of database forms in the same way you would a paper

[1] Trademark of Microsoft Corporation

form.

Any worthwhile database will provide a *form designer* to help you. It should let you choose the position and style of captions and data areas and even personalise your own forms with the inclusion of institution logos or other graphics. For example, Microsoft Access has a 'Forms Wizard' that leads you through the process of designing a form by asking questions about what you need to include in the form.

- **Indexes**
  An index is a set of pointers that give fast access to individual records, plus the ability to access records in a particular order. These are particularly important for very large databases. For example, retrieving a particular record or set of records from the more than 2 million records stored in the Convention In Trade in Endangered Species (CITES) Wildlife Trade Database held at World Conservation Monitoring Centre (WCMC) would be prohibitively slow without the use of an index. An index is particularly useful if there is one field you regularly sort on because it allows faster sorting than is possible on non-indexed fields.

  The data value an index is based on is called a key. For example, a "country of export" key in the CITES database allows the rapid location of wildlife product exports from a particular country and allows the production of shipment reports in "country of export" order.

- **Programmability**
  Many databases are non-programmable - you complete tasks by filling in on-screen forms or choosing menu options as with word processors or spreadsheets. But the need can arise for a specialised database or a higher level or performance. Often, the only way to get this by using a programmable database and write the application yourself (or pay somebody else to do it).

  The advantages of using a programmable database are twofold: flexibility and power. You can design a database tailored exactly to your needs and update it as necessary. Programmable databases also provide the tools to manipulate and validate data in ways not possible with non-programmable ones - and the resulting program can run more quickly too. The major disadvantage is that programmable databases are usually hard to learn how to use and should only be used when a need is identified.

- **Report Designer**
  A database must allow you to extract the information you want from it, in the style that you want and to produce this as a printout (or report). Most database management systems have tools to help you design reports that you require. The report designer should allow you to combine data from more than one table and format it in a professional way.

- **SQL And Client-Server Architecture**
  Structured Query Language (SQL) and the concept of client-server architecture are closely linked and are now increasingly common on PC networks.

Normally a PC database is a single program that handles both the data files and the user interface (forms, reports and so on) but these responsibilities are spit in a client-server system. One application - the client - looks after the user interface, while another - the server - manages the data files at a central location (usually the network file server) and can deal with many clients on a network simultaneously.

Of course, the client and the server have to be able to communicate and the most widely used language for this is SQL. SQL and the client-server architecture started life on mainframe and mini-computers, so that the early PC client applications had to be developed in other languages like C or Pascal. Now, however, PC databases such as Paradox, Approach, dBASE and Access provide SQL support.

- **xBASE Standard**
  Many of the available PC databases use a generic data storage and programming methodology based on those used in the dBASE package. Use of an xBASE system will facilitate the likelihood of trouble-free Import/Export of data with other databases.

Is a user friendly interface important?	Y →	Consider a Windows database. Needs a good form designer
Will you need to link data from more than one table?	Y →	Choose a relational database
Will more than one person need to access the database at any one time?	N →	Choose a flatfile database
Do you need to design complex database structures?	Y →	Choose a database with network support
Do you need to distribute copies of your database?	Y →	Choose a programmable database
Do you need to access the data in lots of different ways?	Y →	Choose a database with SQL support
	N →	Choose a database with query-by-example support
Will you need to include graphs, summations or totals in your reports?	Y →	Choose a database with a specialised report generator
Do you need to use files from other databases?	Y →	Choose a database that supports the import/export file formats
Do you have any unusual requirements ?	Y →	Choose a database that supports these requirements

Figure 3.2: Choosing the Right Database

The options discussed above, in combination with others, can be used to make a decision on which DBMS will best serve the needs of the overall information system. Figure 1 illustrates this process.

Software Listing
The following is an alphabetically-ordered list of the commonly used database management system software, with the approximate cost of a license and name of vendor. The vendors listed are those sales branches located in the United Kingdom. These branches can provide customers with details of branches located in other countries.

Product Name	**Access**
Publisher	Microsoft Corporation
Category	Database management system
Configuration	Windows 3.0 or higher. IBM-PC 386 or higher, 4 Mb RAM or higher.
Languages	Access Basic.
Version	2.0
Availability	£395 single-user license.
Description	Part of the Microsoft Office family of applications; modern, easy-to-use end-user Windows relational database. Suitable for small-mid sized applications only (<20 users, 100,000-500,000 records).

Product Name	**Advanced Revelation**
Publisher	Revelation Technologies Ltd
Category	Database management system
Configuration	DOS; Windows 3.1 or higher. IBM-PC 286 or higher (DOS); IBM-PC 386 or higher (Windows).
Version	2.1
Availability	£895
Description	Powerful relational database distinguished by variable-length, multi-valued fields.

Product Name	**Approach**
Publisher	Lotus Development Corporation
Category	Database management system
Configuration	Windows 3.1 or higher. IBM-PC 386 or higher, 6 Mb RAM or higher.
Version	3.0
Availability	£95
Description	End-user relational database for Windows, integrated well with other Lotus programs such as SmartSuite and Notes.

Product Name	**DataEase**
Publisher	DataEase International Inc
Category	Database management system
Configuration	DOS 3.1 or higher; Windows 3.1 or higher. IBM-PC 8086 or higher, 640 Kb RAM (DOS); IBM-PC 386 or higher, 4Mb RAM or higher (Windows).
Version	4.53 (DOS; 1.1 (Windows).
Availability	£425 (DOS); £249 (Windows).

Product Name	**dBASE 5.0**
Publisher	Borland International Inc
Category	Database management system
Configuration	DOS 3.1 or higher; Windows 3.1 or higher. IBM-PC 386 or higher, 8 Mb RAM (DOS and Windows).
Languages	xBASE.
Version	5.0 (1994).
Availability	£347 (DOS); £245 (Windows) single-user license.
Description	Totally rewritten version of this widespread database. Now includes "two-way tools", object oriented event-driven programming, client-server readiness, and numerous graphical application development tools.

Product Name	**FoxPro**
Publisher	Microsoft Corporation
Category	Database management system
Configuration	DOS 3.0 or higher; Windows 3.0 or higher; Mac; UNIX. IBM-PC 8086 or higher, 1 Mb RAM (DOS); IBM-PC 386 or higher, 4 Mb RAM or higher (Windows).
Languages	xBASE derivative.
Version	2.6 (January 1995).
Availability	£77 single-user licence.
Description	High performance, cross-platform, relational database application development tool. Market leader in xBASE. Will be fully integrated into Microsoft family in next version "Visual FoxPro 3.0", out mid-1995.

Product Name	**Ingres**
Publisher	Computer Associates
Category	Database management system
Configuration	UNIX
Languages	Ingres 4GL
Version	6.4
Description	Well-established relational database system for UNIX.

Product Name	**Oracle**
Publisher	Oracle Corporation
Category	Database management system
Configuration	UNIX
Version	7
Cost	£695 two users.
Description	The best know UNIX database, suitable for even very large database applications and client-server architectures.

Product Name	**Paradox**
Publisher	Borland International Inc
Category	Database management system
Configuration	DOS 3.3 or higher; Windows 3.0 or higher. IBM-PC 286 or higher, 2 Mb RAM (DOS); IBM-PC 386 or higher, 4 Mb

	RAM (Windows).
Languages	PAL (Program Application Language - proprietary).
Version	4.5
Availability	£349 (DOS); £88 (Windows).
Description	Advanced PC relational database development system. The PAL language provides developers with a lot of power and flexibility; though not always suitable for the novice programmer.

Comparison of Functionality

Table 3.1 below provides a comparison of the functionality of the most popular database packages.

A more comprehensive review of 100 database management systems can be found in [1]. Popular computer magazines, such as *What PC?* carry regular "buyer's guides" for software packages, including comparison tables for database packages. These should be consulted to obtain the most up-to-date view on the current state of the market.

DBMS	*T*	*M*	*P*	*Tb*	*SQL*	*xB*	*WW*	*Lang*
Access 2.0	R	Y	Y	255	Y	Y	N	Euro
A-Rev	R	Y	Y	Un.	Y	N	Y	F,G
Approach 3.0	R	Y	N	10	Y	N	Y	Y
DataEase	R	Y	Y	32	Y	Y	N	15
dBASE IV 5.0	R	Y	Y	99	Y	Y	Y	F,G,S
Foxpro 2.6	R	Y	Y	225	Y	Y	Y	Euro
Paradox 4.5	R	Y	Y	24	Y	N	Y	Y

Table 3.1: Comparison of Functionality of the Most Popular Database Packages

KEY	T	-	Type of database (R = relational, F = flat file)
	M	-	Menus and macros provided
	P	-	Programmable
	Tb	-	Maximum number of tables open (Un. = unlimited)
	SQL	-	Integral SQL included
	xB	-	xBASE software
	WW	-	Word-wrapping editor
	Lang	-	Non-English languages available (F = French, G = German, S = Spanish, Euro = all European).

3.2.3 Spreadsheets

Spreadsheets are basically simple things - little more than automated graph paper. You enter some values into the squares or 'cells' and the spreadsheet does the calculations and puts the answers in other cells.

Some modern spreadsheets, however, have gained so many additional features that the newcomer may be baffled by the apparent complexities.

A few years ago, the only words and concepts you needed to grasp in order to use a spreadsheet efficiently were "cell", "function", "formula", "macro" and "database". Now you can add to that list a few other essentials such as "3D", "multidimensional", "workbook" and "spreadsheet publishing".

Despite the obvious capabilities of spreadsheets, you should *not* use a spreadsheet as a database management system. Spreadsheets are specifically designed to be used for complex calculations, not for flexible management of documented data. With spreadsheets, it is usually not possible to relate different files, the search/report facilities of spreadsheets are limited and sometimes non-existent (which can make information retrieval very difficult), the

modification of stored data can also be time consuming - especially when working with large data files.

If you want to store large amounts of data in several files, these limitations will cause you many problems. The use of spreadsheets should be restricted to the tasks they were designed for performing complex calculations.

Selection Criteria

- **123 Compatibility**
  Lotus 123 defines the standard file format for PC spreadsheets and most competing products provide some degree of 123 compatibility. At the very least, a spreadsheet should be able to load and save 123 worksheets. However, not all spreadsheets are able to load the macros and formulae that may be embedded in a 123 worksheet. Following Lotus' successful legal action against Borland's Quattro spreadsheet, 123 compatibility may no longer extend to the user interface of a spreadsheet.

- **3D**
  A single worksheet calculates and formats data in two "dimensions" - the height and breadth defined by its rows and columns. A 3D spreadsheet adds depth by allowing calculations and formatting to "penetrate" through into the cells of several worksheets conceptually arranged behind one another like the pages of a book. Three dimensional spreadsheets are sometimes called multi-page spreadsheets.

- **Add-Ins**
  New spreadsheet tools and utilities are often implemented in the form of templates or files of macros that can be loaded (added in) whenever needed and subsequently unloaded in order to free up computer memory. Many third party suppliers provide commercial add-ins for the leading spreadsheet products. Inevitably, Lotus 1-2-3 is the best supported in this respect with Microsoft Excel and Quattro Pro not far behind.

- **Cell**
  A cell is the smallest unit of a worksheet. Each cell may contain a single datum and may also contain a formula to calculate data. A cell is formed by the intersection of a row and column.

- **Chart Editor**
  Most (but not all) spreadsheets can generate graphic charts from worksheet data. For example, a spreadsheet recording trade in wildlife products could automatically generate a pie-chart to show the sectoral breakdown of the trade.

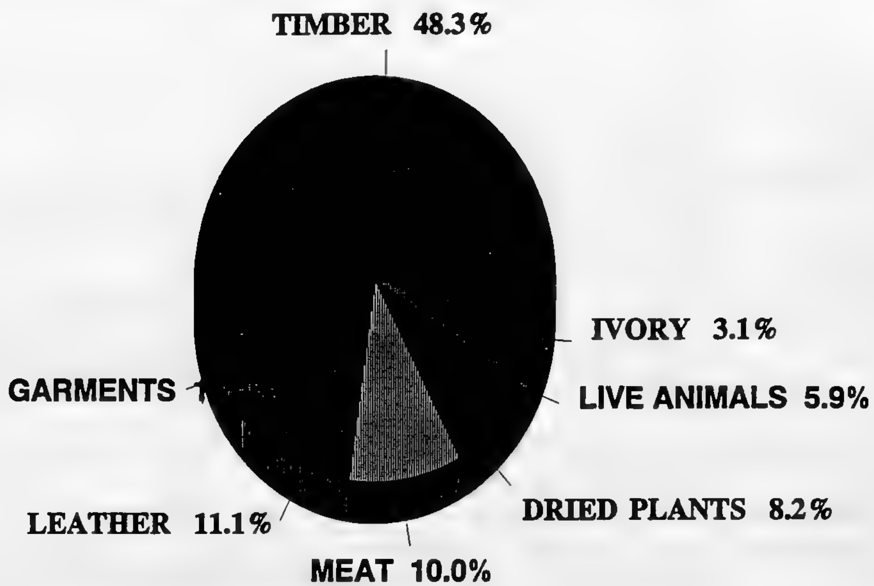

Figure 3.2: Example of a Pie Chart

The best spreadsheets also include interactive chart editors to allow you to add labels and lines, change the colours and fill-patterns or even alter the perspective of the chart.

Spreadsheets have changed considerably over the years. Options that would once have been attractive have now become either redundant, or universally adopted. Market leaders such as Excel, Lotus 1-2-3 and Quattro Pro all offer a similar range of facilities. Consequently, choosing a suitable spreadsheet is considerably easier than choosing a database management system.

Software Listing

The following is an alphabetically-ordered list of the commonly used spreadsheet software, with the approximate cost of a license and the name of vendor. The vendors listed are those sales branches located in the United Kingdom. These branches can provide interested parties with the details of branches they have located in other countries.

Product Name	**CA-SuperCalc**
Publisher	Computer Associates
Category	Spreadsheet package
Configuration	DOS 3.0 or higher; Windows 3.1 or higher. IBM-PC 8086 or higher, 512 Kb RAM (DOS); IBM-PC 386 or higher, 4 Mb RAM (Windows).
Version	5.5 (DOS); 1.0 (Windows).
Availability	£69 (DOS); £73 (Windows).
Description	Complete analysis solution offering full-featured spreadsheeting and multi-dimensional modelling, along with charting, auditing, security and automation.

Product Name	**Excel**
Publisher	Microsoft Corporation
Category	Spreadsheet package
Configuration	Windows 3.0 or higher; Mac. IBM-PC 386 or higher, 4 Mb of RAM; 2 Mb RAM (Mac).
Version	5.0 (Windows); 4.0 (Mac).
Availability	£243 single-user licence.
Description	Part of the Microsoft Office family of applications; market leader spreadsheet taking performance to the highest level. Next release will include basic desk-top mapping facilities and geo-reference capability.

Product Name	**Lotus 123**
Publisher	Lotus Development Corporation
Category	Spreadsheet package
Configuration	DOS; Windows 3.1 or higher. IBM-PC 286 or higher, 1 Mb RAM (DOS); IBM-PC 386 or higher, 4 Mb RAM (Windows).
Version	5.0.
Availability	£239 single-user licence.
Description	Enhanced version of the most popular database of the 1980s, now available for DOS and Windows.

Product Name	**Lotus Improv**
Publisher	Lotus Development Corporation
Category	Spreadsheet package
Configuration	Windows 3.1 or higher. IBM-PC 386 or higher, 4 Mb RAM.
Version	2.1
Availability	£135
Description	Dynamic spreadsheet for Windows, permitting instant rearrangement of data presentation. Well specified with mathematical modelling and analysis functions.

Product Name	**Quattro Pro**
Publisher	Borland International Inc
Category	Spreadsheet package
Configuration	DOS 3.3 or higher; Windows 3.0 or higher. IBM-PC 8088 or higher, 640 Kb RAM (DOS); IBM-PC 386 or higher, 2 Mb RAM (Windows).
Version	5.0
Availability	£38
Description	Comprehensive spreadsheet solution for usability, data analysis and connectivity.

Comparison of Functionality

Table 3.2 below provides a comparison of the functionality of the most popular spreadsheet packages.

Spreadsheet	*Size*	*Shts*	*G*	*Chts*	*Fncs*	*3D*	*123*	*Lang*
CA-SuperCalc	255 x 9999	255	Y	9	205	Y	Y	7
Excel 5.0	255 x 16384	9	Y	83	310	N	Y	Y
Lotus 123 5.0	256 x 8192	256	Y	200	103	Y	Y	Y
Lotus Improv 2.1	4.2b cells	Un.	Y	20	161	Y	Y	N
Quattro Pro 5.0	256 x 8192	32	Y	15	115	Y	Y	8

Table 3.2: Comparison of Functionality of the Most Popular Spreadsheet Packages.

KEY
- Size - Maximum worksheet size (no. of columns x no. of rows)
- Shts - Number of worksheets open simultaneously (Un. = unlimited)
- G - Graphics facility
- Chts - Number of chart types
- Fncs - Number of functions
- 3D - 3 Dimensional worksheets
- 123 - Compatible with Lotus 123
- Lang - Non-English languages available (TBA = To Be Announced)

3.2.4 Statistical Packages

Elementary data analysis procedures, such as summation and averaging, are standard features of most database and spreadsheet packages. They enable data to be summarised with relative ease in the form of lists, tables, and charts. Typical tasks include the determination of species numbers in a given area, or average population densities from quantitative data.

However, in many situations it is necessary to apply more complex statistical procedures to biodiversity data in order to obtain the required outputs. Some examples of situations demanding more complex analyses are:

- assessment of population trends using *time-series analysis*
- modelling of species-habitat relationship using *canonical analysis*
- assessment of biodiversity indices using *weighted summation*
- assessment of protected area complementarity using *clustering algorithms*.

Selection Criteria
Three distinct approaches to performing statistical analyses are common. The first is to develop one's own custom statistical routines using a computer programming language; the second is to make use of non-commercial programs that have been written by academics to perform specific statistical procedures (in some cases the source code for such programs may be supplied, allowing alterations to be made); the third is to make use of the predefined statistical routines offered by a commercial statistics package.

This first approach provides the greatest flexibility in designing statistical routines, but does require a good knowledge of statistical theory and programming techniques. In some cases the task may be simplified by drawing on third party "libraries" of commonly used statistical routines, or alternatively, implementing published program listings directly (these are referred to as "numeric recipes"). Libraries and program listings are commonly available for the "C", FORTRAN, and BASIC programming languages, plus some less widely used languages such as PASCAL. A selection of program listing sources is provided at the end of this section.

The second approach depends upon the availability of suitably designed programs. Academics often write programs in the BASIC and FORTRAN languages, the latter being especially popular for complex, multivariate analyses. The most common platform for these programs is the DOS operating system running on an IBM-PC, although programs for the Macintosh computer are also seen frequently. Three academic programs are reviewed in the case studies section below (*Ecostat, MVSP, TWINSPAN*).

Despite the greater flexibility offered by programming approaches, many analysts will be satisfied with the third approach which makes use of the predefined routines of a commercial statistics package. The decision as to which package to adopt is not straightforward however. Some of the most important issues to consider are:

- range of data analysis techniques offered
- facilities for presentation of results
- design of the user interface
- import/export facilities for data exchange
- quality of user documentation and after-sales support.

Software Listing
The rest of this section reviews the functionality, platform, and availability of several popular statistics packages (prospective users are encouraged to seek further information on the products from their respective publishers). Software is listed alphabetically and attributed to

the following sub-categories:

- matrix manipulation package
- commercial mathematical processor
- academic (non-commercial) package.

Product Name	**Ecostat**
Publisher	Biological Software
Category	Academic (non-commercial) package
Configuration	DOS 2.0 or higher IBM-PC 8086 or higher
Availability	One off charge covering copying, media and postage. Programs only supplied on 720 Kb 3.5 inch IBM format disk
Description	FORTRAN-based suite of statistics routines aimed at biologists. Contains functions for descriptive statistics, chi square, students t test, Mann-Whitney U test, Wilcoxon signed ranks test, Linear regression (least squares), product moment correlation coefficient, Spearman's rank correlation coefficient, plotless sampling calculations (closest individual and nearest neighbour methods), and multiple correlation and regression

Product Name	**MATLAB (Matrix Laboratory)**
Publisher	The MathWorks Inc
Category	Matrix manipulation package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Macintosh; SUN; DEC VAX/VMS; DEC RISC; HP 9000; IBM RS/6000; Silicon Graphics; CONVEX; CRAY IBM-PC 386 or higher, 4 Mb RAM or higher, 8 Mb hard disk space (Windows)
Version	4.0 (1993)
Users	Large
Availability	Strictly by licence from The Mathworks, Inc. Documentation and support are impressive. University science departments and industry are main users
Description	High-performance numeric computation and visualisation software. The standard instructional tool for introductory courses in applied linear algebra, as well as more advanced courses. Used for research and practical engineering and mathematical problem solving in industry. Typical uses include general purpose numerical computation, algorithm prototyping, matrix algebra, statistical modelling, and signal processing

Product Name	**Mathematica**
Publisher	Wolfram Research Inc
Category	Mathematics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Windows NT; Macintosh; CONVEX; DEC; HP Apollo; IBM; MIPS; NEC PC 9801; NEC EWS; NeXTSTEP; Silicon Graphics; Sony; Sun Microsystems; other UNIX platforms IBM-PC 386 or higher, 4 Mb RAM or higher (DOS and Windows); 68020

	CPU or higher, 6 Mb RAM or higher (Macintosh)
Version	2.2 (1992)
Users	200,000
Availability	Single or multi-user licence from Wolfram Research, Inc. Demonstration disks available upon request. Comprehensive documentation available from Wolfram Research and many bookshops and libraries (eg periodicals, guides, applications)
Description	General system for mathematical applications. Handles numeric, symbolic, and graphical computations, and can be used as both an interactive calculation tool and a programming language. Numerical capabilities include arbitrary precision arithmetic and matrix manipulation. Mathematica can be used for representing knowledge in mathematical fields, modelling data, and visualising results in a variety of media (text and animated graphics)

Product Name	**Minitab**
Publisher	Minitab Inc
Category	General statistics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Macintosh System 6.0 or higher; UNIX IBM-PC 286 or higher (DOS); IBM-PC 386 or higher (Windows); 2 Mb RAM or higher (Macintosh)
Version	8.0 (Macintosh 1992)
Users	120,000
Availability	Single or multi-user licence from Minitab Inc
Description	Complete and flexible statistics package used by commercial, government, and educational users worldwide. Used for arithmetic and matrix operations, statistical analysis and process control. Number range rather restrictive, and graphical capabilities primitive in comparison with other packages. However, Minitab is very easy to use and contains a wide range of routines

Product Name	**MVSP (Multivariate Statistics Package)**
Publisher	Dr Warren Kovach, Institute of Earth Studies, University College of Wales.
Category	Academic (non-commercial) package
Configuration	DOS 2.0 or higher IBM-PC 8086 or higher
Availability	Supplied on shareware terms: demo version is provided free, full version only after registration fee is paid
Description	FORTRAN-based package including routines for principal components analysis (PCA), principle coordinates analysis (PCO), correspondence analysis/reciprocal averaging, (dis)similarity matrices, diversity indices (Simpson, Shannon, Brillouin), cluster (similarity) analysis (nearest neighbour, furthest neighbour, weighted/unweighted pair group, weighted/unweighted centroid sorting, minimum variance), basic plotting routines

Product Name	**SAS/STAT**
Publisher	SAS Institute Inc (worldwide distributors)
Category	General statistics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Macintosh System 6.0 or higher; OS/2; UNIX; VMS; VM; MVS IBM-PC 286 or higher (DOS); IBM-PC 386 or higher (Windows); 4 Mb RAM or higher (Macintosh); SUN Sparc/IBM RS 6000/DEC Alpha/HP 9000 (UNIX)
Version	6.09 (1993)
Users	20,000
Availability	Single or multi-user licence from SAS Institute. Full range of technical support options available, including publications, consulting, training courses, user groups, and telephone support
Description	A range of data analysis tools from simple descriptive statistics to advanced regression, analysis of variance, categorical data analysis, multivariate analysis, clustering, scoring, discriminant analysis, survival analysis, psychometric analysis, and non-parametric statistics

Product Name	**S-PLUS**
Publisher	MathSoft Inc
Category	General statistics package
Configuration	Windows 3.1 or higher; X11, Motif, and OPENLOOK window system on UNIX IBM-PC 386 or higher, 4 Mb RAM or higher (Windows); many UNIX workstations
Version	3.2 (1993)
Users	Large
Availability	Users of S-PLUS share new functions and techniques over an electronic bulletin board, which also contains access to a library of state-of-the-art functions. An instructional video is available upon request
Description	Interactive computing environment for graphical data analysis, statistics, and computational programming. Supports a superset of the S programming language developed by AT&T, enabling one to compute, view, and program interactively with data. S-PLUS contains all the usual statistical routines such as hypothesis testing, statistical modelling, and presentation graphics, plus flexible tools for exploratory data analysis (including dynamic graphics that allow 'brushing' of scatterplot matrices); support for window systems (X11 and Windows); spreadsheet like data editor; advanced statistical functions implementing leading ideas in modern research; object oriented programming language with interfaces to C and FORTRAN

Product Name	**SPSS (Statistics Package for the Social Sciences)**
Publisher	SPSS Inc (worldwide distributors)
Category	General statistics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Macintosh System 6.0 or higher; UNIX (SUN Solaris 2.2 or higher; SUN Motif 1.1 or higher; DEC

	Alpha Open DMS; HP UX); VMS
	IBM-PC 286 or higher, 2 Mb RAM or higher, 11 Mb hard disk space (DOS); IBM-PC 386 or higher, 8 Mb RAM, 21 Mb hard disk space (Windows); 4 Mb RAM or higher, 20 Mb hard disk space (Macintosh); SUN Sparc/IBM RS 6000/DEC Alpha/HP 9000 (UNIX)
Version	5.0 (DOS); 6.1 (Windows); 6.1 (Macintosh); 5.0 (UNIX).
Users	100,000 (DOS); 50,000 (Windows); 500,000 (others)
Availability	Single or multi-user licence from SPSS Inc. Full range of technical support options available, including excellent documentation, training courses, bulletin board, and telephone support
Description	Tool for managing, analysing and displaying information. Comes with statistical glossary, integrated data editor (spreadsheet), and high resolution graphics (GUI versions only). A very wide range of statistical routines and data manipulation facilities are available via a series of modules which may be purchased independently. Interface to MapInfo desktop mapping software is particularly good in Windows version

Product Name	**Stata**
Publisher	Computing Resource Center
Category	General statistics package
Configuration	DOS 3.1 or higher; UNIX
	IBM-PC 286 or higher, 512 Kb RAM or higher (DOS); HP 9000 (UNIX)
Version	3.1 (1993)
Users	6000
Availability	Single or multi-user licence from Computing Resource Center
Description	Very stable statistics, graphics, and data management tool. Functions include Logit, Probit, regression, instrumental variables, survival analysis, econometric functions, maximum likelihood, matrix programming, non-linear regression, multivariate analysis, cluster analysis

Product Name	**Systat**
Publisher	Systat Inc
Category	General statistics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher; Macintosh; UNIX; VMS.
	IBM-PC 286 or higher, 512 Kb RAM or higher (DOS); IBM-PC 386 or higher, 4 Mb RAM (Windows)
Version	6 (1990)
Availability	Single or multi-user licence from Systat Inc. Demonstration disks available upon request
Description	Statistics, graphics, and data management package. Provides full range of univariate and multivariate statistics routines, including cluster analysis, multidimensional scaling, time-series analysis, and factor analysis. Also provides facilities for Logit, Probit, quality assurance, and market research projects. Wide range of data manipulation facilities, plus macro language for process automation. Excellent 3-D graphics

Product Name	**TWINSPAN (Two-way Indicator Species Analysis), DECORANA (Detrended Correspondence Analysis), CANOCO (Canonical Correspondence Analysis)**
Publisher	Microcomputer Power; also available from Biological Software
Category	Academic (non-commercial) package
Configuration	DOS 2.0 or higher; Macintosh (CANOCO only) IBM-PC 8086 or higher; Macintosh (CANOCO only)
Availability	Public domain software, packaged for use on the IBM-PC by Microcomputer Power (full catalogue of programs available upon request). Version from Biological Software is cheaper but has restricted data handling capacity
Description	Mathematical procedures for analysing site-species matrices, generated for instance by dividing a study area into quadrats and conducting a species inventory in each. TWINSPAN is the most widely used technique for community classification, producing a two-way sorted table of the original matrix. DECORANA and CANOCO are the most widely used methods of ordination, producing diagrams representing the similarity in species composition of different quadrats

Product Name	**UNISTAT for DOS/Windows**
Publisher	Unistat Ltd
Category	General statistics package
Configuration	DOS 3.1 or higher; Windows 3.1 or higher IBM-PC 8086 or higher (DOS); IBM-PC 386 or higher, 4 Mb RAM (Windows)
Version	4.72 (DOS 1993); 2 (Windows 1994)
Availability	Single or multi-user licence from Unistat Ltd. Demonstration disks available upon request
Description	Complete data handling, analysis, and presentation tool featuring dedicated spreadsheet, plus a wide range of statistics and presentation quality 2D/3D graphics. Package includes non-parametric tests, contingency tables, cross-tabulation, regression, ANOVA, multivariate analysis, time-series analysis, quality control, and many other routines. Support for string data and missing data is provided, plus data exchange into a variety of formats including Lotus 123, Excel, dBASE 2,3,4,5, DIF, Sylk, and ASCII

3.2.5 GIS/Mapping Systems

A Geographic Information Systems (GIS) is a system which will manage data which is referenced to locations on the earths surface (for example sample locations, topography, boundaries of regions, maps etc). GIS have has been used to manage environmental information and aid decision-makers since the mid 1960's and is thus a fairly mature technology. The concept of GIS is that it permits the management and processing of spatial information in the same way that conventional DBMS can handle numeric or categoric data. This allows for the integration and summarisation of environmental information using natural units - such as watersheds, natural forest areas, soil units and so on, and to combine these effectively with man-made administrative data collection units. Thus it can provide the link between the decision-maker's viewpoint and the natural boundaries of the problem. GIS software is therefore a potentially valuable tool in biodiversity information management.

Selection Criteria
Several hundred commercial vendors can provide GIS software packages, and consequently a very wide choice of functionality is available. The two basic approaches are **raster**, in which the data are represented by a huge matrix of grid cells, and **vector**, in which the spatial data is kept as a series of connected line segments (sometimes called "arcs").

Raster GIS are generally cheaper and simpler, and can provide very quick processing for approximate answers, and are thus often applied to regional planning and assessment. Vector-based GIS software is more complex and defines the data with much more detail and spatial accuracy. Application is wide-spread, particularly where there is a need for complex analysis and accurate delineation of boundaries.

GIS software prices vary considerably. Three rough price categories occur:

- **Demonstration Systems ($0-1000)**
  These systems are mostly for training and demonstrating the concepts of GIS. Generally they are raster based and will only handel relatively small datasets.

- **Limited GIS ($1000-10,000)**
  These are production systems (for real applications) that offer functions which allow the processing of modest sized datasets. They are thus useful for project-oriented studies and decision making applications. Many of them in this class are raster based and relatively limited in the range of functions available, for instance these may lack elaborate input and output options, and map projections.

- **Full GIS ($10,000-100,000)**
  Full GIS are usually vector based and offer full geometric processing capabilities, including a range of input and output options, ability to handle very large databases, full topological overlay, multiple map projections, input and transfer form other GIS, and so on. These often require Unix based operating systems and powerful computers.

Geographic Information (GIS) packages offer a vast array of spatial analysis functionality. Prior to purchasing a GIS, the requirements for a GIS package should therefore be defined clearly. For example, will the GIS be used for modelling or simple two dimensional map design? This type of consideration will greatly affect the choice of GIS and its cost.

Many of the longer established products have built up an international user base that collectively attend regular local, regional and international conferences. Several now have their own email list servers and news groups over the Internet and Compuserve to exchange ideas and provide answers to problems. International or local support for the product maybe provided by the manufacturer or distributor as part of the cost of purchase or as an additional maintenance contract. For a complicated software package, support, both as training and continued technical support is an extremely important factor in the success of new installation. Different distributors are strong in different areas of the world, and consequently the support a user can expect varies with their locality. Local support and an established user base should be an important consideration when reviewing the possible options for the implementation of a GIS.

There is considerable research into GIS and its application and a number of journals dedicated to the subject, such as *International Journal of Geographic Information Systems*, *Geojournal*, and *Cartographica*. A number of trade magazines provide useful information on GIS software and related hardware, and often feature consumer reports. Popular magazines include *GeoInfo Systems*, *GIS Europe*, *GIS World* (see Bibliography, Section 7.3).

Basic text books on the subject are numerous and include Aronoff (1989), Burroughs (1989), McGuire (1988), and Antenucci (1991).

Software Listing

The following list details a number of commercially available GIS packages. The list has been compiled from a number of published sources, including *The European GIS Yearbook 1994* and the UNEP publication *A Survey of Geographic Information System and Image Processing Software 1993*, as well as experience of users of the package. The vendors listed are predominantly located in Europe or North America, but many have offices or representatives in developing countries. An initial contact with the address given should permit the location of the nearest local distributor of the producer.

Software is ordered alphabetically and attributed to one of the following sub-categories:

- automated mapping (do not provide spatial analysis)
- CAD (many drawing tools, but usually lack database links and map transformation utilities)
- GIS (includes map viewer software).

Product Name	**4CE**
Publisher	Applications in CAD Ltd
Category	CAD
Configuration	DOS.
Description	Spatial data model in vector/grid form. Data import/export. Data transformation functions. Data capture from digitising tablet.

Product Name	**ARC/CAD**
Publisher	Environmental Systems Research Limited, Inc.
Category	GIS/CAD
Configuration	Windows 3.1 or higher, AutoCad. IBM-PC 386, 8 Mb RAM.
Languages	PC ARC/INFO simple macro language and AutoCad autoLISP language
Availability	Single platform
Description	ARC/CAD brings GIS functionality to the AutoCAD environment. ArcCAD is seemlessly integrated into the AutoCAD graphical environment.

Product Name	**ARC/INFO; PC ARC/INFO**
Publisher	Environmental Systems Research Limited, Inc. (regional distribution network throughout the world)
Category	GIS
Configuration	DOS; UNIX; VMS. IBM-PC 386, maths co-processor (DOS-PC); 24 Mb RAM, 100 Mb disk space for program, 100 Mb disk swap space (UNIX/VMS).
Languages	Simple Macro Language (SML) (PC); Arc Macro Language (AML) (UNIX/VMS).
Version	3.4.2 (PC); 7.0.2 (UNIX/VMS).
Availability	- PC: hardware key. - UNIX/VMS: floating license: install on a single machine, accessible to a specific number of user across a network. Node locked license: lock to a single machine, accessible to a specific number of users. Core vector based product, several extensions to include grid cell modelling, network analysis, raster to vector conversion, terrain analysis, co-ordinate geometry, feature based data management tools and performance enhancement extensions (UNIX/VMS).
Description	- PC: version stores attribute information in dBASE III format. Management of spatial data in vector format. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet. Spatial analysis. Application toolkit. - UNIX/VMS: versions offer a complete GIS environment. UNIX is the current development platform, VMS release usually several months later. Manages spatial data model in vector/raster/grid form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis. Integrated model processing. Applications/external database integration toolkit. Currently the most popular GIS package in the world. ARC/INFO export files becoming a standard as a method for the transfer of spatial data between various GIS. Interaction with GIS is via command line, although very flexible and manuals are very good, this can result in a rather steep learning curve.

Product Name	**ArcView 2**
Publisher	Environmental Systems Research Limited, Inc. (regional distribution network throughout the world)
Category	GIS/Viewer
Configuration	Windows 3.1 or higher; Windows NT; Mac; UNIX. IBM-PC 486 66MHz, 16 Mb RAM (Windows 3.1/NT).
Languages	Avenue: object oriented programming language enabling customisation of the graphics environment and automation of programming tasks.
Version	2
Description	A GIS/viewing package enabling visualisation and manipulation of ARC/INFO data in a flexible and windows and menus type graphical user interface. Main features include links to external databases: ORACLE, Ingres, Informix, Sybase, dBASE; DDE between ArcView 2 and other

Windows/Mac/UNIX programs; client server architecture enabling the Mac and Windows versions to access ARC/INFO data held on a UNIX host via a network.

Product Name	**ATLAS GIS**
Publisher	Strategic Mapping, Inc.
Category	GIS
Configuration	DOS; Windows 3.1 or higher.
Languages	Application language
Version	2
Availability	As full edit (ATLAS GIS) and read-only (ATLAS PRO)
Description	A popular menu driven desktop mapping package. Management of spatial data model in vector form. Integrated database facilities, plus links to dBASE III files. Data import/export (additional package). Data capture by digitiser tablet. Spatial analysis.

Product Name	**AutoCAD**
Publisher	Autodesk LTD (extensive regional distribution network throughout the world)
Category	CAD
Configuration	DOS; Windows 3.1 or higher; UNIX; VMS.
Languages	AUTOLisp
Version	12
Description	The most widely used CAD package in the world, with over 750,000 copies sold. Available in 18 languages in over 80 countries. External databases supported include dBASE, Paradox, Informix, Oracle.

Product Name	**AUTO/GIS**
Publisher	Spatial Utilities, Inc.
Category	GIS/CAD
Configuration	DOS.
Description	A low-end GIS, AUTO/GIS integrates the functionality of AUTOcad and dBASE (or FoxPro) to perform over 150 spatial analysis functions as well as transformations and co-ordinate conversions.

Product Name	**CADdy**
Publisher	Berkshire & Avon Computing Ltd (UK distributor).
Category	GIS/CAD
Configuration	DOS.
Languages	Applications toolkit
Description	Spatial data model in vector/raster form. Data transformation/integration/manipulation functions. Data import/export. Data capture from digitising tablet or raster image.

Product Name **CARTOGRAPH**
Publisher Cartograph Ltd
Category GIS
Configuration DOS; Windows 3.1 or higher.
Availability As full edit work station per seat.
Description External database: PARADOX. Spatial data model in vector/raster form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis. Applications/external database integration toolkit.

Product Name **DIGIT-II; GIMMS**
Publisher GIMMS (GIS) LTD
Category Automated mapping
Configuration DOS; UNIX; VMS.
Languages GIMMS batch mode - applications development toolkit.
Availability Prices vary depending upon organisation.
Description Digit II is a user friendly digitising package, which can be used in conjunction with other GIS packages as well as GIMMS. GIMMS is a flexible automated map production/GIS package that can be run either in batch mode or through a user interface. Management of spatial data model in vector form. Data capture by digitiser tablet.

Product Name **FASTCAD**
Publisher Fatscad GIS Ltd
Category GIS/CAD
Configuration DOS; Windows 3.1 or higher.
Description Management of spatial data model in vector form. Data transformation/integration/manipulation functions. Data capture from digitising tablet. Spatial analysis. Integrated model processing. Data import/export.

Product Name **GENAMAP**
Publisher GENASYS II LTD
Category GIS
Configuration UNIX.
Languages Applications(GENIUS)/external database integration toolkit.
Availability Several additional modules extend flexibility and range of functions.
Description Management of spatial data model in vector/raster form. Data transformation/integration/manipulation functions. Data capture from digitising tablet. Spatial analysis. Integrated model processing. Applications/external database integration toolkit. Its development toolkit allows Genamap to be incorporated into larger integrated systems via C-based libraries. Popular in the Southern Hemisphere.

Product Name	**GIS PLUS**
Publisher	Caliper Corporation
Category	GIS
Configuration	DOS; Windows 3.1 or higher.
Languages	Applications toolkit
Description	A full featured, easy-to-use system. Spatial data model in vector/raster form. Data import/export. Data integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis Applications toolkit.

Product Name	**GRASS (Geographic Resources Analysis Support System)**
Publisher	US Army Construction Engineering Research Laboratory (USA-CERL)
Category	GIS/IA
Configuration	UNIX.
Version	4.1
Description	A popular public domain package with many spatial functions. Good integration of raster/vector. Probably the most widely used GIS for hydrological/watershed modelling applications. Possible port to PC soon. Spatial data model in vector/raster form. Data transformation/integration/manipulation functions. Spatial analysis. Integrated model processing. Weak points: relatively poor user interface, need to improve vector query and DBMS links.

Product Name	**ILWIS**
Publisher	ITC
Category	GIS/IA
Configuration	DOS. IBM-PC 386 or higher, math co-processor.
Languages	Batch processing capabilities.
Availability	As minimal system and fully capable software.
Description	Spatial data model in vector/raster form. Data transformation/integration/manipulation functions. Data capture by digitiser tablet. Data import/export. Will read/write in dBASE format. Spatial analysis. Integrated model processing. Popular with biodiversity workers.

Product Name	**JMAP**
Publisher	Era-Maptec Ltd
Category	Automated mapping
Configuration	Macintosh.
Availability	Countries supported: Australia, Chile, Ireland, UK, Bolivia.
Description	Desktop Mapping package.

Product Name	**LOCATOR GIS**
Publisher	Sokkia Ltd
Category	GIS
Configuration	Windows 3.1 or higher.
Description	LOCATOR GIS used for the collection, addition and editing of GIS data

in the field.

Product Name	**MACGIS**
Publisher	Institute for a Sustainable Environment
Category	GIS
Configuration	Macintosh. Mac II minimum.
Languages	Application development language.
Availability	As fully capable software.
Description	A relatively cheap raster based GIS for the Macintosh. Spatial data model in raster form. Data integration/manipulation functions. Integrated model processing. Spatial analysis. Data capture from raster image. Data import/export.

Product Name	**MapInfo**
Publisher	MapInfo Corporation
Category	GIS
Configuration	Windows 3.1 or higher; Macintosh; UNIX. IBM-PC 386 or higher, 4 Mb RAM (Windows).
Languages	MapBasic; applications development toolkit.
Version	3.02
Availability	As full edit work stations.
Description	MapInfo is the best selling desktop mapping software. Built-in database format using SQL format queries. Management of spatial data model in vector/raster/grid/matrix form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitiser tablet/raster image. Spatial analysis. Integrated model processing. Applications/external database integration toolkit.

Product Name	**MGE - Modular GIS Environment**
Publisher	Intergraph (UK) LTD
Category	GIS
Configuration	DOS; Windows 3.1 or higher; Windows NT; UNIX.
Languages	Applications/external database integration toolkit.
Availability	As license for read-only and full-edit work station
Description	Popular high end GIS system available on many platforms, in direct competition with ARC/INFO. Management of spatial data model in vector/raster/grid form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis. Integrated model processing.

Product Name	**MOBILE GIS**
Publisher	Procis Software Ltd
Category	GIS
Configuration	DOS.
Description	MOBILE GIS extends the availability of digital maps and related data to the field workforce through the use of DOS pen-based or portable

computers. It provides GIS functionality required in the field with facilities for on-site data collection in graphical format.

Product Name	**OZGIS**
Publisher	The Clever Company
Category	GIS
Configuration	DOS; Windows 3.1 or higher.
Languages	Application development language
Version	10.2
Availability	As minimal or fully capable software. Evaluation software available.
Description	Spatial data model in vector form. Data import/export. Data transformation/integration/manipulation functions. Spatial analysis. Application development language.

Product Name	**REGIS/ULTIMATE CAD**
Publisher	Art Systems Ltd
Category	GIS/CAD
Configuration	Windows 3.1 or higher.
Description	Fully integrated with windows GIS system. Spatial data model in vector form. Data import/export. Data transformation functions. Data capture from digitising tablet.

Product Name	**SPANS GIS; SPANS MAP**
Publisher	Tydac Technologies Ltd,
Category	GIS; Viewer
Configuration	OS/2.
Languages	Applications toolkit
Description	A powerful and modular analytical GIS (SPAN GIS) and stand-alone desktop mapping package (SPANS MAP). Management of spatial data model in raster form. Data import/ export. Data transformation/ integration/manipulation functions. Data capture from digitiser tablet/raster image. Spatial analysis. Integrated model processing. Applications toolkit.

3.2.6 Image Analysis Systems

Image analysis systems provide tools for the processing of digital images. Thews may derive from remote sensing satellites, the scanning of photography or raster GIS. These have been mainly developed as aids to the interpretation of remote sensed imagery, but are now merging with GIS technology. Functions offered usually include geometric rectification and automated image classification. The basic differences between the very low cost systems and more expensive IA systems are the range of choice in automated classification, size of the image which can be handled, and the range of output choices.

Product Listing

The following lists some well known commercial packages:

Product Name	**CHIPS**
Publisher	Institute of Geography
Category	Image analysis
Configuration	DOS; Windows 3.1 or higher.
Description	Spatial model in raster form. Data import/export. Spatial analysis. Data transformation/integration/manipulation. Integrated model processing. Data capture via TARGA.

Product Name	**EASI/PACE**
Publisher	PCI
Category	Image analysis/GIS
Configuration	Windows 3.1 or higher; Mac; UNIX; VMS
Availability	Full edit work stations.
Description	A full featured remote sensing package with capabilities in satellite image analysis, terrain analysis, digital photogrammetry and vector GIS available.

Product Name	**ERDAS IMAGINE**
Publisher	ERDAS Inc
Category	Image Analysis/GIS
Configuration	Windows NT; UNIX.
Languages	Applications toolkit; C programmers toolkit.
Availability	Full edit work stations.
Description	Proprietary database. Linkages to Sybase, Oracle. Satellite imagery, aerial photography and vector data can be integrated. Sophisticated analytical models can be constructed by pointing and clicking on filenames and functions. Management of spatial data model in vector/raster/grid form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis. Integrated model processing. Applications toolkit. Close integration with ARC/INFO, via integration of the ARC/INFO vector data model within IMAGINE.

Product Name	**DISMAP**
Publisher	Clough Engineering
Category	Image analysis
Configuration	UNIX.
Languages	Applications development toolkit.
Availability	As fully functional run time versions.
Description	A powerful UNIX based image processing system. Spatial data model in raster form. Data transformation/integration/manipulation functions. Integrated model processing. Spatial analysis.

Product Name	**DRAGON**
Publisher	Goldin-Rudahl Systems
Category	Image analysis
Configuration	DOS.

Availability	As full edit work stations
Description	Data capture by raster image. Data import/export. Spatial analysis. Data transformation/integration/manipulation functions.

Product Name	**IDRISI**
Publisher	Clark University Graduate School of Geography.
Category	Image analysis
Configuration	DOS; Windows 3.1 or higher.
Description	The IDRISI software package provides professional level, high end analytical capability in geographical analysis, image processing and spatial statistics. Primarily raster based, with vector digitising, editing and display functions. Designed as a set of modules which can be readily integrated into other research applications. Easy to use, very affordable and extremely popular. Management of spatial data model in vector/raster form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitiser tablet. Spatial analysis. Integrated model processing. Applications toolkit.

Product Name	**MAPBOX**
Publisher	Decision Images, Inc
Category	Image analysis
Configuration	DOS; UNIX.
Description	Database proprietary. Management of spatial data model in raster/grid form. Data import/export. Spatial analysis. Integrated model processing.

Product Name	**MICROBRAIN**
Publisher	MPA Communications Pty. LTD.
Category	Image analysis
Configuration	DOS (Microsoft Windows and Windows NT pending). IBM-PC with SVGA graphics card.
Languages	Applications development toolkit.
Availability	As fully capable system.
Description	Spatial data model in raster form. Data import/export. Data integration/manipulation. Data capture by digitiser tablet/raster image.

Product Name	**RESOURCE**
Publisher	Decision Images, Inc
Category	Image analysis
Configuration	DOS. IBM-PC with Imagraph, Number Nine, ATVista, Matrix image processing card.
Availability	As fully capable software.
Description	Fast image processing system with some GIS functionality. Spatial data model in vector/raster form. Data integration/manipulation functions. Data import/export. data capture by digitiser tablet/raster image.

Product Name	**ROOTS PRO**
Publisher	Decision Images, Inc
Category	Image analysis
Configuration	DOS; Mac.
Description	Management of spatial data model in raster form. Data import/export. Data transformation functions. Data capture from digitising tablet.

Product Name	**Satellite Image Processing System**
Publisher	National Remote Sensing Agency
Category	Image analysis
Configuration	DOS; UNIX. IBM-PC 386, 4 Mb RAM, 160 Mb hard disk (DOS).
Languages	Batch capability
Availability	As minimal and fully capable software
Description	Spatial data model in raster form. Data capture by digitiser tablet/raster image. Data transformation/integration/manipulation functions.

Product Name	**SPRING**
Publisher	INPE-National Inst. Space Research
Category	Image analysis/GIS
Configuration	DOS; UNIX. IBM-PC 386 or higher, 8 Mb RAM, 400 Mb hard disk (DOS); 32 Mb RAM, 600 Mb hard disk, 8 bit display (UNIX).
Description	Spatial data model in vector/raster/grid form. Spatial analysis. Data import/export. Data transformation/integration/manipulation functions. Integrated model analysis. Integrated database called Codebase is dBASE IV; external DBMS supported include Ingres, Oracle, Sybase, Informix. Data capture by digitising tablet/raster image.

Product Name	**TERRA-MAR - Micro Image (PC), IDIMS (UNIX)**
Publisher	Sales and Service: CSI
Category	Image analysis
Configuration	DOS; UNIX.
Languages	Applications toolkit.
Description	Management of spatial data model in vector/raster form. Data import/export. Data transformation/integration/manipulation functions. Data capture from digitising tablet/raster image. Spatial analysis. Integrated model processing. Applications toolkit.

Product Name	**TNT MIPS**
Publisher	Microimages
Category	Image analysis
Configuration	DOS; Windows 3.1 or higher; UNIX.
Languages	Applications toolkit.
Description	Runs X-Windows system to achieve cross-platform capability. Spatial data model in vector/raster form. Data transformation/integration/manipulation. Data capture from digitising tablet/raster image. Spatial analysis.

Product Name	VI^{2}STA
Publisher	International Imaging Systems
Category	Image analysis/GIS
Configuration	UNIX.
Languages	Applications development toolkit
Availability	Minimal package will carry out image exploration, enhancement and display in an X-Windows environment. Fully capable system includes over 250 image processing commands, an advanced filter package, the raster GIS module and a tape ingest module that supports over 40 satellite and airborne sensor formats.
Description	Spatial data model in raster form. Comprehensive remote sensing toolkit. Data import/export. Data capture by digitising tablet/raster image. Data transformation/integration/manipulation. Integrated model processing. Spatial analysis.

3.2.7 Biodiversity Application Software

The primary objective of biodiversity information management is to provide governments and NGOs with the information they require to support environmental protection and sustainable development. The scale of this problem is such that over the last decade, many institutions holding biodiversity information have applied information technology specifically to manage biodiversity data in efficient ways. The resulting tools, which can broadly be defined as biodiversity application software, fall into the following rough categories:

- **Species Information Systems**
  Sources of information on particular life forms or taxonomic groups (eg *FishBase*); some are released as multimedia packages containing "finished product" information sources (eg distribution maps, photographs, taxonomic nomenclature).

- **Biodiversity Assessment Tools**
  Used to gauge the distribution and status of species, communities and habitats; by relating species occurrence to underlying habitat, some systems permit rapid biodiversity assessment using predictive techniques (eg *BIMS*).

- **Collection Management Systems**
  Permit the entry, storage, querying, and reporting of biological specimens in museums, herbaria, universities and other collections (eg *BRAHMS*).

- **Miscellaneous Systems**
  Sources of information supporting biodiversity conservation in novel or indirect ways (eg *ENVIS*).

With most systems, a trade off may be observed between the geographic scale of the information holdings, and its subject area. For example, a localised system serving the needs of a single institution, may bring together many areas of biodiversity information (see *Biodiversity Data Bank*), whereas a global system may be restricted to a single subject area for practical reasons (eg *Index Kewensis* is concerned purely with the nomenclature of plants).

Software Listing
It is difficult to define "typical" biodiversity application software due to the wide variety of tools currently in use. One way forward is to review a variety of systems performing different functions and illustrating different approaches. The reader can then decide which systems (if any) are appropriate for their needs. Nevertheless, a common feature of the systems under review is that they are *transferable* to different situations, not rooted to one project or location. However, where transfer was not anticipated, or is not desirable for some reason, systems with novel methodologies are still included.

To fully describe the functionality of biodiversity application software, a slightly richer template has been used. New elements include:

Where used	Locations using the system.
Resolution	Geographic resolution for which the system is intended (eg site, managed area, country, world).
Data	Details of the main categories of data managed by the system.
Format	Format in which this data is maintained/exchanged.
Language	The application language in which the system was developed.
Outputs	Details of the main reporting tools available, plus other system outputs.
Summary	Summary statement.
References	Details of key documents describing the system.

The following list is ordered alphabetically, and each item is attributed to one of the following sub-categories:

- species information system
- biodiversity assessment tool
- collection management tool
- miscellaneous system.

Name	**ALICE Biodiversity Database System**
Contact	Dr R Allkin, ALICE Software Partnership
Category	Biodiversity assessment tool
Description	A family of programs for biologists designing and building their own checklist or biodiversity database. Intended primarily for data capture, ALICE also has species-orientated query facilities and pre-defined reports. Applications include writing checklists, building species inventories, and developing species identification systems.
Where used	The International Legume Database and Information Service (ILDIS), involving collaborating institutions in more than 20 countries; UK poisonous plants database; species inventories in several protected areas.
Resolution	Can be used at any scale from site to global.
Data	Taxonomic names, synonyms, homonyms, variants, authorities; geographic gazetteer of recording localities; custom species attributes (eg "wingspan", "leaf length"); free text species descriptions; bibliography.
Format	XDF (standard exchange format sanctioned by IUBS Commission for Plant Taxonomic Databases), ASCII, dBASE, DELTA.
Outputs	Pre-defined reports answering questions such as "Which poisonous tree species occur in country X?", "Which native species are threatened in country X?", "Who published taxonomic name X?", and "Who said that plant X is poisonous?". Report formats may be customised.
Configuration	DOS 2.0 or higher; UNIX (or Xenix); VMS. IBM-PC 286 or higher, 512 Kb RAM or higher, 20 Mb hard disk space.
Availability	The Alice Software Partnership has a professional relationship with users. In exchange for a licence fee, programs are provided with documentation, user support and updates. On-site guidance for installation, use, and how to develop your own database, can be arranged.
Summary	General purpose species description system with strong data exchange facilities.
References	Alice Software Partnership (1990).

Name	**BG-BASE 4.0**
Contact	Kerry S. Walter and Michael J. O'Neal, BG-BASE Inc
Category	Collection management tool
Description	Database application designed for managing biological information in four categories: taxonomy, distribution, conservation, and collections management (living and preserved). Suitable for a variety of institutions including botanic gardens, arboreta, zoos, university campuses, horticultural societies and private gardens.
Where used	BG-BASE has been installed at 53 locations in eight countries, including Arnold Arboretum, Harvard University, USA; Royal Botanic Gardens, Kew, U.K., National Botanic Garden, Harare, Zimbabwe, and WCMC.
Resolution	There is no limit to the number, nor geographic scope of the records. BG-BASE can be used equally well to handle world datasets of threatened plants, and small, site specific collections.
Data	Taxonomic names, author, distribution, habit, habitat, common names, parentage, description; specimens; sources (such as contact, address,

phone, fax); bibliography (fully linked to specimens); verifications; images. Compatible with *The International Transfer Format for Botanic Gardens*, and *World Geographic Scheme for Recording Plant Distributions*.

Format Advanced Revelation, ASCII, dBASE, Lotus 123.

Outputs Automatic generation of accession books and cards; conservation status, population demographics, presence in protected areas, in the form of maps, printed lists, and statistical tables. Data can be queried freeform using Advanced Revelation native query language or SQL.

Configuration DOS 3.0 or higher. Advanced Revelation 3.1 or higher.
IBM-PC 386 or higher. 2 Mb RAM, 40 Mb hard disk space.

Language Developed in Advanced Revelation relational database package (variable length, multi-value fields). Windows version planned for 1995.

Availability BG-BASE has been tuned to user's needs over a ten year period. A comprehensive user manual is provided (currently under revision), and a regular newletter is produced containing news from BG-BASE users, technical tips, and details of new locations using the system.

Summary The most widespread plant collection management software available; very powerful reporting facilities; requires properly structured training for maximum benefit.

References O'Neal (1989).

Name **Bioclimate Prediction System (BIOCLIM)**

Contact Dr John R Busby, Environmental Resources Information Network

Category Biodiversity assessment tool

Description Software that uses previously generated climate surfaces to generate climate estimates for sites where a species has been recorded, generates climate profile for that species, and evaluates geographic areas in terms of their climatic similarity to the profile.

Where used Mainly Australia, although suitable climate surface databases have been developed for New Zealand, Papua New Guinea and other areas (Africa?)

Resolution Can be implemented at any scale for which climate and species distribution data are available (national and regional scale in practice).

Data Climate surfaces, species distribution records.

Format ASCII.

Outputs Generation of species' climate profile; prediction of species distribution based on climate correlation.

Configuration DOS.
IBM-PC 8086 or higher.

Language Originally developed in FORTRAN; currently several versions, at least one converted to C++.

Availability A basic user manual is provided, continuous support is not; system was converted from a mainframe version to PC and does not meet commercial standards in terms of user interface design or ease of use; to realise the potential of BIOCLIM, a solid grounding in FORTRAN is required.

Summary Successfully used on a wide range of taxa (including vegetation units).

Name **Biodiversity Data Bank 1.0 (BDB)**

Contact	Dr J Reynolds, Prof. D Pomeroy, or Herbert Tushabe, Makerere University Institute of Environment and Natural Resources
Category	Biodiversity assessment too
Description	Desk-top tool for storing, analysing and mapping biodiversity data.
Where used	National Biodiversity Data Bank, MUIENR, Uganda.
Resolution	Most appropriate for national scale.
Data	Taxonomic names, species distribution records, background maps (vegetation, altitude, endemic zones, protected area network); institutions; contacts; bibliography.
Format	FoxPro 2.5.
Outputs	Actual and predicted species distribution maps/area lists; estimation of population density from qualitative abundance scores; freeform queries in SQL.
Configuration	Windows 3.1 or higher. IBM-PC 386 or higher. 4 Mb RAM or higher.
Language	Originally developed in dBASE IV (DOS); upgraded to FoxPro 2.6 for Windows 1994; works in tandem with MapInfo desk-top mapping software (any PC mapping software capable of reading dBASE format files can be used).
Availability	Full technical documentation is provided; however no user manual has yet been written; continuous support is not available outside Uganda; BDB is written professionally in terms of user interface design, ease of use, and data validation, but would require *in situ* training until a user manual is produced.
Summary	Uganda's first national biodiversity assessment tool; promising design; good range of analyses; lacks user manual.
References	Reynolds (1993).

Name	**Biodiversity Information Management System (BIMS) [formally MacKinnon-Ali Software System (MASS)]**
Contact	Dr John MacKinnon, Asian Bureau for Conservation
Category	Biodiversity assessment tool
Description	Relational database for monitoring the conservation status of species, wildlife habitat and protected areas
Where used	Most Asian countries; used to determine conservation priorities at institutions in Bhutan, China, Indonesia, Thailand, and Vietnam.
Resolution	Can be implemented at any scale for which consistent background map sources are available (national scale in practice).
Data	Taxonomic names, species distribution records, background maps (vegetation, altitude, endemic zones, protected area network), threats to biodiversity (eg local hunting/harvesting, trade, livestock competition, pests, habitat fragmentation); institutions; contacts; bibliography.
Format	FoxPro 2.0.
Outputs	Automatic generation of species' threat categories; prediction of species distribution based on habitat type; estimation of population density from qualitative abundance scores; dendrogram representation of species-habitat usage (via clustering algorithm).

Configuration	DOS. IBM-PC 8086 or higher.
Language	Originally developed in FORTRAN; upgraded to dBASE III and later FoxPro 2.0; graphical routines developed in C.
Availability	User manual provided, continuous support is not; various aspects of BIMS are still under development (eg data validation, user interface design, ease of use, packaging); to realise the full potential of BIMS, an intensive period of training is required.
Summary	Conceptually, a landmark system; needs improving for widespread use.
References	MacKinnon (1992), MacKinnon (1994).

Name	**Biological and Conservation Data (BCD) System**
Contact	Dr Richard Warner, The Nature Conservancy, Science Division, Conservation Systems Department
Category	Biodiversity assessment tool
Description	Data management package that facilitates the collection, distribution, and exchange of information pertinent to the preservation of biodiversity.
Where used	At Natural Heritage Programmes (NHPs) and Conservation Data Centres (CDCs) throughout the USA, plus Canada, Puerto Rico, and 13 Latin American countries.
Resolution	Can be used at any scale; most used at the national (or large state) level.
Data	Species and community types and occurrences; sites, land ownership parcels, managed areas; sources of information. Data organised in standard fields and files according to recommendations of Operating Procedures Group (OPG) of TNC.
Format	Advanced Revelation; can exchange with other database and GIS formats (eg GRASS, ARC/INFO).
Outputs	Biodiversity inventories; environmental assessments; element stewardship abstracts; preserve portfolios; legal reports; many others. Data can be queried using natural language interface (ie 'English-like' query phrases).
Configuration	DOS 3.0 or higher + Advanced Revelation 2.0 or higher. IBM-PC 386 or higher; 2 Mb RAM or higher; 70 Mb hard disk space.
Language	Advanced Revelation relational database (variable length, multi-value fields).
Availability	Full training programme encouraged via collaborative agreement with TNC.
Summary	Powerful tool designed originally for the USA but now functioning in other locations in North America and many Latin American countries. Suitability for each situation should be carefully examined.
References	TNC (1992).

Name	**Botanical Research and Herbarium Management System (BRAHMS)**
Contact	Denis Filer, Oxford Forestry Institute
Category	Collection management tool
Description	An information system for storing and processing botanical data, primarily that derived from or relating to botanical collections. The system has been developed for use by professional botanists, for general herbarium

	management, and for those working in disciplines such as ecology, forestry, and conservation science.
Where used	Locations in Africa and Central and South America, including National Museums of Kenya, Nairobi.
Resolution	Can be used at all scales; mostly used for national collections.
Data	Taxonomic names, common names, accession lists, species distribution records and phenology, institutional addresses and contacts, bibliography.
Format	FoxPro 2.0.
Outputs	Automatic generation of labels, determination slips and lists, addresses and mailing lists; taxonomic treatments formatted for different journals (with full synonymy); citation lists; distribution maps.
Configuration	DOS 3.0 or higher. Versions for Mac and Windows are planned. IBM-PC 386 or higher. 2 Mb RAM or higher.
Language	Initially developed using dBASE; upgraded to FoxPro relational database in 1992.
Availability	The system is supplied with full technical documentation and user manual. A module known as RDE is also provided for Rapid Data Entry. BRAHMS is only supplied via a formal collaborative arrangement, in which installation, training and support are provided.
Summary	Powerful botanical data management tool, angled towards the research aspects of collection management. Support structures need examining carefully for widespread use.
References	Filer (1994).

Name	**CERCI**
Contact	Invertebrate Conservation Centre
Category	Species information system
Description	Computer software for the management and analysis of detailed husbandry and demographic data on animal collections and captive animal populations.
Configuration	IBM-PC 386 or higher.
Language	dBASE IV 1.5.

Name	**Countryside Information System (CIS)**
Contact	Dr R.G.H Bunce, Land Use Group, Institute of Terrestrial Ecology (ITE)
Category	Biodiversity assessment tool
Description	Stores, analyses, and presents data for each one kilometre square of Great Britain (Northern Ireland). Intended to help policy makers and researchers obtain information about the British countryside in a standard and user friendly way.
Where used	U.K. Department of the Environment, ITE (Merlewood Research Station, Monks Wood).
Resolution	U.K.
Data	Census data which are available for each one kilometre square of Great Britain; sample data which are referenced to the ITE Land Classification. Examples include land cover, linear features, summary vegetation, soils and freshwater animals data.

Format	ASCII.
Outputs	Data can be extracted and presented in tables and charts for any region of Great Britain. Data can also be overlaid on maps highlighting arbitrary features. To ensure users have detailed information about the quality and accuracy of the presented statistics, these are automatically displayed.
Configuration	Windows 3.1 or higher. IBM-PC 386 or higher; 4 Mb RAM or higher.
Availability	CIS is supplied as part of a commercial-quality package that includes technical documentation, user manual, and support.
Summary	Professionally built desk-top tool permitting spatial analysis of the British countryside. A version is currently being planned for Europe.
References	Barr (1993).

Name	**Environmental Assessment and Reporting Support System (EARSS)**
Contact	Kurt Fedra, Advanced Computer Applications, International Institute for Applied Systems Analysis (IIASA)
Category	Under development
Description	Modular set of interactive computer tools to support State-of-the-Environment (SoE) reporting processes within an issues and model orientated framework, at a global, regional, and national level. It supports efficient access to a very large volume of environmental and development related socio-economic data, organised by issues, geographically, or in terms of processes and models.
Where used	IIASA, Austria; GRID Bangkok; GRID Nairobi; ultimately the system is intended for scientific and professional staff at the level of national governments, regional organisations, and academic institutions that support SoE reporting.
Resolution	Global (and lower).
Data	Wide-ranging GIS coverages (eg roads, railways, lakes, rivers, districts, land use, vegetation, soil degradation, forest cover, raw satellite imagery, for many counties); public domain and commercially available worldwide environmental data sets (eg from Digital Chart of the World, CIA, Rutgers University, FAO/UNESCO, IIASA); world tabular data sets (eg Agenda 21 Declaration, UN Global Population, CIA World Factbook, UNEP Environment Database, World Resources Institute (WRI) World Resources Reports).
Format	Various.
Outputs	The central function of EARSS is the assessment of SoE and related development indicators, organised by issues derived from Agenda 21 as the organisational framework. Issues are described in terms of: context (spatial and temporal reference); summary level assessment (status , trend, data availability); list of relevant indicators; hypertextual description of the issues (from Agenda 21) and a narrative summary of the assessment, indicating data needs.
Configuration	X-Windows; Windows NT version planned. UNIX workstation.
Summary	Ambitious system aiming to centralise world environmental data sets for

	analysis and reporting within a novel, indicator-based, framework.
References	Fedra (1994).

Name	**Environmental Information System (ENVIS)**
Contact	Mr S.K Puri, Indira Gandhi Conservation Monitoring Centre (IGCMC)
Category	Miscellaneous system
Description	A suite of packages aiding retrieval of information on government and non-governmental environmental activities.
Where used	IGCMC, New Delhi.
Resolution	India.
Data	Environmental NGOs (>1200); environment-related questions in the Indian parliament (since 1980); media clips concerning the environment; Indian environmental bibliography (planned); photo library of Indian environmental issues.
Format	FoxPro 2.5; images in PCX, BMP, and GIF format.
Outputs	Each package is provided with a user interface offering ways to interrogate the data. Questions such as 'Which NGOs are involved with wetland conservation in Kerala State?', or 'What questions in parliament related to the dam building in 1992?' can be asked. The results may be printed by means of custom designed reports.
Configuration	Windows 3.1 or higher. IBM-PC 386 or higher; 4 Mb RAM or higher.
Language	FoxPro for Windows 2.6.
Availability	The system is currently not available outside of IGCMC. However, plans are being made to release data holdings over the Internet, and to provide run-time versions to other organisations.
Summary	A novel system concentrating on the institutional and media aspects of biodiversity conservation.
References	WWF-India (1994).

Name	**Expert Center for Taxonomic Identification (ETI)**
Contact	Dr R Sluys or Peter H. Schalk, Expert Center for Taxonomic Identification
Category	Species information system
Description	An ambitious project to create a centralised resource of worldwide biodiversity information, via a network of contributing partners. The project encompasses software for entry of species information, species identification, and multimedia species presentation.
Where used	Queensland Museum, Australia; Smithsonian Institution; University of California; Institute of Taxonomic Zoology, Amsterdam; Shikoko University, Japan; may other institutions concerned with taxonomy in Europe and worldwide.
Resolution	Global.
Data	Taxonomic description, morphology and structure, reproduction, ecology, practical importance, distribution, molecules and chemistry, taxonomy, synonyms, references, line drawings, photographs, sound recordings, video.

Format	Data received on any format (eg hard copy, database, ETI format); maintained in ETI format; released on CD-ROM (see Configuration).
Outputs	Multimedia presentation of species information (text, drawings, photographs, sounds, video); a module called "IdentifyIt" can help determine the identity of a specimen from a series of observations; a module called MapIt is planned to illustrate species distributions.
Configuration	Windows 3.1 or higher; Macintosh System 7.x; NeXT. IBM-PC 386 or higher/Macintosh/NeXT Cube; 4 Mb RAM or higher; CD-ROM drive; Soundblaster card (for sound production on IBM-PC).
Availability	Partners for the ETI programme are actively encouraged. Each enters into an agreement with ETI to provide species data on a suitable media (including special purpose software such as *Linneus II* provided by ETI). In return ETI promises to distribute the results to partners regularly on CD-ROM.
Summary	Although ETI encompasses various software items, it is better thought of as a structured process to assemble worldwide species information by means of a network of cooperating partners. ETI is a good example of the very latest technology being applied in appropriate ways.
References	Schalk (1992).

Name	**FishBase**
Contact	R Froese, M.L.D Palomares, or D Pauly, International Center for Living Aquatic Resources Management (ICLARM)
Category	Species information system
Description	A global database on fishes developed by ICLARM and FAO with support from the Commission of the European Communities (CEC). The database presents information on all aspects if ichthyology and of fishes as resources, notably on their nomenclature, distribution, ecology, reproduction, growth, mortality, etc
Where used	More than 63 researchers from 18 countries have contributed to the collection and validation of FishBase data holdings. Particularly active countries are Australia, Bangladesh, Ghana, Hawaii, Malawi, Malaysia, Mexico, Peru, the Philippines, and Vietnam.
Resolution	Global.
Data	Systematics (valid scientific names); common names (English, French, and Spanish); distribution; commercial importance (target/bait species, sport, aquarium); morphology (photographs of larvae, adults, eggs, gills, striking features); physiology (oxygen and food consumption, swimming speed); ecology (relative abundance, ecological niches at different developmental stages, behaviour, reproduction and life history, diet, predators, competitors); population dynamics (growth rates, mortality rates); genetics (allele frequencies, cellular DNA contents); pathology (diseases, parasites); species introductions; bibliographic references. Current data comprises 8000 species of fish (one third of the world total), including all North America and European species.
Format	Data received in any format (eg hard copy, database); maintained in DataEase format; released on CD-ROM (see Configuration).

Outputs	It is planned to release the whole database on CD-ROM by the end of 1994. However, many specific outputs are also available such as species accounts, family accounts, lists of species sharing a common name, lists of dangerous fishes, and species lists for given geographic areas. For any given country it is also possible to prepare checklists of threatened fishes, freshwater fishes, marine fishes, introduced fishes, game fishes, aquarium fishes, and fishes used in aquaculture.
Configuration	DOS 3.0 or higher. IBM-PC 386 or higher; 4 Mb RAM or higher; 100 Mb hard disk space; CD-ROM drive.
Language	DataEase 4.5.
Availability	The full FishBase software package (with pictures) currently requires about 100 Mb of hard disk space, and has only been provided to close collaborators (around 20 institutions). Most users will prefer to wait for the CD-ROM which is planned for release by the end of 1994, and from then on to be updated regularly.
Summary	The largest data bank on fishes in the world. Like ETI, the success of FishBase lies in the development of close collaborative ties with data providers around the world.
References	Froese (1993).

Name	**Forest Reserves of Ghana: Geographic Information Exhibitor (FROGGIE)**
Contact	Dr W.D Hawthorne, Oxford Forestry Institute
Category	Biodiversity assessment tool
Description	Interactive map-based database for assessment of forest biodiversity. Developed originally to manage Ghana forest inventory, but now being extended into generic forest assessment tool.
Where used	Planning Branch, Forestry Department, Kumasi, Ghana; Pasoh Forest Reserve, Malaysia.
Resolution	Can be implemented at any scale.
Data	Taxonomic list of trees, distribution records from 1 ha plot data eg 300,000 individual trees in Ghana), tree status (based on economic use, local rarity, taxonomic relatedness, global rarity).
Format	FROGGIE, dBASE, BRAHMS.
Outputs	Biodiversity "scores" (genetic heat) for different forests/sites/plots, displayed using GIS-style interface; economic indices for similar areas; "red star" status assessments.
Configuration	DOS 3.0 and higher IBM-PC 386 or higher; 4 Mb RAM or higher.
Language	Microsoft Basic Professional Development System (compiled Basic).
Availability	FROGGIE is currently being developed into a sophisticated visualisation tool for a variety of forest inventory data. The new version (planned for April 1995) will be written in Visual Basic (DOS) and come complete with full documentation. It will be entirely compatible with the BRAHMS collection management software and thus be able to share data files. The availability of support structures and documentation should be carefully

	examined.
Summary	New version will be useful for mapping forest inventory data in different locations. In combination with BRAHMS may provide a complete biodiversity information management system.
References	Hawthorne (1992).
Name	**Index Kewensis (IK)**
Contact	Janet Caldwell or Alexander Powell, Customer Services, Electronic Publishing, Oxford University Press
Category	Species information system
Description	The world's most comprehensive registry of plant names, begun in 1882 with assistance from Charles Darwin. Recently published on CD-ROM by Oxford University Press in collaboration with the Royal Botanic Gardens, Kew.
Where used	Libraries, herbaria, centres of botanical research worldwide.
Resolution	Global.
Data	Scientific names of plants (author-inclusive reference to the literature where the plant was first described.
Format	Data can be downloaded from IK as plain text (ASCII).
Outputs	IK can be searched quickly by typing the first letters of the family, genus or species to narrow the field (thus you do not need to know exact spellings); further, the boolean operators AND,OR, and NOT, plus the wildlcard characters * and ? can be used to form more complex search expressions; records can be viewed, saved to file, or printed in three styles: author view (family, genus, species, author); publication view (genus, species, publication, author); and whole record view (entire entry).
Configuration	DOS 3.0 or higher; MS CD-ROM extensions 2.0 or higher. IBM-PC 286 (AT) or higher; 640 Kb RAM or higher; CD-ROM drive.
Availability	IK on CD-ROM costs UK Sterling 995. For this one receives the search software and data on CD-ROM, a full user manual, and details of future updates as they are made available. Software allowing the CD-ROM to be networked is now available.
Summary	An immense resource for the botanic researcher owning an IBM-PC with CD-ROM drive. Windows and MAC versions would be useful. However, it should be noted that IK provides only minimal information on each species.
Name	**RECORDER 3.2**
Contact	Rosy Key, English Nature
Category	Biodiversity assessment tool
Description	Relational database for organising site related species records. Aims to answer two common queries: the species inventory for a particular location; and the circumstances of a record at a given location.
Where used	Biological recording centres, researchers, conservation trusts, museums, local authorities, and individuals throughout Britain. For example the Lincolnshire Trust for Nature Conservation, and Somerset Environmental Recording Centre.

Resolution	U.K. Although not generic, a version is being planned for Europe.
Data	Sites (gazetteer of biological recording locations); species (list of biological recording elements maintained centrally by English Nature); records (details pertaining to the observation/specimen recorded, including species, location, date, abundance, behaviour, recorder, and other information); sources (list of biological data recorders).
Format	Advanced Revelation.
Outputs	Users can determine species distributions and site inventories using the "Species Info" and "Site Info" windows respectively. Outputs are provided in the form of lists, tables, maps, and histograms. Maps are generated using an internal routine (Plot5) which allows grid overlays, symbol shading, re-sizing, and custom background map). Freeform queries can be made via the Advanced Revelation 'Record Selection Window' using the R/List language or sentence builder.
Configuration	DOS 2.0 or higher; versions for Windows, Mac and Unix are planned. IBM-PC 286 (AT) or higher; 640 Kb RAM or higher; 60 Mb hard disk space.
Language	Advanced Revelation 3.1.
Availability	RECORDER is packaged with full documentation, training, and user support (eg a bi-monthly newsletter). The current version is also bundled with Advanced Revelation 3.1 software so that users do not have to purchase this separately. The package is continually being improved according to user demands.
Summary	Widely used biological recording tool for use within the U.K. Excellent example of user support. Versions for other platforms than DOS would be welcome, as would a generic version for other countries.
References	English Nature (1993).

Name	**Wildlife Information Network (WIN): Wildlife Database**
Contact	Susan Jackson, Wildlife Information Network
Category	Under development
Description	Database of up to date wildlife veterinary and animal husbandry information, designed to support network of information centres worldwide.
Where used	Information centres are currently located at Zoo Outreach Organisation, CBSG India; Ragunan and Surabaya Zoos, Indonesia; Zoo Negara, Malaysia; Singapore Zoological Gardens, Singapore; Dusit Zoo, Thailand; Uludag University Faculty of Veterinary Medicine, Turkey; The Royal Veterinary College, London.
Resolution	Global.
Data	Taxonomic names (with help from Natural History Museum, London); people and places having relevant experience with particular species (5 year literature search to be conducted); veterinary and animal husbandry information (eg common complaints, anaesthesia, treatment regimes, nutritional requirements).
Format	Oracle (suggested only).
Outputs	Taxonomic or physical descriptions guide user to species identification;

	hypertext links to veterinary and animal husbandry information; institutions and experts on the particular species are listed (including contact details).
Configuration	Windows 3.1 or higher. IBM-PC 486 or higher; 8 Mb RAM or higher; CD-ROM drive; fax modem; desirable are video controller with M-JDEC option; ISDN interface; laser printer.
Language	Oracle Book 1.0 (suggested only).
Availability	Professional software and documentation planned; installation and training services likely; access to information holdings on plastic security card basis. Access charges and Internet compatibility uncertain at this stage.
Summary	Welcome tool for wildlife veterinarians and conservation biologists, particularly in situations where species have dwindled to small populations.
References	Jackson (1994).

Name	**World Bird Database (WBDB)**
Contact	Dr Colin Bibby, BirdLife International
Category	Under development
Description	Network of site and country databases feeding a central global bird database at BirdLife International headquarters. Aims to provide information, at a global scale, on bird species, sites, habitats, and conservation issues. Will be used to monitor the conservation status of all species of birds, identify conservation needs, and locate important bird areas (IBAs). At a regional scale, the WBDB will be used to monitor bird populations and trends, and help develop integrated country conservation programmes.
Where used	To include a worldwide network of partners cooperating with BI.
Resolution	Global.
Data	Global-level species database (threat status, major habitats, major threats, global population size, conventions, EBAs, biomes); country-level database (species lists, population estimates, trends, abundance, range, season); IBA database (sites-species information, threats, habitats, designations, population estimates, conservation actions and requirements); locality database (locality-related species records, abundance, habitats, altitude, season); supporting bibliography
Format	Not determined.
Outputs	Wide range of predefined listings, reports, tables, and maps.
Configuration	Not determined.
Language	Not determined.
Availability	In return for managing and contributing national data, cooperating partners in the WBDB will have free access to the global species database developed at BirdLife International. Regional and national WBDB programmes will build on existing biodiversity data management activities wherever possible.
Summary	Well designed distributed database for bird conservation.
References	Van Dijkhuizen (1994).

Name	**WORLDMAP 2.4**
Contact	Dr Paul H Williams, Department of Entomology, The Natural History Museum (UK)
Category	Biodiversity assessment tool
Description	Graphical tool for the interactive assessment of priority areas for conserving biodiversity. Can be used to find a sequence of priority areas accounting for the maximum biodiversity as measured by species richness, higher-taxon richness, and various other phylogenetic dispersion measures.
Where used	Natural History Museum, London; National Museums of Kenya, Nairobi; biodiversity research groups in Southern Africa.
Resolution	National and global; can be applied at any scale for which background mapping and species data exist.
Data	Species name, clade code, root weight, and distribution records (WORLDMAP is best suited to groups of species for which a cladogram is readily available - eg 'bumble bees'). Distribution is normally measured by presence/absence within the squares of a predefined grid imposed over the study area (eg quarter square degree grid over South Africa).
Format	ASCII.
Outputs	An inventory of species occurring in a grid square can be revealed by clicking the mouse on the square concerned; data for all squares (or alternatively all species) can be summarised in a text file report. To obtain a "priority areas sequence", high diversity squares (and their associated fauna) may be progressively removed from the analysis, revealing areas of next highest diversity as so on (greatest complementarity). The results of this process are automatically saved to an output file, including a histogram representing the "cumulative diversity score".
Configuration	DOS 2.0 or higher. IBM-PC 8086 or higher; 640 Kb RAM or higher; VGA colour video controller; mouse.
Language	C language.
Availability	WORLDMAP is supplied with basic documentation covering installation, use, and potential error messages; users are referred to scientific journals for detailed discussion of biodiversity measuring methodologies. A sample data set is provided with the system to guide demonstrate its potential to new users. Ease of transfer of existing data and maps to WORLDMAP format, and long-term support issues should be examined carefully.
Summary	A novel tool for assessing conservation priorities on the basis of maximising phylogenetic diversity. The biodiversity measures employed (eg spanning-tree length) are not universally accepted however, leading to the conclusion that conservation of ecosystem diversity may be more sensible at this stage.
References	Humphries (1991), Williams (in-press).

3.2.8 Data Capture Tools

A number of new technical advances have recently greatly eased the process of collecting and converting biodiversity data, especially for spatial and geographically referenced information. A recent review of the state of this technology can be found in Crain (1992). Some of the more important areas are expanded in the following.

Geographic Positioning Systems (GPS)

Despite the new tools available for automated data conversion, in a great many cases data conversion is still carried out solely by human operators. No fully automated spatial and non-spatial data conversion utility is totally foolproof; all still require a degree of human input, but many of them can reduce the amount of input and the time required to train previous to the data conversion task.

Global Position Systems utilise a series of satellites to enable the determination of positions on the Earth's surface. The units which achieve this are referred to a GPS Receivers and can be small enough to be hand-held or integrated into moving vehicles. These are obviously important aids in determining the location of sample sites or biological observation, which in the past was often accomplished by marking maps or air-photos - an error-prone process, especially in dense forest or featureless terrain. Absolute accuracy on the ground is normally limited to 100 meters, but relative accuracy using "differential" methods from a nearby accurately surveyed point can easily be a few centimetres.

GPS uses the triangulation of stationary satellites to deduce their location. These receivers can be linked to digitising software, allowing data capture in the field. This process is becoming more popular, particularly in areas where very little data already exists and accurate locations are required (to the nearest 100 metres).

Improved accuracy normally means increased cost, with highly accurate units (which utilise several transmission frequencies and many "channels",ie satellites) costing $50,000. Less accurate units suitable for field work cost a few thousand dollars. Analysis software is also needed and is in some cases at an extra charge.

In a recent issue of *GIS World* (see Bibliography, Section 7.3) 8 models varying in price from $3000 to $12,000 were tested and reviewed (Van Diggelen, 1994). Some well known suppliers of GPS include Garmin International, Leica Inc, Magellan Systems Corp, Motorola Inc, and Trimble Navigation Ltd (see Address List, Section 8.2). Many of these companies have offices outside of the USA.

A recent issue of *GeoInfo Systems* included a 9 page "Buyers Guide" which contains the addresses of approximately 40 suppliers of GPS equipment (GeoInfo Systems, November/December, 1994, p 53-61).

Optical Scanners

Laser technology coupled with artificial intelligence has allowed for the creation of devices for the rapid digitising of imagery and spatial data, such as maps, without tedious hand tracing on a digitising table. The large format optical scanners typically can cope with a document one metre square at a resolution as small as 25 microns. Following a scan of the map or document, raster-to-vector conversion is achieved through intelligent software. Some vendors offer optical recognition of characters as well to help with "tagging" of polygons or sample locations. Data entry using scanners into a GIS produces more consistent and error free results than manual digitising and greatly reduces human resource costs.

These are physically large devices and tend to be costly (eg $100,000 including required computer and software). Because of the high capital cost, such an input device is best if there is a high volume of data to be converted and/or it can be shared between several institutions. Many of the advantages and disadvantages of this approach are outlined in Ingersoll (1994).

These come in a variety of sizes and formats from A4 upto A1 and from black and can produce results in just black and white or in thousands of colours. The costs of scanner generally reflects its functionality with reference to size, scan density and number of colours. There are many manufacturers now producing scanners and several more now provide scanning and vectorisation facilities. Some well known vendors of optical scanners are Calcomp, Carl Zeiss Inc, Intergraph Corp, Laser-Scan Inc, and UNISYS Ltd (see Address List, Section 8.2).

Digitisers
There are two large companies that dominate the field: CalComp and Summagraphics. Several other companies produce a variety of models including "clones" of the CalComp and Summagraphics digitisers, often at a lower price.

Optical Character Recognition (OCR)
OCR is the process of scanning and computerising text -automatically. Printed text is converted into a computer image by the scanner, and subsequently processed into digital characters by the OCR software. OCR works well with typed or printed material, but performs poorly with hand-written or poorly printed text. The relative advantage of OCR over manual entry of text into a word-processor, depends entirely on the performance observed.

3.3 Internet Communications

3.3.1 What is the Internet?
The Internet is the term describing the emerging union of connected computer networks transferring information around the globe between millions of computer users every day. It is often referred to as the "network of networks".

> *"You would not be far off if you imagined the Internet as a kind of computer amoeba, reaching out and connecting separate islands of computer resources into a seamless web"* (Estrada, 1993).

The networks that comprise the Internet are connected by computers, known as routers, which need to be able to decide how to transmit data most efficiently across different parts of the network. The Internet Protocol (IP) makes sure that the routers know where to send the data by addressing it in small data packets. These packets are prevented from being lost or damaged by the Transmission Control Protocol (TCP). The combination of these protocols is commonly denoted as TCP/IP. The important consequence in this standard for passing information is that all computers and operating systems are visible on the network provided they communicate with TCP/IP.

3.3.2 Usefulness of the Internet

There are clearly endless uses to be found when millions of computers are linked up in this way. However, to be helpful there are general uses which are commonly appreciated. These include:

Electronic Mail

A resource that allows messages and data to be sent and received by individuals or groups of individuals.

Public Forums and Conferences

A number of resources that allow news and messages to be publicly accessible.

Information Resources

Information, data and software is available all over the network. These may be accessed through a variety of Network Information Retrieval (NIR) resources. These resources will allow both the retrieval and serving of such information.

Real-time Communication

Resources are available to enable the simultaneous transmission of text, video and audio information between communicating individuals.

These four uses encompass a wealth of individual resources. These shall be discussed later.

3.3.3 Getting Started

There are numerous considerations one can address in choosing both whether one should, and how one can access the Internet. A detailed appraisal of these is given in *Connecting to the Internet* (Estrada, 1993). Given that you wish to connect to the Internet there are two major decision that have to be taken:

- which Internet provider is most suitable
- what kind of connection is suitable
  either dial-up connection via modem
  or dedicated (leased) line.

3.3.4 Choosing the Internet Provider

Network providers are primarily concerned with the installation and maintenance of the connection between them and their clients, be it a home or place of work. Commercial providers are likely to be able to meet most of the requirements made upon them. However, it is worth considering the following points for review with potential providers to be sure (the following information has been summarised from Estrada, 1993).

Network Reliability

Providers should be able to guarantee almost continuous connection time. Statistics should be available to confirm this. Providers should also show evidence that they have a capacity to 'troubleshoot' problems over a 24 hour period.

Network Performance
Providers should be able to provide 'round-trip' times for local connections in milliseconds for a variety of digital line speeds, typically 9.6, 19.2, 56, 1,544 and 10,000 kbps (kilobytes per second). These may be compared between providers. In addition it is important to understand their policy in adopting new hardware for expansion to faster and more reliable connections.

Network Connectivity Restrictions
Some networks have in place "acceptable use policies" (AUP). This can restrict access to specific user types such as with research and academics. Commercial gateways, notably the Commercial Internet Exchange (CIX) are AUP free. It is worth investigating whether the provider has at least one commercial gateway.

User Services
Given the ever changing resources available on the Internet it is worth noting whether a provider has a user support service. Such support will prove to be invaluable for keeping abreast of new developments.

Security
The Internet breeds the electronic equivalent of the **thief** who looks for open windows and doors. Security is only a real problem for dedicated lines (see below). The most robust form of security is to place a "firewall". This is a computer set up between your computer network and the Internet through which all the traffic is diverted. However, the issue of security is too complex an issue to discuss in full here. Your provider should be able to advise on this.

Cost
There is no single policy for charging to connect to the Internet. Charges may be fully commercial, shared or even free. Costs vary for services such as setup, line rental, router rental, usage tolls etc. For evaluating the relative costs quoted by providers one should review chapters 5 and 6 of Estrada (1993).

Finding Providers
This will depend upon whether the connection is to be a dedicated line or direct dial. A list of providers is given for each in Estrada (1993). If access to e-mail is possible contact the following:

- for dedicated access providers e-mail **dlist@ora.com** with the message **Send DLIST**

- for direct dial providers e-mail **info-deli-server@netcom.com** with the message **Send PDIAL.**

3.3.5 What Kind of Connection is Suitable?
Depending on the expertise and funds available, either a **dialup** or **dedicated line** connection may be established. The latter is mainly used by major Internet users who require an

immediate and fast connection, possibly by many users in an organisation. Dialup connections are cheaper since a connection is only established when it is required, and can often be made by means of existing telecommunications paths. Dialup connections occur in two forms:

Online Accounts
These accounts are ideal for accessing the Internet for the first time. They are cheap and easy to implement. One simply pays for an account with an Internet provider giving you access to, at minimum e-mail, FTP and TELNET, and for most now WAIS, WWW and Gopher (see Network Information Retrieval (NIR), Section 3.4.3). This effectively makes the your computer (local) into a terminal of the Internet host computer (with appropriate emulation, eg VT100). This means that the Internet host is the machine performing all the operations. However, it is possible to "download" data retrieved to the host back to the local computer. The equipment required at the local site includes a computer, a modem (2400+ baud) communications software (often provided with the modem) and a standard telephone line. The Internet provider should provide additional information for connection one an account has been established.

Dialup IP Links
This is necessary when you are a heavy user of the Internet or you are part of a local area network with many users wanting access. The connection is commonly referred to by the particular protocol it is running, namely Serial Line Internet Protocol (SLIP) or the more advanced Point to Point Protocol (PPP). With either of these protocols your computer (local) becomes temporarily part of the Internet with its own IP address capable of directly sending and receiving data from other computers. The basic equipment is the same as with the online accounts except that SLIP or PPP software is required. You may, if you are very heavy users decide to invest or rent a "router". Modern versions have SLIP, PPP and a modem built in. Internet providers will assist in the installation of both router and router-less solutions, provided they are running SLIP or PPP themselves.

You may also overcome the need to use modems by using the Integrated Services Digital Network (ISDN) which provides a much faster and reliable connection for dialup access. The local phone company should be able to advise on costs and accessibility. You may also use the X.25 network for direct dial though it is slow and is not recommended for SLIP or PPP.

3.4 Internet Resources

3.4.1 Sending Messages

Electronic Mail
The most commonly appreciated use the Internet is through the Electronic Mail (e-mail) system. It allows text written on a computer to be posted to 'mail boxes' on other, 'remote' computers. This has the advantage of convenience, in that users messages can be composed and sent directly from the computer, and speed, in that messages commonly reach their destination within minutes. These advantages encourage a 'dialogue' between correspondents which is more difficult to achieve through the postal mail. In addition, e-mail facilitates group communication. E-mail allows you to set up arbitrarily large groups and any member

of the group can communicate with the whole at any time. This makes it very useful both to disseminate information and to query a group for answers to questions.

Choosing a Mail System
E-mail systems have developed to such a point where it is possible to exchange basic e-mail with any other e-mail system. Though there are numerous systems around providing various features, some of the more sophisticated provide additional links into the Networked (Internet) Information Retrieval (NIR) tools including gopher, ftp etc. Others provide utilities for transferring a variety of file formats including for instance 'binary' data. One should consider that there are good "public domain" e-mail systems available, notably NuPOP.

Before deciding it is useful to consider the following questions:

- **Do you expect to exchange things other than just messages?**
  All mailers will deal with basic messaging. Other transmission requirements such as binary graphics and voice, can only be used when the sender and recipient both have the local capability to deal with these formats. If your information exchange requires dealing with such specific needs then it is advisable to choose the exact same mailer and operating system.

- **What is your preferred user interface?**
  There are both character and graphic based mailers available. The most common distinction between such systems occurs between DOS and MS Windows.

- **How often do you travel?**
  If e-mail usage is necessary outside your regular place of work it is necessary to consider e-mail that enables the connection of a portable computer to the network, (or by dial-up). This would allow messages to be downloaded and conversely allow messages to be queued (off-line) for delivery.

Essentially one should reflect upon any specific needs first. If your needs transpire not to be great and you are mainly concerned with basic messaging, then begin with looking at the systems used by your collaborators. It is worth noting that there are many 'public domain' mailing systems that are appropriate for basic messaging.

Mailing Lists Using LISTSERV
LISTSERV is a programme that automatically receives and sends e-mail. The programme is used in association with subject based groups of e-mail users who wish to communicate through a central messaging system. The programme is also given the task of maintaining multiple electronic mailing lists, handling all membership requests (subscriptions and cancellation of subscriptions, and so on). Many list owners collect monthly logs of all messages sent to the list, and some also provide files of other information. (Smith 1993)

Listserver Commands
A summary (Thomas 1993) of these commands can be retrieved by sending the message "send listserv refcard" to any listserver. The main listserver is listserv@BITNIC.educom.edu, but there are many listservers around the world. A comprehensive list of biological related

listservers is provided on the Internet. (Smith 1993)

To subscribe to any of these mailing lists, send e-mail to the listserver at the same address. For example, subscriptions to the Smithsonian Institution's biological conservation list, CONSLINK, may be obtained by sending the following message (example provided in Smith, 1993):

subscribe conslink <Your Name>

to listserv@SIVM.si.edu. To turn off mail from a list temporarily, for example while you are away on vacation, send the message:

set <listname> nomail

To unsubscribe permanently, for example because your e-mail address is about to change, send the message:

unsubscribe <listname>

Send subscription and other administrative requests to the listserver, not the list; e-mail messages sent directly to the mailing list will (generally) be sent to all the list subscribers. Only the listserver can process subscription requests, and the listserver only knows about requests that it receives directly.

LISTSERV programs of version 1.7f and higher have a very useful feature that lets you receive a daily digest (actually a concatenation, with a table of contents) instead of many individual articles. Send e-mail to the appropriate listserver with the message:

set <listname> digest

Archives

In addition to handling the membership requests for particular mailing lists, most listservers also archive all messages sent to each list in monthly log files. These files, along with other items contributed by list subscribers, are archived by the listserver and can be retrieved by e-mail. Listserv@SIVM.si.edu keeps an archive of various lists of conservation organisations and field stations, several newsletters, and a large collection of bibliographic references relating to biological conservation. (Smith 1993)

Commands for retrieving files from listserver archives are described in the listserver command reference guide (Thomas, 1993). For quick online guides it is possible to request a list of information guides from a listserver by sending the message **info** to the listerver address.

3.4.2 Network News

Network news is the Internet equivalent of a discussion group or a "bulletin board" system (BBS) like those set up on private networks such as Compuserve. To the user the network news organises discussions under a set of broad headings called "news groups" which are sub-grouped into specific subjects. A "news reader" helps select different topics whilst keeping everything in order through the tracking of items read and received.

News Groups
News groups are organised hierarchically, with the main grouping first in the name, followed by an arbitrary number of subgroupings. The main and subgroups are delimited by the "." character. For example:

sci.bio.ecology

News is supplied from "news servers" which may be accessed from a computer by a news reader. The server collects news from a number of places the most important one being USENET. News servers keep the articles for a predefined time and then eventually discards them. Most of the server's news groups come as part of USENET, a group of news groups generally considered to be of interest globally, and free. USENET is best described as a set of voluntary rules for passing and maintaining news groups. It is not a network, it does not require the Internet. There are seven major news categories associated with USENET; **comp** (computer science); **news** (news about network news); **rec** (hobbies and recreation); **sci** (science, engineering and social science); **soc** (society and politics); talk (debate and controversy); **misc** (anything that does not fit into the above). In addition there are present "Alternative News Groups Hierarchies" which look like USENET news groups. Due to this the term USENET is frequently expanded to include these groups. The most common include **alt** (alternative thoughts, lifestyles etc); **bionet** (biology); **bit** (Bitnet listserv discussion groups); **biz** (business).

Network news services predates the Internet and may still be used without requiring a connection. This makes it a valuable resource for institutions in countries that are not connected.

3.4.3 Network Information Retrieval (NIR) Tools
The following is an overview of major networked information retrieval (NIR) tools available on the Internet. There are many excellent books which discuss the Internet and NIR Tools in detail. Such books include Krol (1992).

The number of these NIR tools is large and growing quickly. Certain techniques reappear regularly and seemingly different tools may perform similar tasks, allowing a simple classification of projects encompassing most of the existing tools and services.

The classification presented here is only one possible ordering. The goal is to define in broad outlines what can be done with particular tools, realising that users will always find novel unanticipated ways of applying them.

Interactive Information Delivery Services (Gopher, World Wide Web)
Basic Internet services such as electronic mail and anonymous FTP can be used to share information across the Internet, but neither allows simple browsing and neither is particularly easy for the newcomer to learn to use. Gopher and the World Wide Web (WWW, W3) are two recent developments that attempt to make it easier to distribute information over the

Internet. Both allow the user to browse information across the network without the necessity of logging in or knowing in advance where to look for information.

- **Gopher**
  The Gopher project was first developed at the University of Minnesota to provide a simple campus-wide on-line information system. Gopher represents information as a simple hierarchy of menus and files. It has limited capability to recognise different types of files, allowing, for example, the display of selected types of image files. Gateways to other services are provided (usually in a manner that is transparent to the user). The underlying Gopher protocol is simple, and has facilitated the creation of freely available clients for use on a variety of hardware platforms and operating systems. The more recent Gopher+ protocol adds the ability to provide documents in alternate forms (PDF, PostScript, RTF, Word). These features and the ease of installing and administering gopher servers has led to an explosive growth of gopher sites since its initial deployment. As of November 1993, there were over 2200 known servers.

  For further information contact:

Name:	The Internet Gopher Development Team
Email address:	gopher@boombox.micro.umn.edu
Postal address:	Microcomputer & Workstation Networks Center 152 Shepherd Labs 100 Union Street SE. University of Minnesota Minneapolis, MN 55455
Telephone:	+1-612-625-1300
Fax:	+1-612-625-6817

- **World Wide Web**
  World Wide Web relies on hypertext: formatted documents are displayed, and hypertext links within the document can be selected to travel from the current document to another. W3 allows a user to annotate documents (using hypertext links), provides gateways to other services, and has multimedia support (for example, on appropriate hardware platforms it can intermix text and images in a displayed document). There is a range of free W3 clients, supporting many environments. World Wide Web was originally developed at CERN for the High Energy Physics Community.

  For further information contact:

Name:	Tim Berners-Lee
Email address:	timbl@info.cern.ch
Postal address:	CERN, 1211 Geneva 23, Switzerland
Telephone:	+41-22-767-3755
Fax:	+41-22-767-7155

Gopher and W3 share a maintenance problem in that there is no automated way to update links to other documents when those documents are moved or removed.

Directory Services (WHOIS, X.500)
Directory Service tools are intended to provide a lookup service for locating information about users (often referred to as White Pages), or services and service providers (Yellow Pages). For example, a White Pages service might be used to locate an electronic mail address, given a name and organisation, while a Yellow Pages service could be used to locate an online library catalog or file archive site.

- **Whoi**
  One of the first directory services deployed on the Internet was WHOIS, a simple White Pages service created to track key network contacts for the early DARPA-sponsored incarnation of the Internet. A number of sites currently operate WHOIS servers, based on a range of extensions and enhancements to the original model. WHOIS enjoys the advantages of simplicity and the presence of WHOIS client software on a preponderance of Internet-connected hosts. Work is underway on a more powerful protocol, known as WHOIS++, which is backwards-compatible with WHOIS.

  For further information contact:

Name:	Network Solutions, Inc.
Email address:	hostmaster@rs.internic.net
Postal address:	Network Solutions AttN:InterNIC Registration Services 505 Huntmar Park Drive Herndon, VA 22070
Telephone:	+1-703-742-4777

- **X.500**
  The X.500 Directory Service is a much more ambitious Directory project that has been under development for a number of years under the aegis of ISO/OSI. Implementations, concerned primarily with White pages services, are available in the public domain and from commercial sources. There are LDAP based X.500 clients available for most major platforms, as well as a LDAP based gopher gateway to X.500.

  For further information contact:

Name:	The PARADISE Project
Email address:	helpdesk@paradise.ulcc.ac.uk
Name:	The White Pages Pilot Project
Email address:	wpp-manager@psi.com

Despite years of effort, there is still no single White Pages Directory Service for the entire Internet; Yellow Pages services remain even less well developed and deployed. The cost of setting up the service is one obstacle; maintaining the required databases is even more daunting.

Indexing Services (archie, veronica)
There are several Internet-based projects that build indexed catalogues of information to facilitate searching and retrieval. The first such services provided network access to library card catalogues, with more recent projects indexing network-based information.

- **archie**
  The archie service began as a simple project to catalog the contents of hundreds of ftp-accessible online file archives. The archie service gathers location information, name, and other details describing such files and creates an index database. Users can contact an archie server and search this database for files they require.

  The archie service is accessible through a range of access methods, including telnet, stand-alone client programs running on a user's own machine, gopher, WWW, or via electronic mail. The initial implementation of archie tracks over 2,100,000 filenames on over 1,200 sites around the world (as of November 1993). There are about 30 (geographically distributed) archie servers. Both commercial and freely available versions of the archie client software are available.

  Work continues on extending the archie service to provide additional types of information. The latest version is being used to provide a prototype Yellow Pages service and directories of online library catalogues and electronic mailing lists.

  For further information contact:

Name:	Archie Group, Bunyip Information Systems Inc.
Email address:	info@bunyip.com
Postal address:	Bunyip Information Systems Inc., 310 St-Catherine St. West, suite 202, Montreal, QC CANADA H2X 2A1
Telephone:	+1-514-875-8611
Fax:	+1-514-875-8134

- **veronica**
  Veronica arose as an attempt to do for the world of Gopher what archie did for the world of ftp. A central server periodically scans the complete menu hierarchies of Gopher servers appearing on an ever-expanding list (over 2000 sites as of November 1993). The resulting index is provided by a veronica server and can be accessed by any gopher client.

  For further infomation contact:

Name:	veronica development team
Email address:	veronica@veronica.scs.unr.edu

Postal address: VERONICA development team
SCS Computer Center Building mailstop 270
University of Nevada, Reno
NV 89557-0023
Telephone: +1-702-784-4292 or +1-702-784-6557
Fax: +1-702-784-1108

Text-based Indexing Services (WAIS)

- **WAIS**

  Wide Area Information Servers (WAIS) is a system for indexing and serving infor mation in a network-based environment. It is distinct from indexing tools such as archie and veronica in that it is used to index text-based target documents on a server, as well as descriptions of the contents of a server.

  A WAIS server allows the administrator to set up an index of the documents (or resources) to be published. The user employs a WAIS client to attach to a particular WAIS server, and specifies a search pattern which is matched against the server's index. In early WAIS clients, searches are specified as simple natural-language queries; common ("stop") words are removed, and Boolean "ORs" are implicitly added between the remaining list of words. Matching documents are rank-ordered according to a simple statistical weighting scheme which attempts to indicate likely relevance. The user may choose to view selected documents, or further refine the search. The results of one search may be used to successively refine future searches ("relevance feedback"). Gopher clients can also access WAIS servers via a transparent gateway.

  Both freely available and commercial versions of WAIS servers and clients are available. Current work is attempting to add Boolean expressions and proximity and field specifications to queries.

  There are currently (as of November 1993) some 500 registered WAIS databases with an estimated 2000 additional databases that are not yet registered. There are approximately another 100 commercial WAIS databases.

  For further information contact:

  Name: Than Lee, WAIS, Inc.
  Email address: info@wais.com
  Postal Address: 1040 Noel Drive, Suite 102, Menlo Park CA 94025 (USA)
  Telephone: +1-415-617-0444
  Fax: +1-415-327-6513

3.4.4 *Further Internet Resources*

Moving Files

- **ftp**
  For instances when files are required to be copied from a remote site the most robust method employs a tool called **ftp**. **ftp** is named after the application protocol it uses: the "File Transfer Protocol (FTP)." As the name implies, the protocol's job is to move files from one computer to another. It does not matter where the computers are located, how they are connected, or even whether or not they use the same operating system. Provided that both computers can "talk" the **FTP** protocol and have access to the Internet, you can use the **ftp** command to transfer files.

- **Anonymous FTP**
  FTP has a limitation in that data suppliers must allow remote users to login with specific login/passwords which are known to the host system. This has a system administration overhead which can be unwelcome. Anonymous FTP overcomes this problem. I allows users who do not have a login name or password to access certain files on a machine. In order to ensure security anonymous FTP restricts users to a predefined area on the host file system generally only allowing files to be copied off. Never-the-less, anonymous-FTP is extremely popular and useful and is the commonest method used for transferring files over the Internet.

Remote Computer Access

- **Telnet**
  Telnet allows someone using a computer with full Internet access to login to another computer that is also connected to the Internet. This is provided that a user name and password are granted to the person logging in. This is particularly useful if one is required to use your own machine from a different site. Public 'guest' logins are sometimes setup with restricted access rights to run applications.

3.5 Non Digital Information Exchange Formats

3.5.1 *Microfilm and Microfiche*

In the past 25 years or so microform has been one of the main ways for libraries and organisations to store large quantities of documents. The main advantages of microform storage are:

- small space requirements
- relatively cheap production and distribution of microform and microfiche, in particular
- recognised international standards which assure the quality and thus the longevity of the medium under the appropriate storage conditions.

The commonest formats for microform are:

- 35mm microfilm and
- 24 times reduction on 6 x 4 inches microfiche holding approximately 60 frames.

There are, however, a number of variations on these formats which usually result in more data or information being presented, the exception being jacketed microfiche where the quantity of frames is less. Microforms are either positive or negative: positive being black printing on a white ground, or negative with a black or blue ground with print represented in white. The master copy is produced on silver halide film with copies of microfiche being prepared very cheaply on diazo material.

The main disadvantage with the medium is user aversion. A microfilm or microfiche reader is an essential tool to permit the information on the microform to be read: it cannot be read with the naked eye. Reader aversion to microforms is due to difficulties experienced in finding the correct pages as serial searching is required with microfilm or the seeming "jumping around" in the case of microfiche. Thus, although not essential, a microform reader which can provide prints is highly desirable. Until ten years ago the technology of printing was such that prints were produced by a chemical process on specially coated paper, the readable life of which was a few months. Now with appropriate equipment the prints will have the same life as those from a plain paper photocopier.

Microforms are principally used for distribution of reports and learned journals, the latter being in positive microform and the former in diazo copies.

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4 DATA MANAGEMENT STANDARDS

4.1 Documentation of Data

4.1.1 Metadata

Environmental data describe objects or phenomena of the environment or related to the environment. Without circumstantial information data values have no lasting meaning and cannot be interpreted or exchanged among organisations. It is the most widespread quality problem of all dataproduct sources, that documentation and circumstantial information is neglected.

The circumstantial information in itself does not indicate anything about the environment. It solely gives the context for understanding and comparing the datavalues and is therefore often also termed "metadata" or "co-data" rather than circumstantial information.

In the publication NMD (1981) and in subsequent information from the Nordic Council of Minitsters, a set of rules is set up to help characterise environmental data, dealing with 8 groups of circumstantial information.

The European Environment Agency makes extensive recommendations in its Chapter *Descriptive Concepts for Environmental Data* in the report prepared for the Catalogue of Data Sources project (EEA, 1993).

4.1.2 Spatial Data

The human eye is highly efficient at recognising shapes and forms, but the computer and Geographical Information System (GIS) needs to be instructed exactly how spatial patterns should be handled and displayed. Standards need to be defined for these spatial instructions.

Haralick (1980) and Shapiro (1980) have shown how a relational database structure for points, lines and polygons can be established that treats the raster and vector approaches to modelling geographic topology as equivalent alternatives. They define a standard for data descriptions of these topological entities.

With the wide range of commercial GIS and cartographic software available, until recently there was no standard for describing and transferring data between different data producers and users. The Spatial Data Transfer Standard (SDTS) or Federal Information Processing Standard 173 (FIPS 173 - see NIST, 1992 and FGDC, 1993) was designed to tackle this issue. SDTS defines a format for spatial (ie geographic and cartographic) data transfer from the conceptual level to the details of physical file encoding. The United States Geological Survey, as the FIPS 173 maintenance authority, is committed to promoting acceptance of FIPS 173 and to supporting its use. The United States Geological Survey (USGS) is seeking additional approvals from the American National Standards Institute and the International Standards Organization in an effort to broaden access to FIPS 173 among commercial and international users.

The GIS data transfer National Standard of Canada is Edition 1.2 of The Digital Geographic Information Exchange Standard (CGIS-DIGEST, 1994) developed within the Digital Geographic Information Working Group (DGIWG). DIGEST also a NATO stndard, STANAG 7074. It is expected that future editions of DIGEST will also become National Standards of Canada, superseding this one. However, Edition 1.2 of DIGEST will be frozen until June 1996.

4.2 Data Quality

The modern approach to data quality is to consider it in terms of fitness for use - that is quality is a relative term which depends on the intended use and the ultimate end-user of the information. Quality standards therefore must reflect this. The most sweeping quality standards, which can apply to manufacturing as well as information management are the group of standards known as the ISO-9000 series, maintained by the International Organisation for Standardisation.

The key documents of this series are:

ISO 9000-1 Quality Management and Quality Assurance Standards - Part 1: Guidelines for selection and use

This presents the structure of the standards and which ones apply to which situations.

ISO 9000-3 Guide to the Application of ISO 9001 to the development, maintenance and supply of software.

This is relevant to biodiversity software development and distribution.

ISO-9001 Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing

ISO-9002 Quality Systems - Model for Quality Assurance in Production, Installation and Servicing

ISO-9003 Quality Systems - Model for Quality Assurance in Final Inspection and Test

The above three standards vary in detail only and apply to differing manufacturing and service situations. An information management organisation would normally fall under 9002.

ISO-9004-1 Quality Management and Quality System Elements - Part 1: Guidelines

This defines the quality elements which make up a total quality system, and are the best advice of how to implement.

ISO-9004-2 Quality Management and Quality System Elements - Part 2: Guidelines for Services

This guideline, in particular interprets Standards 9001, 9002 and 9003 in terms of service organisation - that is as they would apply to the provision of biodiversity information management services.

ISO 8402 Quality Vocabulary

Contains definitions of the terms which are now internationally accepted.

ISO-10011-1 Auditing Quality Systems

Contains information on how to verify or "audit" a quality assurance system.

Copies of these standards may be obtained from International Organisation for Standardisation (ISO) (see Address List, Section 8.2).

The International Organisation for Standardisation is also sponsoring international efforts in other areas of environmental quality management. ISO Technical Committee TC207 is addressing itself to "Environmental Management" standards, which includes sub-committees on Environmental Management Systems, Environmental Auditing, Environmental Labelling, Environmental Performance Evaluation, Life Cycle Assessment, Terms and Definitions, and Environmental Aspects in Product Standards. The overall chairmanship of this effort is with the Canadian Standards Association (see Address List, Section 8.2).

Considerable attention has also been paid to questions of accuracy and quality in spatial data. A good review of the current situation can be found in Goodchild (1989)

A major contribution toward standardising the definition, assessment and reporting of GIS data quality has been made by the Data Set Quality Working Group of the National Committee for Digital Cartographic Data Standards. A summary of the data quality standards developed by this working group, as well as work on other aspects of cartographic data standards, is presented in the January 1988 issue of *The American Cartographer*.

More specific treatments of data quality can be found in Aronoff (1989), Chrisman (1984), Dunn (1990), Goodchild (1989), Hunter (1992), Kamran (1993), Ralphs (1993), and Vonderohe (1985).

4.3 Data Exchange Formats

4.3.1 Overview

The exchange of information between systems can be a time consuming and difficult process, often requiring that the data are exported to a primitive ascii format. In particularly, conversion of spatial data has proved complex due to the very large size of some files and the varied nature of the data, for example, raster data, 2D and/or 3D vector and attribute information. These difficulties have led to the development of national and international standards for the transfer of data. Despite this, much spatial data is currently transferred via a de facto standard using a proprietary software exchange format.

Further reading on data exchange standards can be found in a variety of GIS journals, for example *GIS World*, *Mapping Awareness and GIS in Europe*, *GIS Europe*, *GIS Asia and Pacific*, plus several GIS reference books.

4.3.2 De facto Data Exchange Standards

The most popular spatial data exchange formats are those used by the most widely established GIS/CAD packages, namely ARC/INFO and AutoCAD. Each of these packages have their own interchange format which is used by a multitude of other packages to transfer or at least accept information. The most popular format is **DXF** produced by the Autodesk product AutoCAD. AutoCAD is by far the most popular CAD package in the world, with over 750,000 copies sold and is now available in over 18 languages. The number of attributes that can be attached to a DXF file is very limited as it was designed to be used with CAD packages.

The most common GIS exchange format is ARC/INFO export file (E00). This is an ASCII format and is capable of storing spatial data and a feature attribute table. This format was designed to allow the interchange of data between the various platforms of computers that ARC/INFO is available on. With new releases of software, additional features are included and the export format modified accordingly. This can lead to difficulties in transferring information between different versions of the export format. Other widely used vector exchange formats include Interactive Graphic Design Software (IGDS) and Standard Interchange Format (SIF) produced by Intergraph products; Initial Graphics Exchange Standard (IGES), often used in transferring CAD data and Digital Line Graph (DLG), one of the formats used by the US Geological Survey.

ERDAS have produced a long established and popular set of image processing and raster GIS systems. The GIS format produced by these products has become a de facto standard for the exchange of raster satellite information. Tabular non-spatial information is most often transferred using the dBASE III format. dBASE III and clones of it are extremely common in the PC and Macintosh environment, making it a very popular choice for exchange of information. The alternative to dBASE III format is some form of ASCII delimited usually with commas or tabs.

4.3.3 National and International Data Transfer Standards

Information for this section has been provided from the journals *GIS World*, *Mapping Awareness and GIS in Europe* and a review of data transfer standards maintained on the Internet GIS-L listserver by Peter Bolton (1994).

Many national standards are being set-up by national standards organisations, parts of these standards are also being used as a basis for international standards incorporated into the ISO standards scheme.

> *"A number of efforts are under-way to develop standardised data exchange formats for digital cartographic data. These efforts are variations on the 'neutral file structure' theme, with differing degrees of flexibility within the file structure. At a meeting of the International Cartographic Association Working Group on Digital Cartographic Data Exchange Standards representatives of the following countries*

indicated an active involvement in developing exchange standards: Australia, Canada, China, Federal Republic of Germany, Finland, France, Hungary, Japan, New Zealand, Norway, South Africa, Sweden, Switzerland, United Kingdom, Union of Soviet Socialist Republics and the United States." (Guptill, 1991).

The following is a brief list of some of the national standards, many other standards exist or are currently under construction.

NTF (National Transfer Format) is a United Kingdom standard for the exchange of geographic data. "NTF is designed for all types of raster and vector map data" (Guptill, 1991). Five levels of transfer are established from simple raster data to vector data, attributes, topological structure and a user defined format."NTF establishes a set of rules for formatting data on a magnetic tape or other medium, while at the same time offering flexibility." (Guptill, 1991).

SAIF (Spatial Archive and Interchange Format) "is a Canadian standard for the exchange of geographic data. It uses an object oriented data model, and consists of definitions of the underlying building blocks, including tuples, sets, lists, enumerations, and primitives" (Bolton, 1994)

SDTS (Spatial Data Transfer Standard)

FIPS 173 (Federal Information Processing Standard). According to Bolton (1994):

"SDTS is the newly approved standard for transfer of geographical, geologic and other spatial data. SDTS can contain a wide variety of geographical information and was developed on the need for a standard for US census data. At the basic level, STDS defines the physical location of a listed series of 'primitives' such as lines, points, polygons and arcs. It can position these primitives on a raster bitmap image of a region. The full power of SDTS comes from being able to define 'objects' that contain these primitives but also contain information fields. An object may be an airport or a freeway. Particular 'instances' of these defined objects can then be modified to suit the particular case. The SDTS standard defines the data model. The actual file format is an adaption of a standard known as ISO 8211 (ANSI/ISO 8211-1985 or FIPS 123). The format contains directories of objects and instances of objects. The data is stored in a combination of ASCII text and binary and is designed to be completely portable. There is much pressure for SDTS to become a universal standard for data".

However, it does incorporate some restrictions. For example, it was initially only able to store data in one of two projections used for the United States, making it unusable for anywhere else in the world. In addition, it is unable to store spatial data sets that contain both point and line topology together.

4.3.4 Graphics Exchange Formats

The following is a list of graphics exchange formats which are in wide use in different parts of the world. It should be noted that many software packages intended for graphics production and editing have the capability to convert to and from many of the formats listed.

CGM (Computer Graphics Metafile) (ISO 8632, 1987) is intended to be the standard for the interchange of 2D graphical information; powerful, complex and easily extensible.

DXF (Data Interchange Format) is currently the most popular standard for the interchange of 2D and 3D CAD/CAM drawings. There is no support for images in the format.

EPS (Encapsulated PostScript) is a subset of the PostScript standard which is designed for describing a graphic image embedded in a larger document. EPS graphics are limited to a single page.

GF3 (General Format 3) is a UK-developed scientific data format for the storage of oceanographic and atmospheric science data. Primarily an ASCII text based format.

GIF (Graphics Interchange Format) was created by Compuserve, Inc. for the transmission of images on their network. It has become the de facto standard for the machine independent storage of low (colour) resolution, bitmap raster images.

GKS (Graphical Kernel System) (ISO 7942, 1985 and 8805, 1988) was created by an international committee to be the graphics subroutine library standard. GKS routines can optionally create CGM files from their output. GKS was initially a 2D system but has been extended to 3D.

PCX is a proprietary graphics bitmap format for the PC Paintbrush program, widely supported by DOS and Windows programs.

PHIGS (Programmer's Hierarchical Interactive Graphics Standard) (ISO 9582, 1989) like GKS, was created by a standards committee (ANSI) to be the graphics subroutine library standard. It is much more powerful that GKS as it supports 3D objects, complex geometrics and hierarchical groupings on graphics.

IGES (Initial Graphics Exchange Specification) IGES is designed to be the standard for the exchange of 2D and 3D CAD/CAM data. IGES is not as widely used as DXF due to its complexity and may be supersede by PDES.

PDES (Product Data Exchange using STEP) is an international standard being developed by ISO. PDES is an international project to create "a single international accepted data exchange standard" (Guptill, 1991).

PICT is the graphics disk format corresponding to the Quickdraw graphics subroutine library. **Quickdraw** was created by Apple Computer, Inc., to describe 2D vector and bitmap graphics in their Macintosh computers.

STEP is the acronym for the ISO project Standard for the Interchange of product Model Data. The goals of STEP mirror the goals of PDES, and they will probably become identical. STEP and PDES are described in the draft paper ISO DP 10303, 1988.

SET (Système d'Echange et de Transfer) is an alternative standard to IGES developed by the French, offering a simplified structure.

Postscript is a computer language used primarily in printers for completely describing the appearance of printed pages. Currently the most important graphics standard, PostScript helped create the field of desktop publishing.

TIFF (Tag Image File Format) was created by the Aldus Corporation and Microsoft Corporation for the storage and transfer and grey-scale bitmap images. TIFF has by far the best colour support of any graphics format.

WMF (Microsoft Windows Metafile) is a graphics format similar to Macintosh PICT.

4.3.5 Spatial Data Conversion

The following sections are derived from experience gained the conversion of spatial and non-spatial data at WCMC and from several reports on the difficulties involved, in particular Ingersoll (1994).

The conversion of spatial data from its original medium to a digital one is often the most expensive operation in the establishment of a spatial database. With such high costs, it is important to get useful data into the system, that is to minimise distortion, errors and inconsistencies in the digitising process. Conversion of spatial data from a paper source is inherently fraught with problems. Paper is a poor medium for accurate data conversion. It has been shown to distort by up 15% in any direction depending upon the air temperature and humidity, correspondingly distorting the location of map features. A more stable medium is the plastic Mylar, which is almost unaffected by day-to-day changes in humidity and temperature. Unfortunately, it is often difficult and costly to obtain source information on mylar.

During the last twenty years, many attempts to find a cost effective and efficient technique for the process of automating spatial data conversion have been sought. Despite these efforts, not a significant amount has changed in the way many organisation convert their spatial data to digital form. The currently available techniques can be grouped into the following divisions:

Manual/Traditional

Features from maps are digitised using a digitising tablet. A tablet contains an active matrix of wires that can detect the location of a cursor when it is passed above these wires. By tracing around map features their locations are translated into digital locations, usually in inches on the digitiser surface. The coordinates can then be transformed to real world coordinates using a specialised transformation package. The benefits of this scheme are that they process is relatively straightforward and robust. The involvement of a human operator brings geographic experience to subjective decisions that need to be made during the digitisation process. The software and hardware used to digitise the information is often the same that is used to subsequently edit and analyse the data. This reduces any costs involved with translation of the data to another system for analysis. Weaknesses of this scheme include the overall cost in man hours incurred for manually digitising and for any subsequent clean up of the data. Intense training of the digitising operator prior to the digitisation task being undertaken is essential to ensure accurate data conversion, but incurs further costs. Despite these weaknesses, the traditional method of data entry is probably still the most popular.

Fully Automated
Map source information is first scanned as a raster image and then translated into vector data where required. The processes of vector translation and feature recognition varies, but usually takes less time than the traditional method. Vectorisation of raster features is greatly enhanced if the colour separates for a map can be obtained. It is most effective and hence provides the greatest savings over the traditional method when digitising linear features, such as contour lines. These features can be easily followed by a line tracing program with the minimal amount of supervision from a human operator. Other features are less easy to discern in a totally automated environment. This is made particularly difficult by the interruption of features by the overlay of text, other map features and the blend of colours. The continued development of artificial intelligence programmes and expert systems has led to improvements in capabilities of intelligent raster to vector conversion programmes, with functions such as pattern/feature recognition and the ability to 'learn'. Several GIS packages now include tools for automated the conversion of raster data to vector data.

This fully automated technique has proved successful in a number of large data conversion projects, where the methodology for the data conversion and subsequent error checking were rigorously laid out in advance. For example, the production of Digital Chart of the World database. This database is a digital representation of the 1:1,000,000 scale Operational Navigation Charts (ONC). The project was sub-contracted to the Environmental Systems Research Institute (ESRI) by the Defense Mapping Agency. ESRI used a combination of raster scanning, vectorisation and strict quality controls to produce one of the de facto global GIS databases.

Power-assisted/Partially Automated
A raster backdrop is scanned and geo-referenced and is then used as a locator map to digitise features directly on the screen. Rule based systems can be used to ensure that entities are linked with "sensible" attribute information to speed up the data conversion process and to reduce the number of attribute errors. This processes strength relies on human intelligence to make intelligent decisions about the locations of features, but requires experienced and well trained operators to correctly locate the data.

4.4 Environmental Thesauri

4.4.1 Overview
The ISO Standard 2788-1986 (E) defines a thesaurus as "the vocabulary of a controlled indexing language formally organised so the *a priori* relationships between concepts (eg as broader and narrower) are made explicit". The advantages of a thesaurus are:

- ensures a consistency of spelling around the world
- provides cross-linking and referencing through a hierarchy of categories and a network of related terms
- provides standard lists in multiple languages (eg English, French and Spanish).

While a thesaurus is not a flawless tool for the task of categorising meta-data, the advantages listed above outweigh the drawbacks.

4.4.2 Thesaurus Functionality

Terminology Relationships
"Environmental information" is a broad concept and the information can be held in various different sources. The information entity may be, *inter alia*, a report or document, a dataset (collection of structured data holdings) or an institution.

These sources can be described and referenced through a catalog or a metadatabase by assigning descriptor keywords to the sources. Thus, a report *State of the Forests* might be linked to several descriptor keywords - one of which is likely to be 'forest'. A person wishing to identify information sources relevant to forests could conduct a search on the keyword "forest" and thereby locate that report.

Environmental information deals with complex scientific, technological and social problems which impact the environment in one way or another. The environmental domain extends across multiple scientific domains such as geography, chemistry, biology, sociology, meterology and consequently the terminology has become very extensive. This is in addition to the natural synonymy of languages - of which the English language is particularly prone.

In addition to synonymy, a thesaurus can store a hierarchy of categories. For example, a geographic thesauri would enable a search on the keyword "Africa" to score a hit if it located an an information source with "Kenya".

Catalog Keywording
The same information source can frequently be described by the same keyword descriptor. For example, ambiguities can arise when describing "soils" rather than "dirt", "wood" rather than "forest" or "the Vatican" instead of "the Holy See". When keywords are entered into an environmental catalog or metadatabase, the compiler is confronted with the decision of which of the alternative terms to choose. An environmental thesaurus provides a reference from which terms can be selected and thereby minimise these ambiguities.

Catalog Search and Retrieval
A related issue arises when an enquirer wishes to search a catalog for an information source. If the descriptor keyword being searched for is stored as a synonym (eg "wood" is being searched for, "forest" is the word stored in the catalog) then the search will fail. A thesaurus that links the two synonyms can be used to enable the search to succeed.

4.4.3 Thesaurus Software

There are many ready-to-use software tools to handle thesauri, a number of which are described and compared by Ritzler (1991). Straightforward database software packages, such as dBase IV and MICRO-CDS ISIS, can also be used to build thesauri - examples are described below.

In Rybinski (1993) a software tool for building **multilingual** thesauri is presented. The software, known as MULTHES/ISIS has been designed as a configurable system assisting a user in creating concepts, linking them by means of a set of predefined relations, and controlling the validity of the thesauraus structure. The software has shown valuable features in building multilingual thesauri. The main restriction is is a lack of tools supporting the methodology of merging essential parts of existing thesauri into one.

The software used in the Environment Macrothesaurus System MTM 4.0 (Rybinski 1994) takes the software of MULTHES/ISIS as a starting point and is based on MICRO-CDS ISIS (which can itself be used as a basis for a thesaurus) - see UNESCO (1989). MTM 4.0 provides tools which allow the user to work with a number of thesauri, viewing them simultaneously, and creating a thesaurus as a result of merging essential material from existing thesauri. MTM 4.0 allows polyhierarchy which means that a child object can have more than one parent object.

The Federal Environment Agency of Germany (Umweltbundesamt) uses a software package called aDIS (adaptable Documentation and Information System) to manage its databases - see Batschi (1994). The thesaurus part of aDIS combines traditional approaches of thesaurus development and indexing with the advantages of full text inverted files. The software allows the analysis of the different texts stored during input activities. The text analysis function of aDIS allows the comparison of words of a document text with the list of terms in the database and to perform various thesaurus functions such as elaboration, reduction of terms to root words, identification of synonyms etc.

Pollitt (1994) uses a novel approach in the use of existing thesauri and describes how a thesaurus can be used to both specify the subject of a query and present results when searching a bibliographic database using MenUSE (Menu-based User Search Engine) software. Searching power is exercised by the end-user through the selection and presentation of views of the contents of a database via a structured thesaurus and the identification of concepts of interest which are then used to produce filtered views. The techniques are generic and can be applied to any database which uses a classification scheme or thesaurus.

The Catalog of Data Sources (CDS) project of the European Environment Agency (EEA) involves the collaboration of European countries, with much of the effort in producing the Catalog being devoted to the construction of an environmental thesaurus and its translation into several European languages. Several European countries have prototyped environmental thesauri, using different software approaches. Warsaw University is using MICRO-CDS ISIS and the National Resource Centre in Rome is using dBASE IV. The French EEA CDS collaborators are using Texto and the Dutch EEA CDS collaborators are using TinTerm.

4.4.4 Environmental Thesauri Listing

The European Community publishes a thesaurus guide, which is a survey of existing structured lists of terms developed in one or more of the official European Community languages. The number of thesauri specific to the environment is low.

The highest-profile thesauri are those that have been compiled by INFOTERRA (UNEP, 1990) and the tri-lingual thesaurus compiled by Istituto Technologie Biomediche (CNR) of Rome that will be used by the EEA CDS project (Pinborg, 1992). However, other environmental thesauri have also been developed or are under development; of particular note is the work being done by the German Federal Environmental Agency in Berlin (Batschi, 1994).

A conclusion of the International Society for Knowledge Organisation (ISKO) Conference of 1994 (Rybinski, 1994) was that these multiple environmental thesauri initiatives were not desirable if they lead to an uncoordinated and confusing plethora of choices for the thesaurus user. Collaboration between these initiative was required so that at the minimum a common thesaurus structure could be agreed upon.

The subject of environmental thesaurus standardisation was raised at the final discussion of the conference. Of particular concern was the decision as to which international body should have responsibility for defining the standard for a centralised environmental thesaurus. The logical way forward was for the International Standards Organisation (ISO) to define a thesaurus in English, from which translations into other languages could be made.

A list of the six major environmental thesauri is presented below in alphabetic order:

Name	**CAB International Thesaurus for Agriculture and Environment**
Description	CAB International's Thesaurus contains 56,000 terms and 300,000 relationships.
Name	**CIESIN**
Description	The Consortium for International Earth Science Information Network (CIESIN) on-line catalog system provides a mechanism for term retrieval by providing look-up lists for the DIF fields *Discipline, Parameter, Location* and *Keyword* (Burley, 1994). However, although these lists of terms provide a controlled vocabulary, they have none of the hierarchical structure and relationships that a thesaurus would provide.
Name	**EEA Trilingual Thesaurus for the Environment**
Description	In 1991 a project was started by a working group of the CNR (Rome), the Centre for Information and Documentation on Environmental Research of TNO (The Netherlands), and the Department of the Environment of the United Kingdom, to build a multlingual environmental thesaurus based on the Dutch Milieu-thesaurus, published in 1990. The resulting trilingual (Dutch, English, Italian) *Thesaurus for the Environment* (Felluga, 1991) contained about 3000 preferred, post-coordinated and non-preferred terms classified in 30 groups, each group being presented in a hierarchical structure extended to

seven levels. A version of this thesaurus, recently enriched with the German equivalents, has been produced on CD-ROM by the Publications Office of the CNR.

The updated version of the Dutch Milieu-thesaurus (1994) is at present the basic document for the development of a general thesaurus for the environment on the context of an initiative of the European Environment Agency (EEA). It is foreseen that a matrix classification scheme with a thematic and a functional (facetted) axis will be used for the classification of the terms. The expected classification scheme will be in the form of a set of classes, subclasses and top terms defining a lexicon of about 1000 general terms. This classification scheme is going to be used for data entry and information retrieval in databases of environmental data, like the CDS, Catalogue of Data Sources of the EEA.

Name **INFOTERRA Thesaurus of Environmental Terms**

Description INFOterra is the International Environmental Information System of UNEP. Through a network of national focal points it directs clients with queries on environmental issues to the best known source of expertise for delivering a solution. To this end, it publishes regularly its Thesaurus of Environmental Terms in order that the focal points have a standard reference by which to describe and relate topics of interest.

UNEP GRID has adopted the thesaurus for use with its metadatabase system, thus providing a standard set of subject themes and geographic areas for metadata description. For more information contact INFOTERRA (for Address List, Section 8.2).

Name **JICST Thesaurus**

Description In Takano (1987), two kinds of keywords assigned to Japan Information Center for Science and Technology (JICST) files, natural words and controlled vocabulary, were analysed and the result was used as a helpful tool for compiling the latest edition of the JICST Thesaurus of Science and Technology. The coappearance frequency of both natural and controlled terms provides promising data not only for supporting the Thesaurus revision, but also provides a useful tool for searching by natural words. A future vocabulary control sytem is required to meet versatile functions such as controlling index terms, multilingual and natural language searching

A questionnaire survey of Japan Online Information System (JOIS) users revealed the need for enlargement of terms to be covered in the 1987 edition of the Japan Information Centre for Science and Technology (JICST) Thesaurus, and for descriptions of term history. Some of the following measures were taken: the addition of new terms by referring natural words stored in the JICST database; the improvement of term relations by using English translated Japanese keywords; the addition of some Chinese terms used; and the addition of priority data among synonyms and others.

Name **Umweltbundesamt Environmental Thesaurus**

Description The thesaurus of the Umweltbundesamt (German Federal Environmental Agency) is a polyhierarchical one and is designed for multilingual use. Geographic terms are included in a separate file of the thesaurus, because many problems in the environment are related to regional or local peculiarities. It is structured by broader terms, narrower and related terms. In order to limit the number of controlled terms (descriptors) in the thesaurus, synonyms and quasi-synonyms are used. A special way of forming a synonym is the description of a term with a combination of at least two existing descriptors. The thesaurus contains about 8100 index terms with an additional 22000 nondescriptors (synonyms, quasisynonyms, combinations of terms, single terms (components of terms necessary for automatic indexing), stop words.

The geographic thesaurus and the thesaurus of biological terms comprise more than 3600 descriptors and 2800 nondescriptors. The thesaurus and classification are currently bilingual (German - English).

The environmental thesaurus and classification has not been intended as a comprehensive dictionary, but it should show the terms which are actually used in the different subject fields. Therefore, the thesaurus has incomplete hierarchies, which are kept incomplete intentionally. Extensions will be introduced when necessary.

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5 THEMATIC INFORMATION STANDARDS

5.1 Introduction

5.1.1 Overview

This large section is concerned with standards relating to the management and exchange of biodiversity information. Many topics are discussed including descriptions of widely applied classification systems, minimum (core) data requirements, data definitions, database systems, and descriptions of the work of organisations developing and promoting the use of various standards. These issues are discussed in the context of natural and managed habitats (including terrestrial vegetation, agriculture, forestry, wetlands, coastal and marine habitats, and fisheries), protected areas, species, and threats to biodiversity.

Clearly, a full treatment of thematic information standards would require an enormous number of classification systems, techniques, and database systems to be examined. This section provides only a brief tour of the subject, covering only selected international, regional, and national examples which exist. Subsequent editions of the Resource Inventory will develop the material over time.

The standards which follow range from an internationally accepted transfer format for plant records, to myriad classification systems for habitats, each suited to specific national or regional circumstances. National classification systems abound in all thematic information groups, minimum datasets often having evolved to suit particular sets of ecosystems and the management objectives. Such *de facto* standards are often reflected in local database designs.

The field of biodiversity information management is developing so rapidly that identification of on-going initiatives is itself an important contribution to the promotion of standards. Simply in the area of biodiversity terminology, considerable work is being undertaken by various organisations to produce standardise thesauri to facilitate data exchange (see Environmental Thesauri, Section 4.4).

5.1.2 Geopolitical Definitions

When exchanging information about a country or region, it is necessary to ensure that both those sending and receiving the information are using the same definition of that country or region. Clearly this can be done by providing a boundary overlay with map based information, but in many cases digital data is not required. Therefore, in exchanging information the following standards might be employed.

Name	**UN Terminology Bulletin No.345 - Country Names (plus amendments)**
Description	Lists all countries recognised by the United Nations (states members of the United Nations, members of specialised agencies or parties to the Statute of the International Court of Justice). The Bulletin is available from the Office of Conference Services, United Nations Secretariat (see Address List, Section 8.2).

Name **Codes for the Representation of Names of Countries (ISO 3166)**

Description Includes all countries recognised by the United Nations, but also gives separate recognition to geographically disjunct dependencies, or "other areas of geopolitical interest". The standard is available from the ISO 3166 Maintenance Agency (see Address List, Section 8.2).

At the European level, a more detailed standard has been devised for use within the member states of the European Union. Similar approaches may exist for other regions.

Name **Nomenclature des Unités Territoriales (NUTS)**

Description Divides the European Union into a nested (hierarchical) series of administrative subdivisions defined by Eurostat. There are four levels, the 12 member states, 65 regions (such as the Länder of Germany, 172 provinces (such as the provinces of France), and 465 counties or departments (such as the Départements of France). The standard is available in printed and computer readable formats from Eurostat - GISCO (see Address List, Section 8.2).

For the purposes of reporting on the distribution of plants, the ISO standard (see above) is often sufficient. However, countries vary hugely in size, and island floras are often quite significant. A special standard has therefore been defined for use with plant databases (see TDWG Published Standards, Section 5.8.5 for further details):

Name **World Geographical Scheme for Recording Plant Distributions**

Description Derived by the International Working Group on Taxonomic Databases for Plant Sciences (TDWG), which is an international working group set up in 1985 to explore ideas for standardization and collaboration between major plant taxonomic database projects (Hollis, 1992). The standard provides four nested levels: continents, regions, botanical countries, and *basic recording units*.

Note that in this standard, countries *sensu stricto* can appear at different levels, and thus in the case of large countries like the United States, many different units may occur. This is a disadvantage for any database system requiring output by country name.

The most widely used scheme is the ISO standard used in the compilation of a many international statistical tables. Nevertheless, even where this standard is adopted, the geopolitical entities are often amended to suit the purpose of the analyses. For example, the Convention on International Trade in Endangered Species (CITES) trade database uses the ISO classification in order to manage information on licensed trade in certain wildlife and wildlife products.

The different standards may be related to each other in some cases. For instance, WCMC uses a hierarchical arrangement to in its protected areas database as follows: each country recognised by the UN consists of one or more units of the ISO standard; and each ISO unit comprises one or more basic recording units (as defined by TDWG above). This allows basic recording units to be used for detailed analysis tasks, but maintains the higher level categories for country-level reporting. In managing this type of data, there are two other issues to be aware of:

- changes in national boundaries over time can create difficulties in reporting by country or similar unit, as boundaries may change to exclude some species or features, and include others.

- definition by named unit ignores the fact that some boundaries between units are under dispute.

5.1.3 Habitat Classification Definitions

The habitat classification systems and information standards offered in later sections do not comprise a definitive account; they merely represent examples of different approaches which have been applied. No value judgements are added by WCMC as to the validity of the systems described; a classification or standard is included solely for the purpose of making potential users aware of its existence.

Some attempt has been made to further sub-divide terrestrial and aquatic ecosystems into natural ecosystems[1] and managed ecosystems[2]. However, in many applications land cover[3] and land use[4] are not clearly distinguished: there is frequently a relationship between land use and land cover and one may often be inferred from the other. Furthermore, many areas of land are used for multiple purposes, complicating both surveys and mapping (Young, 1993), and thus many classification schemes are bound to comprise natural and managed components. For instance, the section on terrestrial vegetation may cover land use elements and some aquatic ecosystems such as wetlands.

As a brief summary, Table 5.1.1 has been compiled from selected classification schemes described later in this section. It shows which components, natural and managed, terrestrial or aquatic, are covered by the listed schemes. References to these schemes are supplied at the end of this section, and further bibliographic material may be discovered in the Bibliography, Section 7.3. Note that the listed schemes are broken down by the scale for which they are suited, ie global, continental, or national.

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[1] Note that the use of the term "natural" vegetation can be misleading. It is often difficult to distinguish natural from human induced vegetation, eg the distinction between natural and man-made grasslands is virtually impossible. Therefore, the word "natural" throughout this document must be treated with care and merely implies a distinction from intensive and extensive land use. For the purposes of this study "natural" includes potential vegetation or actual vegetation cover little altered by man and not used for production.

[2] Ecosystems under production.

[3] Burley (1961) defines "land cover" as the vegetational and artificial constructions covering the land surface.

[4] Clawson *et al* (1956) defines "land use" as man's activities on land which are directly related to the land.

Table 5.1.1: Example Classification Schemes and Standards and their Components

Example Schemes	Terrestrial Ecosystems		Aquatic Ecosystems		
	Natural (potential and actual)	Managed (agriculture, forestry and other land use)	Wetlands	Marine	Managed (fisheries)
Global					
UNESCO (1973)	*				
Bailey (1989)	*				
Udvardy (1975)	*				
IUFRO (1992)	*	*			
IGBP-DIS (Townshend, 1992)	*	*	*		
Inman and Nordstrom (1971)				*	
Davies (1980)				*	
Holdridge (1947)	*				
Olson *et al* (1983)	*		*		
Ramsar Convention Bureau (1990)			*		
Cowardin *et al* (1979)			*		
Continental					
Pacific (Pearsall, 1991)	*		*	*	
ITC (Van Gils, 1991-3)	*	*	*		*
Corine Land Cover (CEC, 1993)	*	*	*		
White (1983)	*				
UNESCO (1981)	*	*	*		
Whitmore (1984)	*	*	*		
Bailey *et al* (1991)				*	
NOAA (1993)				*	
FAO (1994)	*	*	*		
National					
ITE (Great Britain) (Fuller *et al* (1994)	*	*	*		
AWB/PHPA Database (Frazier *et al* (1992)			*		
RePPProT (Indonesia)	*	*	*		

5.1.4 References

Hollis, S. and R.K. Brummitt (1992). *World Geographical Scheme for Recording Plant Distributions*. Plant Taxonomy Database Standards No. 2 Version 1.0. Published for the International Working Group on Taxonomic Databases for Plant Sciences by the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, USA.

5.2 Terrestrial Vegetation

5.2.1 Overview

Schemes for classification of terrestrial vegetation have been devised at various scales principally for mapping but also for statistical analyses (such as for forest inventories/assessments etc). Some are exclusive classifications intended for use at local or national scales, while others are applied at wider scales such as continental or global levels.

Information on land cover and land use is required for a variety of management and scientific purposes. The agricultural, forestry, planning and environmental protection sectors rely heavily on land cover/use data for planning as does the scientific community in addressing issues such as global change modelling. From a biodiversity point of view, it is particularly important to be able to monitor land cover change, either change from one category to another (eg drainage of wetlands, deforestation, expansion of built-up area) or modification of condition of land cover (eg selective logging, intensification of cultivation, forest fragmentation etc). Information is required in various forms, at different scales, from the local to global and a variety of techniques are in current use to collect the necessary data.

Methods for collecting information are very diverse and are purpose and user driven. At present, there are large disparities in the type of data collected for different kinds of use, eg for agricultural censuses, forest resource surveys, and inventories of conservation areas (Young, 1993). Methods of data collection include ground observation, census studies, aerial and satellite remote sensing. Classification systems employed to house these data are therefore also diverse, as each system is purpose defined. Data classified according to these different schemes are usually not compatible and at present there is no single, recognised and accepted classification which can be applied across the globe at all scales.

As the global nature of environmental problems has become apparent, vegetation mapping on a global scale becomes increasingly important. Indeed, the need for continental/global vegetation reporting standards was emphasised at the Earth Summit in Rio in 1992. In January 1993 a workshop on vegetation classification was held in Charlottesville, Virginia, under the auspices of the IGBP, the United Nations Environment Programme (UNEP) Harmonization of Environmental Measurements (HEM) project, the Global Change and Terrestrial Ecosystems (GCTE) project of the IGBP and WCMC, to assess the demand for a global classification of vegetation which could serve the needs of a wide community of users (UNEP/GEMS, 1993) (a discussion paper prepared for the Charlottesville workshop by van Gils (1993) provides a useful summary of global vegetation classification systems). The workshop proposed that the best approach would be a multi-layer vegetation classification system; each thematic layer containing a hierarchy of levels which could be overlaid in different combinations to obtain the classification categories. The thematic layers could be considered in groups relating to "actual" vegetation (ie structural, compositional, phenological data); environmental conditions (ie climate, soils, topography); functional use (natural resource uses); and historical data (natural disturbance, human disturbance).

Many different organisations currently have an interest in the harmonisation of land cover and land use information. The need for harmonisation across a broad spectrum of interests was considered at an Expert Meeting, convened by UNEP/FAO in Geneva in November 1993 (Schomaker, 1994; UNEP/FAO, unpublished). The meeting recognised that collaborative efforts at this stage might eliminate many problems and might thus facilitate information exchange now and avoid differences of approach that could inhibit communication in the future. It launched two initiatives:

1. FAO and UNEP, with the support of UNESCO and others, is launching an initiative called LUCLASS.NET - the long term objective of which is to develop land use/land cover concepts, definitions, and classifications which could eventually gain acceptance world wide.

2. UNEP and FAO agreed jointly to initiate a programme to develop translation systems and a glossary of definitions for existing land use and land cover classifications rather than endorse the development of one single scheme. It is inappropriate to 'force' one framework onto a wide range of users; and it is unlikely that they would agree to one single nomenclature due to the wide range of needs and uses. An alternative approach is to find a means of translating between nomenclatures to produce a baseline enabling data collected under one application to be converted to another. ITE effectively illustrated this approach with British land classification systems (Wyatt *et al*, 1994). The translation concept provides flexibility, enables comparison between countries and continents, facilitates global reporting and encourages use of standards. Following on from its experience with British classification systems, ITE together with WCMC has recently started a UNEP/FAO project to evolve from existing global schemes a *General Global Nomenclature for Land Cover and Land Use* using this translation approach. Subsequently, the IGBP-DIS is applying these principles in a land cover classification (Annex 3) which is being adopted in the Fast-track Land Cover Product which is being developed from a global 1 Km land cover dataset (Townshend, 1992).

Some points relating to this include:

- the world's vegetation comprises gradients and mosaics at all scales and does not form discrete compartments with definite boundaries; there will always be compromise within every vegetation classification system, at all levels

- data sampling methods differ and the nature of data determines the applicability scale of the resulting classification system

- nomenclature differs between schemes; for instance the same words can be used to describe different types of vegetation and different words can be used for the same vegetation types.

5.2.2 Minimum Data Requirements

Assessments have been undertaken to develop core datasets or minimum data requirements for land cover monitoring. For example, the International Union of Forest Research Organisations (IUFRO) released a draft set of international guidelines for monitoring global forest resources in November 1992 (IUFRO, 1992). The purpose of the guidelines

> *"is to promote standardised or compatible collection and reporting of selected data for forest monitoring through cooperation in such a way the results offer a common data base for research and management".*

IUFRO identified three levels of monitoring: local, national and global. Based on current global issues, forest extent, biomass production for carbon storage, rates of change of forests, forest quality and health, were the primary concerns at all levels. Tables 5.2.1 and 5.2.2 (taken from IUFRO, 1992) indicate data which are common to all levels of decision making for forest monitoring.

Table 5.2.1: Data Needed at Local, National, and International Levels for Forest Monitoring

Level of Monitoring			
Factor	Local Resource Studies	National Forest Inventory	Regional/Global Monitoring
	Importance (*** high; ** medium; * slight)		
Land Use	***	***	***
Land Cover	***	***	***
Land Degradation	***	***	**
Site Type	***	***	**
Soil Type	***	***	**
Topography	***	**	**
Ownership	***	**	*
Accessibility	***	**	*
Biomass	***	***	***
Timber Volume	***	***	**
Other Forest Products	***	***	*
Biodiversity	**	***	***
Forest Health	***	***	***
Wildlife	***	**	*
Human Impact	***	**	**
Watersheds	**	**	**

Table 5.2.2: Data for Land Cover, Forest, Biomass, and Environmental Quality Monitoring

	Land Cover	Forest	Biomass	Environmental Quality
Plot Identification				
Location Coordinates	*	*	*	*
Elevation	*	*	*	*
Aspect	*	*	*	*
Terrain Position	*	*	*	*
Year Observed	*	*	*	*

Area Classification				
Land Use Class	*	*	*	*
Land Cover Class	*	*	*	*
Vegetation Type	*	*	*	*
Crown Closure	*	*	*	*
Stand History		*	*	
Tree/Plant Ratings				
Species		*	*	*
Height		*	*	*
DBH/DRC		*	*	*
Age		*		
Stem Ratings				
Log Size		*		
Timber Quality		*		
Crown Ratings				
Crown Diameter			*	*
Crown Length			*	*
Leaf Area			*	
Defoliation		*		*
Bioindicators				*
Damage Assessment		*		*
Dendrochronology				*
Understorey Vegetation		*	*	*
Foliar Chemistry				*
Soil Productivity Indicators	*	*		*

5.2.3 Development of Classification Systems

Some organisations are developing guiding principles to be used in constructing vegetation classification schemes. The US Federal Geographic Data Committee (Vegetation Subcommittee) has compiled draft criteria for this purpose. These draft principles are comparable to the criteria presented to the FAO/ECE meeting of experts on Global Forest Resources Assessment-Kotka II in 1993 (Bones, 1993):

- base system on current vegetative cover, not climax or potential
- classification should be universally applicable

- optimise to the maximum extent possible compatibility with other regional or national land cover/land use systems

- classification should be hierarchically designed (ie aggregatable, disaggregatable)

- system should be organised from the general to the specific (top down)

- should be designed to take advantage of emerging technologies (ie digital satellite classification)

- all categories and life forms (ie grass, shrubs, trees) must be accurately defined

- classification must be repeatable from place to place (spatial) and from time to time (temporal)

- categories must be mutually exclusive and additive to 100% of area

- sets minimum standards for percent cover (based on vegetation structure, not species)

- when possible, use standard (not scientific) terminology (ie make terms understandable, simple, and unbiased in meaning)

- should correspond to identified use and needs.

Although addressing the problem of forest classification, these criteria are more widely applicable. In particular, the use of new technologies, especially remote sensing data, must be borne in mind in deciding which system to adopt. It must be assumed that any wide-scale or frequently repeated land cover survey will derive most of its information from this source and the classification system must therefore be compatible.

New technologies also affect the way the data are stored and manipulated whereas all vegetation surveys were formerly directed towards the production of a map, it is likely that in future they will be used for input to a Geographic Information System (GIS) which may produce one or a series of maps. This gives much more flexibility in the types of classification systems and greatly facilitates the design of a hierarchical system. The different attributes of a vegetation unit can be aggregated or disaggregated to produce classifications suitable for a number of different purposes. In any such system, the attributes should be logically arranged in different thematic groups such as physiognomy, phenology, floristics, climate etc. These are discussed in the next section.

5.2.4 Classification Systems and Standards

It would be impossible to detail all existing vegetation classification schemes since most countries have developed their own such schemes and landuse maps, plus a great many continental and global schemes have also been developed. Most schemes focus on one or more of the following criteria (Adams, 1992):

- **Physiognomic**
  Based on features of height, growth form and coverage of vegetation, eg UNESCO (1973). Physiognomic criteria are used in remote sensing. The majority of systems are physiognomic in nature as it is relatively easy to separate dense primary forests, secondary forests, woodland, bush and scattered shrubs, savannas etc (FAO, 1989). In some schemes descriptions of structure, forest architecture and topography are used eg Laumonier (1980)

- **Bioclimatic**
  Based on the climatic regime which prevails in any area ("climate space") and not based on the actual vegetation which is present, eg Holdridge (1967)

- **Phenological**
  Involves the leaf retaining characteristic of the forest canopy, whether the trees lose all their leaves at a time (deciduous species) or are lost gradually so that the tree is never in a leafless stage (evergreen)

- **Floristic**
  Based on certain principal plant taxa which occur within the vegetation

- **Functional**
  Vegetation management such as production of fuel wood, wood biomass etc.

Many schemes involve a combination of the above or include other parameters such as land-use, disturbance history, soil type or geology which affect vegetation cover, such as Whitmore's classification of Melanesia (Whitmore, 1984). The Australians have developed comprehensive vegetation maps, showing both present (1980s) vegetation and natural (1780s at the time European settlement began) vegetation. These classifications are based on structure or growth form such as tall trees, low trees, tall shrubs, hummock grasses; foliage cover in percentage terms (eg >70%, <10%); and floristic type such as *Nothofagus*, *Malaleuca* (AUSLIG, undated).

It is not always useful to restrict a scheme to one determining criterion; especially in a continental context or where more than one ecological region is being classified. For example, two vegetation classes may be physiognomically comparable (eg dense lowland evergreen rain forest of Sarawak and dense evergreen forest of Colombian Choco) but floristically very distinct.

Vegetation classifications may indicate "potential" vegetation, predicted vegetation based on various parameters illustrating vegetation cover before modification by man, or may convey "actual" vegetation, which may or may not include land-use. FAO, for the *Forest Resources Assessment 1990 - Tropical Countries*, categorises and gathers "actual" forest cover information by ecoregion or ecofloristic zone and by country (FAO, 1993). The criteria applied in classifying ecofloristic zones are ecological: climatic, physiographic and edaphic (see Annex 6 for further description).

The concept of wilderness valuation has gained some recognition in the classification and description of lands for conservation, recreation and heritage values, a wider application of this concept would appear possible by following the methods and definitions outlined for Australia by Lesslie and Taylor (1985) and Anon. (1993).

Classification schemes have been developed at a number of different scales. These can be broadly grouped into global, continental, national and local systems. Scale will obviously determine applicability. For example, global schemes are too coarse (low resolution) and inappropriate for national level planning, and local level detail is unwieldy at continental and global levels. However, relationships between scale can be important. For instance, it may be necessary for data collected and categorised at the national level to be compared with other national data at the continental scale. An example would be to undertake a gap-analysis of European forest protection. The same will be true with continental and global scales.

If global monitoring is to take place effectively and efficiently, then it is essential that reporting procedures, using accepted standards, are transparent between the different levels.

Global Scale

Global vegetation classifications include *Vegetation of the Earth* (Walter, 1973) where climate, soil and potential natural vegetation are used, *Ecoregions of the Continents* (Bailey, 1989) and *Carbon in Live Vegetation of Major World Ecosystems* (Olson *et al*, 1983) where a global vegetation map of biomes has been produced to estimate total carbon mass in vegetation. The Holdridge Life Zone Classification (1967) based on bioclimatic zoning is applicable at the global level, and although developed in the late 1940s is cited today in Central America. The UNESCO scheme (UNESCO, 1973), predominantly physiognomic, is based around five fundamental vegetation formations derived from height and cover of vegetation: closed forest, woodland, scrub, dwarf scrub and related communities, herbaceous vegetation and many further subdivisions.

Few schemes deal with "actual" vegetation cover at the global level mainly because of the technical problems and expense of gathering actual vegetation at this scale. The problem is heightened by many national and international organisations collecting data which is often incompatible with global modelling as their schemes were often originally developed for exclusive use. FAO undertook a Global Tropical Forest Assessment (see below) based on actual census material and satellite data (FAO, 1993). WCMC has recently compiled, from national maps, a global map of the tropical moist forests of the world (Collins *et al*, 1991; Sayer *et al*, 1992 and Harcourt and Sayer, in press). Data are derived from numerous sources (traditional survey maps, classified satellite imagery, vegetation maps, land cover/use maps and forest cover maps) at varying scales and data quality. The WCMC dataset is based on a broad forest classification, built on a combination of the classification criteria mentioned above.

An alternative approach is to use satellites in mapping global land cover, which enables a single methodology of data collection and categorisation to be applied throughout. Several assessments, mostly using the NOAA series of AVHHR (Advanced Very High Resolution Radiometer) satellites, principally designed for meteorological monitoring, have recently started to address the task of mapping land cover of the world from space. The AVHRR is particularly useful as it is relatively inexpensive and offers daily global coverage. Its red and near-infra red channels have been used widely in attempting to monitor seasonal vegetation changes. AVHRR, because of its multi-temporal coverage, has the ability to distinguish different vegetation types which may not be discernable in a single image. However, the resolution of 1 Km makes it useful for only general classification schemes, ideally at super-national (1:2 million scale), continental (1:5 million) or at global scales (1:25 million). However, the data suffer from considerable atmospheric and geometric distortion and this, coupled with the poor calibration between the satellite platforms within the series, makes pre-processing of AVHRR data time consuming.

Satellite data are being used relatively successfully under several programmes. The EC-Joint Research Centre Tropical Ecosystem Environment Observations by Satellite (TREES) project has been developed specifically to study tropical forest change at regional and global scales, using remote sensing techniques (Malingreau *et al*, 1993). The forest classification in TREES is fairly coarse and is limited to forest, non-forest, fragmented forest and seasonal forest. TREES is also making use of thermal AVHRR data to detect and map the incidence of fire - an important factor in deforestation in the tropical forest zone. The NASA LANDSAT Pathfinder Tropical Deforestation Project has as its goal the mapping of deforestation throughout the tropics in four points in time over the last 20 years, using high resolution satellite imagery (both LANDSAT Multi-Spectral Scanner and Thematic Mapper) (Lawrence, pers comm. 1992) (see Annex 1 for class descriptions under the NALC component of the Pathfinder Project). In April 1992 the International Geosphere Biosphere Programme's Data and Information System (IGBP-DIS) initiated the 1 km Land Cover project. This has the goal of collecting, archiving and processing daily data from AVHRR imagery for all terrestrial surfaces and then deriving land cover data sets from this archive (Townshend, 1992).

Continental Scale

There are many different continental schemes which could be mentioned such as Sharma (1986a, 1986b), Hueck (1978), UNESCO (1981), Olson and Dinerstein (1994), Devillers *et al* (1993), CEC (1993), FAO (1994), White (1983), Whitmore (1984) and many others. Some, such as Whitmore (1984) and FAO (1994) are "actual" vegetation schemes whilst, others such as White's *Vegetation of Africa* (White, 1983, 1993), specifically developed for the African continent, conveys potential vegetation. White's map units are arranged by phytochoria, a classification of plant species according to their geographical distribution; both physiognomic and floristic characteristics are also used. UNESCO's map of South America (UNESCO, 1981) is based on both floristic and climatic elements: each vegetation type is mapped according to the bioclimatic and ecological framework in which it has developed its physiognomy and its phenology. One of the objectives of the classification is to present real limits of vegetation formations and from them to deduce the relative extent of cultivated areas. Each main category within the legend, which is based on climate (eg "hyperhumid and very humid formations: P>2000 mm") includes a general land use category "mosaic pattern of formations altered by man and of crops".

Other examples of "actual" land cover classifications include the Corine Land Cover dataset (CEC, 1993) and the FAO (1994) AFRICOVER Project: both datasets are derived from satellite imagery. The AFRICOVER Project is in its early stages but aims to produce a homogeneous land cover map and digital data base (including place names, roads, drainage) at a scale of 1:250,000, 1:200,000 and 1:1,000,000 for all the countries of the African continent, based on existing data, remote sensing and GIS techniques (FAO, 1994). The Project also aims to strengthen national and regional capacities in practical application of advanced geographic information technologies to land cover mapping, natural resources assessment and environmental modelling. Although the project is continental in nature, data will be derived from various sources including ground sampling work. The project will rely heavily on networking and national programmes' participation.

The CORINE Programme was set up to improve the availability and use of environmental data in the European Community. This includes bringing together existing information, developing methods for storing, handling and presenting data and encouraging exchange of information. An information system on the state of the environment has now been created and nomenclatures and methodologies developed for carrying out the Programme (CEC, 1991, 1992). Priority areas include biotopes of importance for nature conservation, air and water quality and land cover. The land cover map, derived from satellite images in conjunction with ancillary data, adopts a nomenclature which distinguishes 44 land cover and land use classes, grouped in a 3 level hierarchy (see Annex 2) which can be arranged into further hierarchical subdivisions for national mapping purposes. The classes used in the European map comprise vegetated and un-vegetated land cover and various categories of land use.

National Scale

There are too many national and local systems to describe but it is worth noting a few as examples. Most countries throughout the world, and different management sectors within those countries have designed their own land cover, land use and vegetation cover maps/systems. These are used for land use planning, forest inventories, conservation planning etc. Data may be derived from satellites, conventional mapping, predictive climate mapping and may represent potential or actual vegetation cover and land use.

A national example is the RePPProT (Regional Physical Planning Programme for Transmigration) which has undergone a thorough classification of land cover and land use in Indonesia at a scale of 1:250,000 (Government of Indonesia/ODNRI, 1990). The programme's main objective was to identify land that could be developed for transmigration settlement. RePPProT compiled a series of maps covering land status, land use and land systems, including forest use categories overlaying forest cover to identify areas with potential for development.

Another example is RADAMBRASIL project (Projeto RADAM 1973-5, Projeto RADAMBR ASIL 1975-1983), whereby vegetation cover and land use spatial data were gathered and categorised for Brasil. RADAMBRASIL is a good example of the detail of information that can be collected and classified at higher resolutions. RADAMBRASIL is based on side-looking airborne radar (SLAR), including air photographs in true and false colour and extensive flights and ground checks. 32 volumes of the survey exist, covering the whole of the Brazilian Amazon are available (Prance and Whitmore, 1987).

The Canadian system of ecological land classification characterizes terrain on the basis of geology, soil, land form, climate, fauna and flora. The system is hierarchical, characterized on the basis of approximately 5400 ecodistricts, 177 ecoregions, 45 ecoprovinces and 15 ecozones (see Wiken, 1986). The ecozone is under consideration by the "State of the Environment Report" as an all purpose unit for state of the environment reporting (Freedman *et al*, 1993). It is recognised that the system should be flexible and be capable for environmental reporting in smaller scale units for provincial purposes, as well as in larger-scale units for federal purposes.

ITE in the UK has developed a sophisticated database called the *Countryside Information System (CIS)* which provides easy and flexible access to information about the rural environment of the UK (Wyatt *et al*, 1994). A component of the CIS is the Land Use Classification Information and Documentation (LUCID) which is a database package designed to allow inter-comparison of land use and land cover nomenclatures from land classification systems in use in Britain. ITE have examined seventeen regional, national and international systems for surveying and recording the nature and extent of land use and land cover. Relationships between the categories of these systems have been examined and a common baseline classification prepared (Wyatt *et al*, 1994).

5.2.5 Data Definitions and Models

Data definitions and terminology are driven by each application. An example of a set of data definitions is given in Annex 3; these are the land cover categories defined within the IGBP-DIS Land Cover classification scheme. Many initiatives have developed their own definitions, eg FAO has developed its own system for classifying lands, recognising "natural" and managed formations, including plantations; IUFRO has developed its own set of definitions for forests (IUFRO, 1992). There is a need to standardise land cover and land use definitions, and FAO and UNEP are currently developing standard definitions for land cover/use categorisation.

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Annex 1: NALC Pathfinder Categorisation System

The North American Landscape Characterisation (NALC) project (EPA, 1993) is a component of the NASA Landsat Pathfinder project. The purpose of the project is to produce land cover and land cover change data at 3.2-5.8 ha resolution across Central America, Mexico, Caribbean and Hawaii. The NALC classification system was developed to specifically support NALC project objectives (EPA, 1993) and to be compatible with the other major land cover classification systems. According to EPA (1993) the NALC classification system is compatible to Anderson *et al* (1976), Cowardin *et al* (1979) and Brown *et al* (1979) systems. This example illustrates the type of vegetation classes that can be gathered using higher resolution satellites.

Level 0	Level 1	Level 2
Land	1. Barren or Developed Land	1.1. Exposed Land 1.2. Developed Land
	2. Woody	2.1. Forest 2.2. Scrub/Shrub
	3. Herbaceous	3.1. Herbaceous
	4. Arid	4.1. Arid Vegetation 4.2. Riparian
	5. Snow/ice	5.1. Snow/Ice
Water	6. Water and Submerged Land	6.1. Ocean 6.2. Coastal 6.3. Near-shore 6.4. Inland
Other	7. Other	7.1. Cloud 7.2. Shadow 7.3. Missing 7.4. Indeterminable

Annex 2: CORINE Land Cover Nomenclature

The following table illustrates the hierarchy within the nomenclature of the Corine land cover system and the relationships between the different levels (CEC, 1993).

Level 1	Level 2	Level 3
1. Artificial Surfaces	1.1 Urban Fabric	1.1.1. Continuous Urban Fabric
		1.1.2. Discontinuous Urban Fabric
	1.2.Industrial, Commercial and Transport Units	1.2.1. Industrial or Commercial Units
		1.2.2. Road and Rail Networks and Associated Land
		1.2.3. Port Areas
		1.2.4. Airports
	1.3. Mine, Dump and Construction Sites	1.3.1. Mineral Extraction Sites
		1.3.2. Dump Sites
		1.3.3. Construction Sites
	1.4. Artificial, Non-agricultural Vegetated Areas	1.4.1. Green Urban Areas
		1.4.2. Port and Leisure Facilities
2. Agricultural Areas	2.1. Arable	2.1.1. Non-irrigated Arable Land
		2.1.2. Permanently Irrigated Land
		2.1.3. Rice Fields
	2.2. Permanent Crops	2.2.1. Vineyards
		2.2.2. Fruit Trees and Berry Plantations
		2.2.3. Olive Groves
	2.3. Pastures	2.3.1. Pastures
	2.4. Heterogeneous Agricultural Areas	2.4.1. Annual Crops associated with Permanent Crops
		2.4.2. Complex Cultivation Patterns
		2.4.3. Land Principally Occupied by Agriculture, with Significant Areas of Natural Vegetation
		2.4.4. Agro-forestry Areas
3. Forest and Semi-natural Areas	3.1. Forests	3.1.3. Broad-leaved Forest
		3.1.2. Coniferous Forest
		3.1.3. Mixed Forest
	3.2. Scrub and/or Herbaceous Vegetation Associations	3.2.1. Natural Grasslands
		3.2.2. Moors and Heathland
		3.2.3. Sclerophyllous Vegetation
		3.2.4. Transitional Woodland-scrub
	3.3. Open Spaces with little or no Vegetation	3.3.1. Beaches, Dunes, Sands
		3.3.2. Bare Rocks
		3.3.3. Sparsely Vegetated Areas
		3.3.4 Burn Areas
		3.3.5. Glaciers and Perpetual Snow
4. Wetlands	4.1. Inland Wetlands	4.1.1. Inland Marshes
		4.1.2. Peat Bogs
	4.2. Maritime Wetlands	4.2.1. Salt Marshes
		4.2.2. Salines
		4.2.3. Intertidal Flats
5. Water Bodies	5.1. Inland Waters	5.1.1. Water Courses
		5.1.2. Water Bodies
	5.2. Marine Waters	5.2.1. Coastal Lagoons
		5.2.2. Estuaries
		5.2.3. Sea and Ocean

Annex 3: IGBP-DIS LCWG Global Land Cover Classification System

1 *NATURAL VEGETATION*

1.1 **Evergreen Needleleaf Trees and Shrubs**. Lands dominated by woody vegetation with a percent cover >50% and height exceeding 2 metres. Almost all trees and shrubs remain green all year. Canopy is never without green foliage.

1.2 **Evergreen Broadleaf Trees and Shrubs**. Lands dominated by woody vegetation with a percent cover >50% and height exceeding 2 metres. Trees and shrubs generally remain green year around. Canopy is never without green foliage.

1.3 **Deciduous Needleleaf Trees and Shrubs**. Lands dominated by woody vegetation with a percent cover >50% and height exceeding 2 metres. Trees and shrubs shed their leaves during the dry season, eg Siberian *Larix*.

1.4 **Deciduous Broadleaf Trees and Shrubs**. Lands dominated by woody vegetation with a percent cover >50% and height exceeding 2 metres. Consists of broadleaf trees and shrubs with an annual cycle of leaf-on leaf-off periods.

1.5 **Mixed Trees and Shrubs**. Lands dominated by woody vegetation with a percent cover >50% and height exceeding 2 metres. Consists of mixtures of either broadleaf or needleleaf trees and shrubs in which neither component exceeds 60% of landscape.

1.6 **Closed Shrublands**. Lands with woody vegetation with a height <2 metres. The total percent shrub cover exceeds 30%. The shrub foliage can be either evergreen or deciduous.

1.7 **Open Shrublands**. Lands with woody vegetation with a height <2 metres. The total percent shrub cover is between 10-30% The shrub foliage can be either evergreen or deciduous.

1.8 **Woody Savannas**. Lands with herbaceous understorey, typically graminoids and with tree and shrub cover between 30-50%. The tree and shrub cover height exceeds 2 metres.

1.9 **Savannas**. Lands with herbaceous understorey typically graminoids, and with tree and shrub cover between 10-30%. The tree and shrub cover height exceeds 2 metres.

1.10 **Grasslands**. Lands with herbaceous types of cover, typically graminoids. Tree and shrub cover is <10%.

1.11 **Permanent Wetlands**. Lands with a permanent mosaic of water and herbaceous or woody vegetation that cover extensive areas (ie >500 Km^2) cannot be consistently detected with 1 km AVHRR data.

2 *DEVELOPED LANDS*

2.1 **Annual Broadleaf Crops**. Lands covered with temporary broadleaf crops (eg cotton, soybeans, sugar beets) that are harvested at the completion of the growing season, then remain idle until replanted.

2.2 **Annual Grass Crops**. Lands covered with temporary grass-type crops (eg rice, wheat, maize) that are harvested at the completion of the growing season, then remain idle until replanted. At least 60% of the cropland. At least 60% of the landscape must be covered with cropland.

2.3 **Mixed Annual Crops**. Lands covered with temporary broadleaf or grass type crops that are harvested at the completion of the growing season, then remain idle until replanted. Neither the broadleaf or grass-type crops represent >60% of the cropland. At least 60% of the landscape must be covered with cropland.

2.4 **Urban and Built-up**. Land covered by buildings and other man-made structures and activities. Note that this class will not be mapped from the AVHRR imagery but will be developed from ancillary so.

3 *MOSAIC LANDS*

3.1 **Agriculture/Tree and Shrub Mosaics**. Lands with a mosaic of annual crops and trees and shrub vegetation in which neither component comprises >60% of the landscape. Tree and shrub cover can be either needleleaf or deciduous types.

3.2 **Agriculture and Grassland Mosaics**. Lands with a mosaic of annual crops and grassland or savanna cover in which neither component comprises >60% of the landscape.

4 *NON-VEGETATED LANDS*

4.1 **Snow and Ice**. Lands under snow/ice cover for most of the year.

4.2 **Bare Soil and Rocks**. Exposed soil, sand, or rocks with <10% vegetated cover during any time of the year.

4.3 **Water Bodies**. Oceans, seas, lakes, reservoirs and rivers. Can either be fresh or salt water bodies.

Annex 4: ITC Land Use and Land Cover Classification System

ITC, which offers training in land use and land cover mapping, has developed classification system that separates land cover from land use. The scheme allows:

- consistent differentiation between land use and land cover
- application at any scale (is adaptable to specific regional conditions)
- application in interpreting satellite images and aerial photos.

This system, developed from previous schemes (land use survey-1 prepared by the International Geographical Union and LUS-2) (Van Gils, 1991-3) has been applied in a large number of interpretation exercises using satellite images from various areas in and outside the tropics since 1981. The main classes (I-VII) (see Table) can usually be distinguished on satellite images recorded during the growing season. The second level of land cover classes can also often be recognised by satellite, however at 1:25,000-1:50,000 scales more detailed levels of cover and land use classification are necessary. There are also seven main land use classes which are related to the land cover classes. The ITC approach has been used from local (1:5,000) to regional (1:1,500,000) scales (van Gils, 1993). The LUCC is useful in that it demonstrates the conceptual difference and relationships between land cover and land use.

Class	Land Cover	Related Land Uses
I	**BUILDINGS AND ARTIFACTS** (A) Buildings (B) Roads (C) Canals/ditches canals, dams, dykes (D) Dikes/dams (E) Fences/hedgerows (F) Wells/boreholes (G) Terraces	1,2,3,4,5
II	**FIELDS/CROP PLANTATIONS** (A) Fallow (B) Herbaceous crops (C) Wetland rice (D) Shrub/vine crops	
III	**OPEN NATURAL VEGETATION** (A) Grass (B) Savanna (C) Scrub	3,4,5,6.7 Subdivisions
IV	**FOREST** (A) Forest plantation (B) (Semi) natural forest	2c,3,4,5,6
V	**WATER BODY, SNOW/ICE COVER**	5,6,7,(1b),(1d) (1c),(2),(3)
VI	**BURNED-OVER LAND**	
VII	**BARREN LAND**	7(5)

Class	Land Use	Related Land Cover
1	**SETTLEMENT AND INFRASTRUCTURE** (a) Residential (b) Industrial, quarrying, mining (above ground) (c) Transport and communications (d) Recreational (e) Agricultural	I,II,V
2	**AGRICULTURE** (a) Semi-permanent cultivation (b) Permanent rain-fed cultivation (c) Irrigated cultivation	II
3	**GRAZING** (a) Intensive grazing (b) Ranching (c) Pastoralism	III(IV)
4	**FORESTRY** (a) Timber (b) Pulp-wood (c) Firewood, charcoal, pole wood and other domestic uses (d) Other: eg bark, turpentine, tannin, cork	II,IV,(III)
5	**CONSERVATION** (a) Nature reserve (b) Game reserve (c) Watershed management (d) Dune stabilization (e) Other	III,IV,V,(VI)
6	**HUNTING, FISHING AND GATHERING** (a) Hunting (b) Fishing (c) Food gathering (d) Fibre gathering (e) Firewood collection	III,IV,V,(II)

Annex 5: White's Vegetation Classification of Africa

A vegetation classification of Africa was presented by F. White and adopted by UNESCO (White, 1983). It is based on natural (climax) vegetation and contains the following formations of natural extent:

1. **Forest**. Continuous stand of trees at least 10 m tall, their crowns interlocking.

1a. **Rain Forest**. No without any significant dry season and with trees usually more than 30 m high.

1b. **Dry Forest**. With dry season of several weeks or months.

1c. **Semi-evergreen Forest**. Where some species are deciduous but understorey mostly evergreen.

1d. **Deciduous Forest**. Where trees lose their leaves simultaneously for months.

1e. **Undifferentiated Forest**. With very heterogeneous patterns.

2. **Woodland**. An open stand of trees at least 8 m tall with a canopy cover of 40 % or more. The field layer is usually dominated by grasses.

3a. **Bushland**. An open stand of bushes and climbers usually between 3 and 7 m tall with a canopy covber of 40 % or more.

3b. **Thicket**. A closed stand of bushes and climbers usually between 3 and 7 m tall.

4. **Shrubland**. An open or closed stand of shrubs up to 2 m tall.

5. **Grassland**. Land covered with grasses and other herbs, either without woody plants or the latter not covering more than 10 % of the ground.

6. **Wooded Grassland**. Land covered with grasses and other herbs, with woody plants covering between 10 and 40 % of the ground.

7. **Desert**. Arid landscapes with a sparse plant cover, except in depressions where water accumulates. The sandy, stony or rocky substrate contributes more to the appearance of the landscape than does the vegetation.

8. **Afroalpine Vegetation**. Physiognomically mixed vegetation occurring on high mountains where night frosts are liable to occur throughout the year.

9. **Scrub Forest**. Intermediate between forest and bushland or thicket.

10. **Transition Woodland**. Intermediate between forest and woodland.

11. **Scrub Woodland**. Stunted woodland less then 8 m tall or vegetation intermediate between woodland and bushland.

12. **Mangrove**. Open or closed stands of trees or bushes occurring on shores between high- and low- water mark. Most mangrove species have pneumathores or are viviparous.

13. **Herbaceous fresh-water swamp and aquatic vegetation**

14. **Halophytic Vegetation** (saline and brackish swamp)

15. **Bamboo**

16. **Anthropic Landscapes**

Annex 6: FAO Tropical Forest Resources Project

FAO carries out the most comprehensive global assessment of tropical forest extent and forest management under the Tropical Forest Resources Assessment (TFRA) Project (FAO/UNEP, 1981, FAO, 1988, FAO, 1993). There is a parallel assessment which is undertaken for temperate regions (UN-ECE/FAO, 1992). FAO's Assessment is presented in statistical form (FAO, 1993) but is essentially a mapping and statistical exercise.

FAO's technique of assessment is described here as an example of the different data processing steps required in gathering forest cover and forest cover area change data into standardised formats. A useful summary of the *Global Forest Resources Assessment*, including recommendations for the methodology towards the Assessment 2000 is given in Nyyssönen (1993).

Country data are maintained in FORIS (Forest Resources Information System), which is a computerised database to store/retrieve national/sub-national forest resource information. The statistical data are supplemented with multi-date high resolution satellite data which are maintained within the project's Geographic Information System (GIS).

The tabular data comprise forest resources, population and socioeconomic data at the subnational (province, state) level and the map data include vegetation types, ecofloristic zones and country and subnational boundaries. Demography and ecological parameters were included in the GIS as population pressure and environmental conditions (particularly the population carrying capacity of the area) drive deforestation.

Forest cover, forest biomass and plantation statistics are presented in the FAO Assessment (FAO, 1993). FAO have defined natural and semi-natural forests as "ecological systems with a minimum of 10% crown cover of trees and/or bamboo, generally associated with wild flora and fauna and natural soil conditions and not subject to agricultural practices". This is an wide definition and includes many open vegetation formations which would not normally be regarded as forests. Plantations are defined as "forest stands established artificially by afforestation on land which previously did not carry forests; or forest stands established artificially by reforestation on land which carried forest within the previous 50 years or within living memory and involving the replacement of the previous crop by a new and essentially different crop" (FA0, 1993). Plantations are further distinguished according to function: industrial and non-industrial (see FAO, 1993 for definitions).

The forest cover data for 1990 are ordered by "forest formation". These estimates of forest cover area and changes by forest formation are derived by integrating FORIS database with ecofloristic zone and vegetation maps, digitised at 1:5 million scale.

5.3 Agriculture

5.3.1 Overview

This section considers agriculture as it interrelates and impacts upon biodiversity. Discussion about classification systems is therefore restricted to those schemes which have a direct bearing on biodiversity aspects. As a general comment, the treatment of agriculture with biodiversity is at an early stage of development. Consequently, many areas of overlap *vis-a-vis* classification systems, minimum data sets, and database models are not immediately apparent. However, as countries consider implementing the CBD this situation is likely to change.

Agricultural classification systems may include *land classifications* as well as consider social, economic, and production classifications of agriculture such as subsistence, commercial, grain, dairy, small fruit, mixed, agroforestry, organic, and hobby farming. Important distinctions should be made between "land" as opposed to soil since many people confuse soil classification (eg FAO Soil Map of the World) with the broader concept of land classification, incorporating soil, climate, relief, and hydrology (Beek and Bennema, 1974).

Additionally, there is the difference between *land classification* and *land use classification*. Classifying land *per se* is something done in reconnaissance surveys of an area where there is not time or money to do a full soil survey, but using aerial photographs and field work it is possible to map out land units such as alluvial plains, flat terraces, moderately sloping, and hillsides. This is contrasted from *land use* which could be urban, forestry, agriculture in the broadest sense, or some of the land utilisation types suggested in the FAO Framework eg, rainfed agricultural cropping.

Agricultural classification systems should be capable of measuring, monitoring land use patterns, and assess the level of risk to biodiversity within geographic areas as well as be used for extrapolating research results for use in other areas. Secondly, they should assist in the assessment of threats to biodiversity in general resulting from changes, or potential changes, in the land use practices and patterns of agricultural production.

The measuring and monitoring role of the impact of agriculture on biodiversity is documented in various country level State of the Environment Reports (SEOR) produced over the last few years as response to the World Commission on Environment and Development's 1987 report. Many countries use a framework of zones for land classifications systems to produce their reports. Examples include the Canadian Ecozones (Wiken, 1986).

The impact on biodiversity of agriculture activities can be influenced by:

- the expansion of the area of land under agricultural management
- changes in the intensity of use of other inputs to agricultural production (eg increased fertiliser and pesticide usage)
- changes in the agricultural systems employed that effect the number of plant and animal species it supports.

To illustrate the third point above, consider the example of a rangeland grazing system. This area of land may equally support a system of prairie cereal production. From an agricultural production perspective, the production of cereals requires a higher level of control of non-crop organisms than does a rangeland grazing system. In addition, any system which provides continuous ground cover will be less prone to soil loss and degradation problems which would effect the composition of non-agricultural biodiversity.

As a second illustration, consider the difference between a mono-cropped, single variety cereal field in the US, with a low, multi-cropped Malaysian farm. In the cereal field, the level of biodiversity is small. The use of a single biotype cultivar itself restricts biodiversity. Additionally, monoculture facilitates the utilisation of chemical pesticides, and may reduce yet further the level of biodiversity. In contrast, the multi-cropping system, where two or more crop species are grown simultaneously, actually promotes and takes advantage of biodiversity. Here the variation in crop biotype reduces the technical and economic effect of pest attack, while maximising crop biomass production. It may decrease the need for pesticides, improving sustainable levels of non-crop organisms to flourish.

5.3.2 Classification Systems and Standards

The aim of this section is to take a snapshot of current land use patterns in agricultural production and to expose the effect of agricultural land use upon the level of biodiversity within the area. In order to do this, it is necessary to conduct field surveys of the pattern of agricultural land use practices and the range of restrictions upon biodiversity that these impose.

Measurement and Monitoring

The following are examples of classification systems developed in the context of measurement and monitoring roles.

Name **FAO Soil Map of the World**

Description This study (see FAO, 1990) was initiated in an attempt to record the soil types of the world in one uniform publication. The main purpose of the study was that of soil mapping. As an aside to this work, a record of "vegetation" was made for each of the "soil associations" defined areas. This record is an "investigator assessment" of the general land use or cover vegetation both present, and where possible naturally occurring. This record is not well defined, and it is very much left to individual investigators to decide what information to include. For example, dataset entries could include *Field Crops, Pasture,* and *Woodland.*

Name **Global and National Soils and Terrain Digital Database (SOTER)**

Description The SOTER (FAO, 1993) objectives include the selection, standardisation, coding and storage of information on soils and "terrain". SOTER addresses terrain morphology groupings in which the soils are just one component. The emphasis on standardisation and coding forces the definition of classification systems for both "terrain" and "land cover". "Vegetation" and "Land Use" are stored in two separate files. Within each, the following is recorded:

- the SOTER geographic unit identification
- date of recording
- land use or vegetation as appropriate
- the proportion (%) of land use or vegetation

SOTER adopted a hierarchical classification system for record 3) above. Thus, land use is divided into classes, subclasses and groups, each adding a character to the database field code. Examples for land use and vegetation are found below:

- **Land Use**
  Class A (Agriculture)
  Subclass AA (Annual Field Crops)
  Group AA5 (Wet Rice- Cultivation)

- **Vegetation**
  Class 1 (Closed Forest)
  Subclass 1A (Mainly Evergreen)
  Group 1A5 (Mangrove Forest)

The risk assessment role of SOTER aims to assess the possible threats to biodiversity from human activity in land-based production. To do this, it is necessary to adopt a method of assessment of potential changes in land use patterns. This requires information on the uses to which any piece of land may be put in the future. In hand with this is the need to assess the relative threat to which ecosystems may be put as a result of such changes. The requirement is then threefold:

- The need to assess the demand humans place on the land. This requires an estimate of demand for agricultural land, which would be expected to be highly correlated with population density, land prices and economic pressure to produce.

- A prediction of the most suitable areas of land, into which the expansion of agricultural production is most likely to occur.

- To assess the relative fragility of the land itself to such changes. Information is needed about whether specific soils, within any threatened region of expansion are prone to erosion, water quality problems, flood, deforestation or possibly desertification, as a result of agricultural activity. These factors are generally correlated with the soil's physical and chemical properties, climate and topography.

Although the SOTER project has been tested on three continents it still falls far short of providing the completeness of coverage required for the present project. With reasonable resourcing it might be possible to establish links with the SOTER project in order to have maps completed for the key areas of biodiversity research, because SOTER may be one of the best systems for this purpose.

Land Suitability
In searching for a globally applicable "Land Suitability Classification System", the aim is to provide a standardised measure of any given land's suitability to agricultural production. From this information, agriculture's demand for that piece of land can be assessed, as the demand for land in general rises, and predict the possible uses to which that land might be put, should it enter into production. The possibility of an assessment procedure would help to forecast the likely effect on biodiversity from changes in agricultural land use patterns and from agricultural land use expansion. Since cultivated agriculture encompasses a continuum, from extensive monoculture production to small-scale multi-cropping, then the assessment of land use patterns is of importance to the level of biodiversity observed.

Name **US Department of Agriculture's Land Capability Classification System**

Description An example of a regional land capability classification system is provided by USDA. Land evaluation, may be defined as *the processes of estimating the potential of land for one or more alternative uses*. Among the many national systems for land capability and suitability classification in use throughout the world, the USDA "Land Capability Classification" system (described in Klinngebiel and Montgommery, 1961), has seen widespread application worldwide. However, this approach which assesses lands suitability for agricultural production, is based on economic and technical environment more representative of developed countries, thus there is a need for a more flexible global system.

Name **International Framework for Evaluating Sustainable Land Management**

Description Beek and Bennema (1974) developed a methodology for the classification of "land evaluation" for Latin America. This work formed the basis of the FAO suitability classification system first published in "A Framework For Land Evaluation" (1976). However, this version of the system proved too complex, it has since been modified by other workers, such as Dent and Young (1981), and more recently revised as the "International Framework for Evaluating Sustainable Land Management" (FAO, 1993). The Dent and Young (1981) system is based upon an iterative process to assess the suitability of some piece of land for the production of a specified crop, by means of a specified system. The land is then ranked on a continuum, from suitable to not suitable, specifically for growing that crop. Given resources, this methodology can assess the suitability of areas of land for different land uses. The "amplification" of these land uses will depend upon the purpose of the study, the detail of information available and the research resources available.

Name **CORINE (Coordination of Information on the Environment)**

Description The Corine Soil Erosion Risk and Important Land Resources System (1992) is the European EU sponsored project formed part of a larger EU environmental initiative. The methodology employs the USLE (Universal Soil Loss Equation) along with soil surveys, climatic, topographic, agronomic and vegetative information to overlay maps using GIS techniques. This process was carried out at a scale of 1:1,000,000. The project aimed to assess the level of both potential and actual soil erosion risk. For these purposes, potential was defined as the "risk of erosion, irrespective of current land use or vegetation cover". The use of the term *risk* actually refers to the "risk of erosion under present vegetation and land use conditions". Thus, the risk from potential erosion is much greater than that of actual erosion, and is thus the risk from change in land use patterns toward erosion sub-optimal practices.

5.3.3 Data Definitions and Models

Definitions of land area and land use may vary considerably between countries. There have been many individual surveys of current land use in individual countries but there are very few if any reliable international systems with consistent data definitions. The FAO's Agro-Ecological Zones are one of the best set of definitions presently available. The FAO's land area data typically excludes the area under major inland water bodies, national claims to the continental shelf, and maritime exclusive economic zones (EEZ). (For some countries, national land area may include overseas territories). Further, FAO's world land area total excludes Antarctica. In general, *cropland* refers to arable land and land under temporary or permanent cultivation; *permanent meadows and pasture* includes land and pastures used for five years or more for natural or cultivated forage crops; *forest and woodland* refers to natural or planted stands of trees and includes uncultivated land, wetlands, barren or wasteland, parks, built-on and roads (UNEP, 1993).

Land area and land-use data are revised periodically as new information becomes available and therefore, values may change significantly from year to year. Moreover, the definitions of land-use categories are sometimes adjusted and the data revised accordingly. Consequently, apparent changes in land use should be viewed wit h caution.

The chosen classification schemes should lend themselves to modelling the impacts of changed agro-ecosystems on biodiversity, because they are too complex to monitor cost-effectively by any direct means. The models should be robust due to the paucity of the data for most areas and the need to accept data from different sources and land evaluation methodologies. Simulation of alternative scenarios will then be possible in terms that decision makers can understand. Outputs will be enhanced by linkage to geographic information systems, but some evidence indicates that these may not be as essential to the actual data processing as they will be to the display of results and alternatives for biodiversity impacts.

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5.4 Forestry

5.4.1 Overview

Foresters, ecologists and land use planners assess forests for many reasons at many scales. Forest classifications and description systems can be identified for most countries, and as with other habitat types, there are a few continental or global standards. Such global schemes can often be subjective in application as they are based on loosely defined verbal descriptions rather than on a measured set of parameters (as is the case in forest inventory). These can rarely be used at the national scale as most lack clear utility or are too general. However, data requirements for management often share many common aspects and it is possible to identify similar elements in the various procedures and assessment protocols. The examination of these common concepts and methodologies is being pursued by the International Union of Forest Research Organisations (IUFRO) and FAO, both of which have published reports on these issues and include some suggested standards.

Some forestry text books are widely available and provide a standard description of forestry practice, eg Lamprecht (1989) and Parcel (1993) for general aspects and Evans (1992) for plantations. Some general considerations in the integrated use and management of forestry information are provided by FAO (1986). A global overview of forest literature abstracts (1930s to present) on CD-ROM (a key word interactive data-base) has been produced and is maintained by CAB International.

5.4.2 Classification Systems and Standards

Many different parameters are used in classifying forests and forestry. For clarity, the following discussion is structured under the following major subject areas: forest ecology and land use systems; legal status and policy designation; inventory, resource assessment and monitoring; utilisation, and management practices; and environmental status and sustainability.

Forest Ecology and Land Use Systems

Several of the standard techniques in vegetation description include modified landscapes and land use. With remote sensing techniques and field assessment, land use can be relatively easily identified, (eg the landscape guided method advocated by UNEP, see Loth, 1990). FAO (1982a) has provided a system of classifying forest lands, and recognises "natural" and managed formations, including plantations. This scheme is not usually used outside FAO statistics but does appear to be a recognised standard nonetheless. Touber *et al* (1989) have outlined several useful and clear schemes by which forested lands and associated forestry practices might be classified.

There is not likely to be any widely acceptable measure of habitat "naturalness", and such measures should probably be avoided. In some cases the natural status of vegetation may be subject to debate. In forest vegetation the issue of what is "primary" and what is "secondary" (and what is merely "modified") has no satisfactory criteria for classification; different users have used different criteria, or used subjective judgement. A review of "secondary" forests is given by Brown and Lugo (1990) who consider such forests as those "formed as a consequence of human impact on forest lands" (excluding planting), and they focus on forests that re-grow after complete clearance. The classification of partially modified forests, (eg selective logging, grazing) will be better achieved through more detailed descriptions of the vegetation and its management history. A classification of ecosystem disturbance - "undisturbed", "partially disturbed" and "human dominated" - provided by Hannah *et al* (1994), considers any forest use to remove a forest from the category of "undisturbed". So, most managed (natural) forests would thus fall in the "partially disturbed" class, while plantations are "human dominated", as the primary vegetation has been removed.

Forest trees can reach a very great age, which means that forests, much more than other vegetation types, reflect their history in their composition and structure. The age of a forest formation is generally believed to have implications for biotic values. In some circumstances the age of a natural stand may be estimated from various indicators or auxiliary sources of information. In temperate regions a debate on the definition of old-growth forests has had implications for conservation planning, (eg Hunter 1989, discusses the criteria and applications for such a definition). The development time required to achieve mature forest types creates difficulty in terms of classifying non-climax natural and semi-natural vegetation types, (ie primary and secondary). Any continuum of variation produces a problem for classifications which must produce arbitrary criteria to draw lines of classification. Classification, therefore, may be an inappropriate concept to apply to ongoing successional processes. The ecological basis for a more appropriate description of changing forest communities is a subject of some considerable debate (see Glenn-Lewin *et al*, 1992, for a comprehensive recent multi-author review). A consideration of definitions, terminology and description with regard to the nature of the tropical forest-savannah boundary, is provided in a review edited by Furley Proctor and Ratter (1992). Many different types of forest edge occur, and different descriptions and implied causal mechanism are appropriate at different scales.

Natural disturbance and disturbance by man is also difficult to describe. Some forest formations are heavily influenced by rare, catastrophic events, (eg fires, droughts or cyclones), causing high mortality levels. The ecology of such "non-equilibrium" systems is distinct from environmentally stable systems; a significant link with biological diversity has been suggested. A provisional system of classification is implied by Jackson (1968) for Tasmania who notes alternate steady states for vegetation depending on fire-likelihood. Such designations are believed to have significant implications for conservation and management. As the occurrence of severe disturbances (fire, wind etc) has significant implications for management, many countries provide some measure of risk analysis that is sometimes quoted, or mapped as a classification within a given context. However, no widely recognised standards exist.

- **Plantations**
  Plantation vegetation is generally very homogeneous and lends itself to simple classification depending on the terms required. Normally, plantations can be readily defined by a species and provenance (site of trees seed source origin), but issues of scale, product/objective, and harvesting can be relevant (see later). A description of structural characters includes single or mixed species, single or mixed age classes and native or exotic species. Date and density (saplings/ha) of original planting, are commonly quoted, also how many previous mature plantation crops (rotations) have been produced on the site. In some circumstances several minor cuttings are

performed before the final crop is removed: this is thinning, and is normally planned in advance and checked with specific inventory procedures. Individual plantations are thus sometimes classed on their planned thinning needs.

- **Agroforestry**
  Agroforestry systems can be difficult to place in classical land cover schemes, however at a systems level (defined by the various land use components and their functional relationships), their evaluation and classification have been achieved by ICRAF (Nair, 1989, includes standard data fields for simple and detailed characterisation of systems).

- **Soils**
  Soil information is very important in forest land assessment, and while global standards do exist at a general descriptive level, (eg Bridges, 1978), there is confusion caused by the various nomenclature systems use. A review of this is provided by Richter and Babbar (1991) who also compare the various systems used in the moist tropics, (eg a table of soil taxonomic relations under FAO/UNESCO, Soil Taxonomy, Brazilian System, and ORSTOM) and indicate how consensus is being achieved. A high degree of standardisation on the physical and chemical description of tropical soils has recently been achieved in a text edited by Anderson and Ingram for UNESCOs Tropical Soil Biology and Fertility Programme (1989).

- **Hydrology**
  The value of forest cover often arises from its hydrological significance. There is no clear definition of these attributes but a comprehensive review of the assessment and characterisation of such factors is provided by Bruijnzeel (1990) for UNESCO.

Legal Status and Policy Designation
Legislation determines the management of forest lands, and the legal designations, applicable to forest areas, will vary with context. Many different designations exist: eg Forest Park, National Forest Reserve, Regional Forest Reserve, World Heritage Site, National Park, Tribal Reserve, Village Reserve, Common Lands and Private Reserve. The legal obligations of management regimes will depend on a specific legislation which in turn depends on local conditions in terms of applicability, (eg no logging within 50m of a stream, or on slopes over 30 degrees), or allowing specific uses, of specific areas, by specific people (as a traditional right or as a license holder), or even claiming state ownership of certain tree species on private land. Diversity of legislation and applicability severely reduces the use of general classification schemes outside the national context. For instance, a National Park in one country could have a very different protection status than one in another. Some countries' National Parks have multiple use, other forest lands designated as national parks may be more strictly protected. Some "Forest Reserves" are designated for protection, others are under production. To overcome this problem, IUCN have developed standard categories for managed areas (I-VI) which can be applied to all managed area systems (see Protected Areas, Section 5.7).

Forest policy should specify the designation of priorities for the different elements of a national forest estate. Terms such as "catchment forest", "nature reserve", "production forest" and "amenity area" imply similar (though not necessarily identical) management priorities. The legal basis of these designations and associated restrictions varies by country. Comparison at a national level will depend on objectives, but relevant studies include Poore *et al*, 1989, who considered sustainability at the policy and national statistics level, and also the FAO Forest Series which has many policy review studies.

Inventory, Resource Assessment and Monitoring
A number of initiatives have called for improved forest monitoring, stressing that this is essential for forest conservation and sustainable development. Recent studies of the status of temperate and boreal forests add a global urgency to what had recently been seen as a tropical problem alone. At the global level *Agenda 21* and associated *Forest Principles*, the CBD and the *Climate Change Convention*, all call for different factors to be monitored. The *Forest Principles* encourage the preparation of national strategies for sustainable forestry; the *UN Commission on Sustainable Development* is inviting countries to report on progress including the use of forests for 1995 and countries have been asked to prepare and maintain national sustainable development strategies.

There are many monitoring techniques and methods, for example remote sensing (space and airborne platforms) to detailed tree measurements. The need for objective information has led to a general agreement on principles: definitions and methodologies for forest inventory are documented in many sources and many texts define and explain the concepts of data collection and review processes (Husch, 1971; FAO, 1981; Schreuder *et al*, 1993; Philip, 1994). The FAO Global Forest Resources Assessment, undertaken by FAO every ten years, is the authoritative global assessment of temperate and tropical forests. This assessment is described in more detail in FAO (1982b and 1993) and in Terrestrial Vegetation, Annex 6.

Forestry management for production requires assessments of the state of forest resources and productivity in defined tracts of land. These are used to plan the management of the area, often before the commencement of a felling operation. In well managed forests, monitoring of felling operations, or post-harvesting surveys, is crucial as a safeguard against over exploitation and for checking that forestry practices are in line with planning.

Methods of tree measurement, and the concept of estimated quantities, are well defined and comparable. Thus, data on quantities such as "stocking", "basal area", "merchantable volume" etc (see Forestry Terminology, Annex 1) can be used objectively to describe a defined tract of forest land at a given point in time. There is a need for agreed standards concerning the estimation of biomass for CO_2 sequestration modelling. It is, however, unlikely that standards will be agreed for many years as methods are still being refined and evaluated. Some of the main issues in integrating forest inventory data and related sources can be found in relevant IUFRO proceedings, (eg Wood and Turner, 1992).

Inventories in mixed forest are often restricted to commercial species, or at least have low taxonomic accuracy for rarer and non-commercial species. This means that an inventory cannot be considered comparable with more classical phyto-sociological data. When using inventory data as a surrogate for a vegetation description, it is vital to know the population defined for measurement: usually a list of species and a minimum size (usually by diameter at a reference height) measured.

Forest areas (at various scales) can be described in terms of standing crop (generally this will be timber or a high value crop such as rattan) or yield (a measure of productivity of the current or planned management system). The techniques used in this context are varied and often highly sophisticated. Standing volume is considered in FAO (1980a) while yield (often a well defined classification system for plantations at national levels, though generally lacking objective comparison between countries due to differences in concept and evaluation) is discussed in FAO (1980b); both of these texts provide good overviews of general practice.

In order to assess change (growth, recruitment, mortality productivity etc), the most rigorous standardisation of methodology is required for temporal monitoring of fixed sites. Several texts which advocate standards for detailed site and trees evaluation in mixed forest can be recommended: Manokaran *et al* (1990); Dallmeier (1992); and Alder and Synnott (1992). Adlard (1990) considers similar issues for plantations and low diversity systems, and presents many standard formats for data collection and summary. Few standards can be recognised for more extensive monitoring, but a text of recommendations has been compiled by IUFRO (Päivinen, 1994) which also provides a useful glossary of terms and bibliography.

The term "land evaluation" is frequently used with respect to forest lands. In its broadest sense, land evaluation includes the process of data gathering (inventory and mapping), classification and identification of tracts of land, and interpretation of these data in terms of suitability for all individual tracts of land for a specified use. The term strictly implies an assessment of the land's productivity (actual and potential) under current and alternate land use practices. Good practice would require that technical, legal, economic, social and environmental factors are all given due attention. No single defined characterisation has been agreed but some terminology and concepts have been suggested (FAO, 1984). Many systems of Land Evaluation have been developed in various countries. The Framework for land evaluation (FAO, 1979) is widely used and comprises guidelines for both rainfed and irrigated agriculture for forestry and extensive grazing. A more complete discussion of the various approaches and possible systematisation is given in Laban (1981). A useful summary of the basic concepts of land evaluation, including frequently used terms such as Land Utilization Types (LUTs), Land Use Requirements (LURs), Land Quality (LQ), and Land Mapping Units (LMUs) is given by Touber *et al* (1989).

Utilisation and Management Practices

Forest benefits and produce can be divided into several classes. There are non-extractive benefits, (eg catchment, tourism, conservation) and extractive values, (eg timber, gum, rattan, medicinal plants, meat). The classification of these functions and uses will depend on the objectives of the classifier though general principles will usually be shared: eg Kostov and Baev (1976) propose a classification scheme in which the main benefits are divided into (a) wood-producing function, and (b) non-wood-producing function, this being subdivided into environment-protecting and environment-forming functions. The environment-protecting functions include erosion control, water regulation etc, and the environment-forming functions include recreation (health, hygiene, tourism, etc), and cultural/aesthetic functions (landscape improvement, historical education, etc).

Extractive values are traditionally classed into timber (or wood) and non-timber (often called "minor" forest products. There can be difficulty placing some products in these systems, eg charcoal. In a specific context the non-timber products can be of considerable management significance; such products are rarely noted in any detail by traditionally trained, timber-oriented foresters. FAO (1982b) have provided a classification and definition of forest products which includes some 162 terms/phrases with their definitions arranged in a decimal classification (this is proposed to improve comparability of statistics, and places emphasis on timber).

The economic value of a tract of forest land will often depend on the various significance of each forest benefit/product (which should in turn be reflected in policy and legal designations). A standard assessment of each of these components does not readily exist. At a larger scale, the priorities and principles of a management system are normally adequate for a general description. At smaller scales, ie the size of concessions and felling operations, a more silviculturally detailed (ie quantified) description becomes practical (usually in conjunction with an adequate inventory). For timber extraction, standard figures are cubic meters of timber felled or of timber extracted, and stems/ha, and basal area (m^2/ha) removed and basal area (m^2/ha) stems/ha remaining.

Local scale forestry practice, with respect to timber production, requires inclusion of many factors in order to facilitate adequate characterisation. These can be considered as the components of the management system itself, or as the physical results of the system, (eg aspects such as age structure). Relevant parameters are:

- Scale
  The scale of the management unit and size and shape of the felling unit define the scale of the operation and its impact.

- Felling Cycle
  The period of time between one felling operation (of mature stems) and the next (if thinnings are removed then this is considered separately). In managed mixed age class forests, the word polycyclic is used for operations that extract timber leaving immature stems which will be removed in the next operation; monocyclic systems remove all, or almost all, merchantable timber in one go and do not plan to re-harvest until tress have grown from seed/seedling stage to commercial size

- Selectivity of Felling and Control of what is Removed
  For example, clear felling (common in plantations and in mangroves); selective felling based on size (cutting of stems > defined diameter size) and or species (common in tropical mixed forest where only certain species have value). Pre-felling treatments are sometimes applied, eg cutting of climbers, clearing of impeding stems etc. Post-felling treatments may be undertaken to encourage regeneration, or the reclaiming of minor roads and skid trails

- Method of Regeneration
  For example, the natural regeneration which occurs without any planned intervention, coppice (the re-growth of cut stems), planting and seeding. Planting within natural forest is called enrichment. In some circumstances plantations may regenerate naturally: if the species is exotic this situation can pose a significant threat to

neighbouring ecosystems

- Form of Harvesting and Extraction
  Many terms are used in this area and a wide range of techniques are employed: heavy mechanised, light weight mechanised, manual on-site processing, (eg pitsaw), cable logging, animal assisted extraction, (eg elephants), permanent roads, temporary roads. No generally applicable classification of the range of combinations seems likely, but it could be suggested that protocols for the assessment of the environmental sensitivity of a site and the appropriateness of a given suite of methods could be developed (cf Pearce and Gage, 1977; Davis and Reisinger, 1990)

- Additional Management Interventions
  These can include a wide variety of specific tasks, eg fertilisation, pest control, removal of diseased stems, fire-break establishment and upkeep.

In tropical silviculture, several systems have been used and are identified by simple labels, (eg *Malayan Uniform System*). The various procedures defined by these labels can be found in many texts on tropical silviculture, eg Lamprecht (1989) and Buschbacher (1990). Several older texts on silvicultural systems define many aspects of the terminologies and practices and are still widely cited, eg Troup (1928). (Matthews, (1989,) provides an updated version which includes more recent technologies).

All these aspects of management apply to specific tracts in terms of a management history and planned future. Dates in these cases are usually quoted to the nearest year, and number and date of prior logging episodes is usually considered a minimum statement to define a forest map into different logging histories by "concession", "coupe" or "compartment".

Environmental Status and Sustainability
The assessment of health and forest decline has attracted some attention recently, but the various standards being used regionally are being increasingly questioned and some re-assessment is likely. A very general conceptual definition of terms is provided in FAO (1994), which looks at global forest decline and die-back.

The classification and definition of environmental aspects of forest practice and the designation of sustainability has been addressed by several international fora to endeavour to find a consensus. One consensus on integrating conservation interests in forest management is represented by the IUCN General Assembly resolutions, (eg IUCN 1990), but few objective criteria can be recognised in these resolutions. Various general principles for assessing sustainability have been agreed in various contexts, (eg ITTO 1990, 1993a), but these also lack clear operational criteria. Technically, plantations have a clearer basis for evaluation than natural forests (See Brünig, 1984) and some principles have been defined by ITTO (1993b). Some of the procedural requirements, with particular regard to information are being identified, (eg IIED/WCMC, 1994).

The concept of sustainable forest ecosystem management - as opposed to simply sustained yield of forest products - was a major theme in the *Global Forest Principles* announced following the UN Conference on Environment and Development (UNCED), Rio Summit in 1992. This has meant the inclusion of issues such as maintenance of biodiversity, interaction with local communities and other socio-economic aspects have had to be incorporated into assessments of management effectiveness. As a result, a significant number of initiatives have been set up to examine issues of sustainable forest management in both temperate and tropical countries. Those working on temperate and boreal forests include The Helsinki Process - Ministerial Conference on the Protection of Forests in Europe, and World Wide Fund for Nature UK's work on *Forest Quality*, which are both looking to develop criteria and indicators which could be used as measures of progress and for subsequent monitoring purposes. The Canada/Malaysia Intergovernmental Working Group on Global Forests and the German "Initiative Tropenwald" are carrying out similar work aimed at tropical forests. Many of the initiatives are particularly concerned with producing guidelines to assist in certifying that marketed timber, be it temperate or tropical, has come from a sustainably managed source. These include the Rainforest Alliance's Smartwood Programme, the Soil Association's Responsible Forestry Programme and the German "Initiative Tropenwald". Whilst guidelines and criteria are relatively well-defined, few practical indicators have been verified. However, both the Centre for International Forestry Research (CIFOR) and WCMC are currently setting up case studies in order test potential indicators in the field.

A general consensus on how sustainability is to be defined for the identification of certified production and products is being developed by the Forest Stewardship Council (FSC) (FSC, 1994). FSC is seeking to take the lead in certification and international standardisation. It is intended that certification might be applied to products from sustainable plantations as well as natural forests. The East-West Environment and Policy Institute (1980) also considered how forest lands could be classified in the context of sustainable management practices. Note that these principles and criteria contain many different aspects, (ie policy and legislation, ecology, assessment, silviculture, site characteristics, management control).

A journal has recently been launched with the objective of following the progress of sustainability as a subject which requires technical and policy research (*Journal of Sustainable Forestry*, edited by GP Berlyn, 1993 *et seq*).

5.4.3 Minimum Data Requirements

Several organisations/initiatives have proposed minimum data requirements for forest monitoring. These mainly comprise information on what types of forest data should be gathered for sound forest monitoring and sustainable forest management. Notable examples include IUFROs *International Guidelines for Forest Monitoring* (IUFRO, 1992), TROPENBOS methodology (Touber *et al*, 1989) *Inventory and Evaluation of Tropical Forest Land: Guidelines for a Common Methodology,* and the International Institute for Environment and Development (IIED) and WCMCs *Forest Resource Accounting (FRA)* (IIED/WCMC, 1994). IUFRO proposes a list of data requirements for land cover, forest, biomass and environmental quality monitoring. The TROPENBOS programme, which is developing a systematic approach for sound land use planning aimed at using tropical forests and forest lands on a sustainable basis, has developed common methodologies advocated with respect to land inventory, survey procedures, land evaluation and report and map preparation (see Touber *et al*, 1989).

A management tool known as *Forest Resource Accounting* defines the strategic framework necessary to enable sustainable management to take place and provides a generic system designed to facilitate monitoring through the collation of forest management information. FRA integrates forest information from many sources to make available in forms useful for policy makers and planners (IIED/WCMC, 1994). It provides a system to track changes in forests used for both production and protection - especially in their area, legal status, condition and management. FRA enables ITTO parties to report to ITTO on their progress towards sustainable use of tropical timber. ITTO have agreed to place their tropical forest management on a sustainable footing by the year 2000. FRA, after intensive pilot studies in Indonesia, Ecuador and Cameroon, which were undertaken to identify data-handling measures needed to record the distribution, condition and management status of tropical forests, proposes a set of typical categories for data entry for a national FRA system (see Annex 2 in IIED/WCMC, 1994). Briefly, three levels are relevant for reporting information on forests: site details, country statistics (compiled by the national Forest Authority from all information about sites within the country) and global statistics (compiled by ITTO from country statistics from all ITTO-member countries). Data requirements for reporting include: information on the legal status of forest area, vegetation type and extent, forest condition (impacts on forest and ecological indicators), management status (including management plans, quality of management implementation), social/cultural and economic information, and site biophysical factors (see IIED/WCMC, (1994), for more details on these data requirements).

5.4.4 Data Definitions

Forestry has a well developed technical notation used in mensuration and quantitative descriptions, which is largely international in application (IUFRO, 1959). Effort has been given to defining a standard set of definitions for forestry vocabulary. Ford-Robertsons work (1971), and various translations, have set a standard in this field: this work provides 6807 defined concepts, each identified by a Universal Reference Number (URN), contained in over 5150 alphabetical main entries (key terms),and is supplemented by appendices presenting 30 informative sets of drawings illustrating many terms in various fields, (eg hydrology, sawing, mensuration, road building). Thirty-one "families of connected terms" elucidating the relationships between terms, a list of abbreviations and symbols, and a list of deprecated terms and their preferred synonyms are also provided.

Many translations of forest vocabulary can be found. Chinese terminology is provided in Anon (1981) which is basically a Chinese translation of the original edition by Ford-Robertson. Japanese terminology is considered in Matsui (1981): a quadrilingual cross-referenced dictionary of 2526 frequently used forestry and forest products terms in Japanese and equivalents in English, German and French, as well as Universal Reference Numbers (URNs). Sicard-Lussier (1982) provides a French terminology: terms are defined, translated into English with some notes and illustrations (synonyms for French and English terms are given). The specific terminology of fire in forestry is detailed in Lyon (1986) who lists 1500 terms in English with their Spanish, Italian, German and French counterparts (or translations) and a brief English definition. IUFRO (Schmid-Haas 1990) has recently agreed and compiled a comprehensive and detailed cross-referenced multilingual dictionary of forest terminology (English, German, French, Spanish, Italian, Russian), but without significant definitions or explanations.

Four international systems relating to the management of forestry terminology and information classes have been identified: Ford-Robertson's URNs (Ford-Robertson, 1971 and see above), a more recent adaptation of this system (Yerke, 1983); and the old and widely used Oxford Decimal System (CAB, 1954) which has been used as a bibliographic system of classification of the forest literature for many decades (endorsed by FAO and IUFRO). It appears that the updated version called the *IUFRO Forest Decimal Classification* will be the new standard (IUFRO, 1990), and this is therefore recommended.

These systems provide a *de facto* classification of many aspects of forestry from products and purposes, to silviculture and types of management unit. Developments in this field are still being undertaken in the international forum, eg Caron (1991) includes several papers on forestry information and terminology covering scientific publishing, agroforestry classification, the IUFRO bibliographic database, communication systems in IUFRO, a terminological data bank, a world tree dictionary, a bamboo terminology/thesaurus, and forestry terminology in CAB International. IUFROs Standards and Definitions are presented in Annex 1 together with some terms employed in the FAO Forest Resources Assessment (1990).

5.4.5 Database Models

Forestry information can be recorded and presented on a statistical basis, in the form of tables, and on a spatial basis, in the form of maps. Because of the potential complexity of forestry data and the sheer volume of data that can be collected and analysed, databases (statistical and geographic) have been developed to house data in structured formats. Numerous databases have been developed for a wide range of uses; for storing species information, forest cover and forest use data.

At the species level, the PROSPECT (Programmed Retrieval of Species by the Property and End-use Classification of their Timbers) database, developed by the Oxford Forestry Institute (OFI), is a database containing the wood properties of tropical timbers (Smith *et al*, 1994). The database is primarily concerned with improving the use of lesser known tropical timber species, the object of the database being to try market more secondary tropical species. PROSPECT is one of the largest and most comprehensive databases of wood properties and uses available; over 1000 different tropical species are currently loaded on the database. The database covers 90 properties and 160 uses; it contains information on size of tree, location of occurrence local trade and botanical names, and it uses two methods of end-use classifications (see Smith *et al* (1994) for more information on the PROSPECT database).

The Forest Resources Information System (FORIS), developed by the FAO to maintain the information gathered during their Global Forest Resources Assessment, is a notable example of a system developed to hold data on forest extent.

For land evaluation and forest monitoring, TROPENBOS recommends the commercial application, ILWIS (Integrated Land and Watershed Management Information System), developed by the International Institute for Aerospace Survey and Earth Sciences (ITC). ILWIS aims to provide users with state of the art data gathering, data input, data storage, data manipulation and analysis, and data output capabilities, linking and integrating conventional geographic information systems (GIS) procedures with image processing capabilities and a relational database (Touber *et al*, 1989). Figure 1 illustrates the general data gathering and input procedures of ILWIS.

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Annex 1: Forest Terminology

The International Union of Forest Research Organisations (IUFRO) promotes standardized or compatible collection and reporting of selected data for forest monitoring through cooperation in such a way that the results offer a common data base for research and management. IUFRO encourages use of the following definitions and standards in future monitoring efforts:

Age. The total age of a tree in years

Aspect. The direction a slope of land faces. Record to the nearest degree

Crown Closure. Percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants.

Crown Diameter. The span of the crown of a tree or shrub. measured as the diameter of the vertical projection of the outer-most perimeter of the crown in a certain direction.

Crown Length. The vertical distance from the top of the leader to the base of the crown, measured to the lowest live branch-whorl with live branches, and continuous with the crown.

Defoliation. The visual index of actual foliage compared to the normal, healthy tree growing in similar conditions. Measured as percentage of the "normal" foliage.

Diameter at Breast Height. The outside bark diameter at 1.30 meters (4 ft 3") above the ground level. On slope, ground level is measured from the up hill side of the tree.

Elevation. The altitude above mean sea level that the centre of the plot occurs recorded in metres.

Forest. An ecological system with minimum 10 % crown coverage of land surface.

Indicator. A characteristic of the environment that, when measured, quantifies the magnitude of stress, habitat characteristics, degree of exposure to the stressor, or degree of ecological response to the exposure. For instance, the existence of certain lichens have been used as bioindicators.

Land Cover. That which overlays or currently covers the ground, especially vegetation, permanent snow and ice fields, water bodies, or structures. Barren land is also considered a "land cover" although technically it is lack of cover. The term land cover can be thought of as applying to the setting in which one or more land use (or actions) takes place.

In the FAO Forest Resources Assessment (1990), the following standard terms were defined:

Land Use. The predominant purpose for which an area is employed such as agricultural land, forest land, wetland, urban, transportation and utility corridors.

Location Coordinates. For global purposes, latitude-longitude or Universal Transverse Mercator (UTM) are recommended. If national coordination systems used, conversion formulae to the global standards must be presented.

Log Size. Diameter (most often top diameter) and length of the merchantable portion of a tree.

Monitoring. The periodic measurement or observation of selected physical, chemical, and biological parameters for establishing baselines and for detecting and quantifying changes over time.

Permanent Plot. A plot that is established, monumented, and documented in such a manner so one can remeasure the exact area or same objects at a later time and for which there is an intent and plan for remeasurement.

Plant Species. The major subdivision of a genus or subgenus of a plant being described or measured. Determined from training, by use of key, or by a botanist.

Plot. A known location on the earth's surface having defined boundaries or point of origin.

Slope. The slope in degrees or percentages (45 degrees = 100 %) within the plot or the defined land area.

Stand History. The kind of disturbance (prior to plot establishment) on the sample location. Use past records or visually determine on the plot. 2. - The number of years when the most recent disturbance took place.

Terrain Position. The elevation of the plot compared neighbouring area - higher, lower, or average refer to peak, depression or middle slope, respectively.

Timber Quality. Quality class of the timber.

Tree. Woody perennial having generally one main stem and capable of reaching at least 5 meters at maturity.

Tree Height. The total span of a tree from the ground level to the tip of the tree.

5.5 Wetlands

5.5.1 Overview

Wetlands "occupy the transitional zone between permanently wet and generally dry environments" (Davis, 1994), or are "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" (Cowardin *et al,* 1979). They are critical ecosystems, regulating and maintaining the hydrological condition of rivers, lakes and streams, as well as maintaining water quality by storing nutrients, reducing sediment loads and preventing erosion. Wetlands are important for biodiversity, supporting concentrations of birds (especially waterfowl) by providing essential nesting, migratory and wintering areas; they are critical to fish and wildlife populations and provide important habitat for plants, mammals, reptiles, amphibian and invertebrate species. There is a vital link between many wetlands and the welfare of local communities. The relationship is often strongest in poorer countries where communities may rely directly on wetlands for transport and subsistence, including livestock herding, hunting, fishing and farming. The dependence is now less direct, but no less important, for communities in the more economically developed countries.

The destruction and deterioration of wetlands is widespread: wetlands are among the world's most threatened habitats as a result of drainage, land reclamation, pollution and over exploitation. This results in flooding, scarcity of wildlife, reduced fish and game products, the need for artificial water purification and flood-protection (Maltby, 1986; Finlayson and Moser, 1991). There is now a growing awareness that many wetlands are more valuable in their natural or slightly modified state, than if drained, dyked or built upon. *Wetland Conservation - A Review of Current Issues and Required Action* (Dugan, 1990) is a useful summary outlining the importance of wetlands, looking at reasons for wetland loss and identifying ways and means to improve management.

5.5.2 Development of Classification Systems

Wetlands are frequently complex systems, making monitoring difficult. There may be considerable ecological variation within a single wetland area and many different types of wetland may be found in close proximity (Finlayson and Moser, 1991). Furthermore, different parts of wetland systems are often interlinked with one another and with other dryland or marine systems lying beyond the boundaries of the wetland (Dugan, 1990). However, five major wetland systems are now well recognised (Cowardin *et al*, 1979):

- marine (coastal wetlands including rocky shores and coral reefs)
- estuarine (including deltas, tidal marshes and mangrove swamps)
- lacustrine (wetlands associated with lakes)
- riverine (wetlands along rivers and streams)
- palustrine (marshes, swamps and bogs)
- man-made wetlands, (eg fish and shrimp ponds, farm ponds, irrigated agricultural land, salt pans, reservoirs, gravel pits, water treatment plants and canals).

There is frequent disagreement as to which attributes define spatial distribution. For example, both the limit of tidal influence and the limit of ocean-derived salinity have been proposed for bounding the upstream end of the estuarine systems (Cowardin *et al*, 1979 from Caspers, 1967). In practice, ecosystem boundaries are defined individually for specific applications.

The diversity, complexity, and variation in purpose of wetland habitats, has meant that the classification of wetlands is difficult. Wetlands are dynamic and mapping the exact definition of their boundaries is extremely difficult. Classification schemes have attempted to tackle this complexity problem resulting in highly sophisticated systems. Schemes are either all encompassing, striving to classify all possible wetland types found throughout the world, or are more specific, compiled for one country or region only. Perhaps the best known overall schemes include the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin *et al*, 1979), and the Ramsar classification (Ramsar Convention Bureau, 1990a) which was derived from Cowardin *et al* (1979).

Wetland types are often based on criteria such as water depth, water permanence, water chemistry, life form of vegetation and dominant plant species. For example, the wetland classification detailed in Dugan (1990), based on Scott (1989a) initially classifies wetlands into salt water, freshwater and man-made, then by wetland type (see five major groups above) and then by water permanence (eg perennial, temporary, tidal etc). Wetland classes are also often described amongst land cover/use classifications, eg the CORINE classification (CEC, 1991; CEC, 1993). Wetland types, such as mangroves and peat swamp forests, for example, may be relevant to more than one thematic classification, ie may be covered by both a wetland and forest classification. Relevant definitions for criteria and classes presented above are found in the cited references.

Inventories

One of the first steps to develop effective wetland conservation strategies is to identify important sites and to compile information on them. Regional and national priorities for conservation of wetlands can then be identified. Many inventories and assessments have been compiled at the national, regional and global levels. Noteworthy examples include the International Waterfowl and Wetlands Research Bureau (IWRB) and IUCN regional directories which comprise a series of national reports, each beginning with an introduction summarising the general situation, followed by site accounts of those wetlands which are known or thought to be of greatest importance from the point of view of nature conservation. The site descriptions include basic information on size and location, habitat types, principal vegetation, ownership, degree of protection, land use, fauna, threats, research, conservation and relevant literature (Scott, 1989a; Carp, 1980; Scott and Carbonell, 1986; Hughes and Hughes, 1992; Scott, 1993). These directories often include maps.

In 1993, the Ramsar Convention Bureau compiled a series of regional directories, based on information stored in the Ramsar Database. The four directories (Jones, 1993a; 1993b; 1993c; 1993d) were drafted on the basis of information submitted to the Ramsar Convention Bureau by the Contracting Parties of the Ramsar Convention and were prepared for the Fifth Meeting of the Conference of the Contracting Parties to the Ramsar Convention, Kushiro, Japan, June 1993 (Ramsar Convention Bureau, 1993). The standardisation for information gathering and database entries was facilitated by the use of the *Information Sheet on Ramsar Sites* (see Annex 1) and *Classification System for Wetland Type* specifically designed to guide

Contracting Parties (see The Ramsar Convention below). These directories cover all sites included in the Ramsar "List of Wetlands of International Importance" up to 1 March 1993. Each site description includes a reference to the Ramsar *Criteria* (as approved by Conference Recommendation 4.2 at Montreux in 1990) (Ramsar Convention Bureau, 1990b) under which the site qualifies for designation (see Annex 2 for description of *Criteria*).

Numerous national inventories have also been compiled. The IUCN Wetlands Programme and other international and national collaborating organisations such as IWRB have sponsored a number of these. Inventories for Kenya (Crafter *et al*, 1992) and Brazil (Diegues *et al*, 1994) are examples. Other national examples include the inventories compiled under the Asian Wetland Bureau (AWB) programme, (eg *A Directory of Philippine Wetlands* by (Davies *et al*, 1990), *The Indonesian Wetland Inventory* (Silvius *et al*, 1987) and *Directory of Indian Wetlands* (WWF/India, 1993). All these contain descriptions of important wetlands; some classify wetlands according to "wetland type" (Scott, 1989; WWF/India, 1993) and also include criteria which justify the inclusion of each site, based on the Ramsar *Criteria*.

Site and local level information is also extensive and often available in published form. Examples include *A Preliminary Inventory of Coastal Wetlands of Côte d'Ivoire* (Nicole *et al*, 1994), *The Hadejia-Nguru Wetlands* (Hollis *et al*, 1993), *The IUCN Review of the Southern Okavango Integrated Water Development Project* (IUCN, 1993), and so on.

Mapping

Wetlands are transitional, seasonal and complex, with poorly defined and usually dynamic boundaries, making mapping very problematic. Furthermore, although, for example, the Ramsar Convention defines 6 m depth as the limit of coastal wetlands, it is rare to find such a depth contour specifically mapped. Consequently attempts to map a coastal wetland will encounter two difficulties: defining the ephemeral inland boundaries, and locating the (arbitrary) 6 m depth contour. The former difficulty, in particular, has forced a departure from normal cartographic practice, and it may be necessary to gather data over several years or seasons to be able to depict a wetland in its "proper" place.

Detailed site-level mapping is also difficult due to the complexity of natural habitat mosaics, and the consequently high levels of information required to satisfactorily represent these cartographically. This will vary with scale, and often wetland types have to be aggregated for the sake of clarity and integrity. At sufficiently high resolutions it may be possible to identify individual types but at lower resolutions (smaller scales) it will be necessary to merge types.

A good example of this is the map of major wetlands in the United States (Dahl, 1991) based on the wetland classification described by Cowardin *et al* (1979). This is intended only to give an approximate distribution: due to limitations of scale, small isolated wetlands are not displayed whilst other large, deepwater habitats such as lakes, rivers and reservoirs (not normally considered "wetland"), closely associated with wetlands, are included. There has been no attempt to map the individual wetland types. Instead, wetlands are synthesised into major classes such as "predominantly wetland" or "typified by high density of small wetlands".

Numerous national and regional maps are available. Some of these have been gathered together, digitised and presented in a series of regional map compilations in *Wetlands in Danger* (Dugan, 1993). These spatial data are maintained within WCMCs Geographic Information System (GIS).

5.5.3 Example Classification Systems

Name **The Ramsar Convention**

Description *The Convention on Wetlands of International Importance especially as Waterfowl Habitat,* commonly referred to as the *Ramsar Convention* from its place of acceptance in Iran in 1971, is the intergovernmental treaty which provides the framework for international cooperation for the conservation and wise use of wetlands. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) serves as Depositary for the Convention. The Convention entered into force in 1975 and now has Contracting Parties from all over the world. A useful summary of the objectives, methods of working, activities and achievements of the Convention to date is presented in *The Ramsar Convention Manual - A Guide to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (Davis, 1994).

The Ramsar Convention plays an important role in helping to prevent detrimental changes to wetland sites by providing a global framework, which promotes cooperative, intergovernmental action to enable conservation and sustainable management of wetland areas.

Under the Convention (Article 1.1) wetlands are defined as *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres"*. An addendum provided in Article 2.1. states that wetlands *"may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands"*. The coverage of the Convention therefore also includes rivers, shallow coastal waters and coastal formations such as coral reefs.

On joining the Convention, each Party has to designate at least one site for inclusion in the "List of Wetlands of International Importance" (Article 2.4). To guide Contracting Parties, a set of *Criteria* have been established to identify wetlands of international importance (see Annex 2). To assist accurate and consistent recording of details of each wetland site, an approved "*Information Sheet on Ramsar Wetlands*" has been established (see Annex 1), and also an approved "*Classification System for Wetland Types*" (see Annex 3). An hierarchical portrayal of the latter is given in Annex 4.

Name **Classification of Wetlands and Deepwater Habitats of the United States**

Description The *Classification of Wetland and Deepwater Habitats of the United States* (Cowardin *et al*, 1979) has been officially adopted by the US Fish and

Wildlife Service. To improve national consistency, other Federal and State agencies have been encouraged to use this system which provides a basis for information gathering for most scientific, educational and administrative purposes. The classification system was designed for use over a wide geographic area and for varied end uses.

The structure of the Cowardin classification is hierarchical, moving from systems (wetlands and deep water habitats sharing similar hydrologic, geomorphologic, chemical or biological factors, ie the five major wetland groups mentioned above) and more specific subsystems higher up in the hierarchy down to classes, subclasses and dominance (species) types at the most detailed levels. An example through the hierarchy would be:

System = Palustrine
Class = Moss-lichen wetland
Subclass = Moss
Example dominance type = peat moss (*Sphagnum fuscum*)

The system applies five system names, eight subsystem names, 11 class names, 28 subclass names and an unspecified number of dominance types. Note, however, that the specified dominance types are only examples and that the user can identify additional dominance types and determine where these fit into the classification hierarchy. As a whole, it is a complex system, but if used at one particular site application, for a specific purpose, is straightforward.

Annex 6 contains the Cowardin hierarchy of wetlands and deepwater habitats, showing systems, subsystems, and classes.

5.5.4 Minimum Data Requirements and Database Models

Effective management of wetland information, based on agreed classifications and standard terms, is vital if competent monitoring of these sensitive systems is going to take place. This entails not only compiling more accurate and complete data but also improving access to it. Trends and changes in wetland type or degradation of wetlands can only be assessed if there are accurate historical records available to compare new data with. The most effective method of managing information is within a database. Several applications are now in place which have been specifically designed for wetlands. Some examples include:

Name **Ramsar Database**

Description The "List of Wetlands of International Importance" is maintained in the Ramsar Database which is managed by the International Waterfowl and Wetlands Research Bureau (IWRB) in Slimbridge, UK. Not only does this database enable IWRB to maintain the "List", but empowers IWRB to respond rapidly to reports of changes in ecological character at listed sites. The coding system which is employed for the Ramsar Database, representing Ramsar's Classification of Wetland Type, is presented in Annex 5.

The Ramsar Database holds the following information (Davis, 1994):

- site name
- date of designation
- location
- coordinates, and
- total area
- wetland type (derived from the above mentioned Ramsar classification)
- physical and biological characteristics
- administrative area
- protected area status
- land tenure
- land use (both at the wetland and within its catchment)
- changes in ecological character, and
- physical, socio-economic, floral and faunal values

Name **AWB/PHPA Wetlands Database**

Description The Asian Wetland Bureau (AWB), under the Sumatra Wetland Project, in cooperation with the Directorate General of Forest Protection and Nature Conservation (PHPA) has developed the *Wetland Database Management System* which seeks to improve the conservation and sustainable management of the wetlands of Sumatra (Frazier *et al*, 1992). AWB is currently developing, improving and expanding the *Wetland Database* (WDB) and broadening the focus of the database to include information on important wetlands throughout Indonesia. WDB stores information on aspects which are most important for sustainable management, including:

- location of wetlands
- conservation status of these areas
- land ownership
- the values of wetlands
- habitat types
- animal and plant species
- existing and proposed land uses
- the impacts of activities in wetlands

The *Users Manual* (Frazier *et al*, 1992) is a very useful document which explains the workings of the database and outlines in detail the structure of the WDB. This includes comprehensive descriptions of the structures and coding of the wetland habitats classification used in the database, but also other attribute data such as habitat condition codes, land· use and impact classifications and codes.

Name **CORINE Biotopes Database**

Description CORINE (Coordination of information on the environment), a project for gathering, coordinating and ensuring consistency of information on the state of the environment in the European Community, was established in 1985. One of the main priorities focuses on compiling an inventory of biotopes. A biotope is "an area of land or a water body which forms an ecological unit of Community significance for nature conservation, regardless of whether this area is formally protected by legislation." (CEC, 1991a). The CORINE Biotopes Project was therefore developed to make available an information system to allow nature protection policies to be developed and assessed under an objective framework.

Data were extracted from existing national or regional dataholdings and new data were collected and entered into a database. Later data were entered into a geographic information system to facilitate mapping and spatial analyses and linking CORINE biotope data to other datasets such as topography, land cover etc. In order to achieve consistency in reporting the characteristics of sites in the biotopes, a standard format was designed: the standard site record contains the complete description of one geographical site, descriptive categories include: Site Identification; Site Location; Ecological Information; Species and Site description (CEC, 1991b).

Over 100 wetland types are identified within the CORINE classification system (CEC, 1991a). These are organised under the following major groups: coastal and halophytic communities, non-marine waters, forests, bogs and marshes, inland rocks, screes and sands and agricultural land and artificial landscapes.

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Annex 1: Information Sheet on Ramsar Sites

The Ramsar Convention Bureau (1990) suggest the following data are collected on Ramsar sites:

1. Country
2. Date (or update) of compilation
3. Reference number (for completion by Database Manager)
4. Name and address of compiler
5. Name of wetland
6. Date of Ramsar designation
7. Geographical coordinates
8. General location (nearest large town)
9. Area (in hectares)
10. Wetland type (see above)
11. Altitude (average or maximum and minimum)
12. Overview of site (thumb-nail sketch in two or three sentences)
13. Physical features
    - geology and geomorphology
    - origins (natural or man-made)
    - hydrology (including seasonal water balance, inflow and outflow)
    - soil type and chemistry
    - water quality (physio-chemical characteristics)
    - depth, fluctuations and permanence
    - tidal variations
    - catchment area
    - downstream area (especially in the case of sites important in flood control)
    - climate
14. Ecological features (main habitats and vegetation types)
15. Land tenure (ownership of site and surrounding areas)
16. Conservation measures taken
    - legal status
    - management category
    - management practices
17. Conservation measures proposed (but not yet implemented)
18. Land use (human population, principal human activities and main forms of land use)
19. Possible changes in land use and proposed development projects (major developments likely to have a serious long-term effect)
20. Disturbances and threats (human activities at the site or catchment area which may have a detrimental effect on natural character)
21. Hydrological and biophysical values, (eg recharge and discharge of groundwater, flood control, sediment trapping, prevention of coastal erosion)
22. Social and cultural values, (eg fisheries production, forestry or historical associations, religious significance)
23. Noteworthy fauna
24. Noteworthy flora

25. Scientific research and facilities
26. Conservation education
27. Recreation and tourism
28. Management authority
29. Jurisdiction (territorial, eg state, region or municipality - and functional, eg Dept of Fisheries, Dept of Agriculture
30. References (scientific)
31. Reasons for inclusion (reference to criteria)
32. Outline map of site (to be appended)

Annex 2: Criteria for Identifying Wetlands of International Importance

Article 2.1 of the Ramsar Convention states that "Each Contracting Party shall designate suitable wetlands within its territory for inclusion in a "List of Wetlands of International Importance" which refers to "international significance in terms of ecology, botany, zoology, limnology or hydrology". The criteria below have been approved by the Conference of the Contracting Parties for identifying wetlands of international importance.

Criteria

A wetland is identified as being of international importance if it meets at leat one of the criteria set out below:

1. Criteria for representative or unique wetlands

A wetland should be considered internationally important if:

(a) it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region;

or (b) it is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region;

or (c) it is a particularly good representative example of a wetland, which plays a substantial hydrological, biological or ecologic role in the natural functioning of a major river basin or coastal system, especially where it is located in a trans-border position;

or (d) it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.

2. General criteria based on plants or animals

A wetland should be considered internationally important if:

(a) it support an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species;

or (b) it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna;

or (c) it is of special value as the habitat of plants or animals at a critical stage of their biological cycle;

or (d) it is of special value for one or more endemic plant or animal species or communities.

3. Specific Criteria Based on Waterfowl

A wetland should be considered internationally important if:

(a) it regularly supports 20,000 waterfowl;

or (b) it regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland value, productivity or diversity;

or (c) where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

Guidelines for Application of the Criteria

To assist Contracting Parties in assessing the suitability of wetlands for inclusion in the List of Wetlands of International Importance, the Conference of the Contracting Parties has formulated the following guidelines for application of the Criteria:

(a) A wetland could be considered of international importance under Criterion 1 if, because of its outstanding role in natural, biological, ecological or hydrological system, it is of substantial value in supporting human communities dependent on the wetland. In this context, such support would include:

- provision of food, fibre or fuel;
- or maintenance of cultural value;
- or support of food chains, water quality, flood control or climatic stability.

The support, in all it aspects, should remain within the framework of sustainable use and habitat conservation, and should not change the ecological character of the wetland.

or (b) A wetland could be considered of international importance under Criterion 1, 2 or 3 if it conforms to additional guidelines developed at regional, (eg Scandinavian or West African) or national level. Elaboration of such regional or national guidelines may be especially appropriate:

- where particular groups of animals (other than waterfowl) or plants are considered more suitable as a basis for evaluation;

- or where waterfowl and other animals do not occur in large concentrations (particularly in northern latitudes);

- or where collection of data is difficult (particularly in very large countries).

or (c) The "particular groups of waterfowl, indicative of wetland values, productivity or diversity" in Criterion 3(b) include any of the following:

- loons or divers: Gaviidae;
- grebes: Podicipedidae;
- cormorants: Phalacrocoracidae;
- pelicans: Pelecanidae;
- herons, bitterns, storks, ibises and spoonbills: Ciconiiformes; swans, geese and ducks (wildfowl): Anatidae;
- wetland related raptors: Accipitriformes and Falconiformes; cranes: Gruidae
- shorebirds or waders: Charadrii; and
- terns: ternidae.

or (d) The specific criteria based on waterfowl numbers will apply to wetlands of varying size in different Contracting Parties. While it is impossible to give precise guidance on the size of an area in which these numbers may occur, wetlands identified as being of international importance under Criterion 3 should form an ecological unit, and may thus be made up of one big area or a group of smaller wetlands. Consideration may also be given to turnover of waterfowl at migration periods, so that a cumulative total is reached, if such data are available.

Annex 3: Classification System for Wetland Types

The Ramsar Convention Bureau (1990) provides the following system for classification of wetlands:

1 *MARINE AND COASTAL WETLANDS*

1.1 **Marine waters**. Permanent shallow waters less than 6m deep at low tide; includes sea bays, straits.

1.2 **Subtidal aquatic beds**. Includes kelp beds, sea-grasses, tropical marine meadows.

1.3 **Coral reefs**.

1.4 **Rocky marine shores**. Includes rocky offshore islands, sea cliffs.

1.5 **Sand, shingle or pebble beeches**. Includes sand bars, spits, sandy islets.

1.6 **Estuarine waters**. Permanent waters of estuaries and estuarine systems of deltas.

1.7 **Intertidal mud, sand or salt flats**.

1.8 **Intertidal marshes**. Includes saltmarshes, salt meadows, saltings, raised saltmarshes, tidal brackish and freshwater marshes.

1.9 **Intertidal forested wetlands**. Includes mangrove swamps, nipa swamps, tidal freshwater swamp forests.

1.10 **Brackish to saline lagoons** with one or more relatively narrow connections with the sea.

1.11 **Freshwater lagoons and marshes** (coastal zone). Includes delta lagoon and marsh systems.

2 *INLAND WETLANDS*

2.1 **Permanent rivers and streams**. Includes waterfalls.

2.2 **Seasonal and irregular rivers and streams**.

2.3 **Inland deltas** (permanent).

2.4 **Riverine floodplains**. Includes river flats, flooded river basins, seasonally flooded grassland, savanna and palm savanna.

2.5 **Permanent freshwater lakes** (over 8ha). Includes large oxbow lakes.

2.6 **Seasonal freshwater lakes** (over 8ha), floodplain lakes.

2.7 **Permanent and seasonal, brackish, saline or alkaline lakes**, flats and marshes.

2.8 **Permanent freshwater ponds** (below 8ha), marshes and swamps on inorganic soils with emergent vegetation waterlogged for at least most of the growing season.

2.9 **Seasonal freshwater ponds** and marshes on inorganic soil. Includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

2.10 **Shrub swamps**. Shrub-dominated freshwater marsh, shrub carr, alder thicket; on inorganic soils

2.11 **Freshwater swamp forest**. Seasonally flooded forest, wooded swamps; on inorganic soils.

2.12 **Peatlands**. Shrub or open bogs, fens.

2.13 **Forested peatlands**. Peat swamp forest.

2.14 **Alpine and tundra wetlands**. Includes alpine meadows, tundra pools, temporary waters from snowmelt.

2.15 **Freshwater springs**, oases.

2.16 **Geothermal wetlands**.

3 *MAN-MADE WETLANDS*

3.1 **Water storage areas**. Reservoirs, barrages, hydro-electric dams, impoundments (generally over 8ha).

3.2 **Ponds**. Includes farm ponds, stock ponds, small tanks (generally below 8 ha).

3.3 **Aquaculture ponds**. Fish ponds, shrimp ponds.

3.4 **Salt exploitation**. Salt pans, salines.

3.5 **Excavations**. Gravel pits, borrow pits, mining pools.

3.6 **Wastewater treatment**. Sewage farms, settling ponds, oxidation basins.

3.7 **Irrigated land and irrigation channels**. Rice fields, canals, ditches.

3.8 **Seasonally flooded arable land**, farm land.

Annex 4: Coding System for Wetland Types

The classification system provided in Annex 3 is portrayed in hierarchical form below.

Type	Level 1	Level 2	Level 3	Level 4
		Subtidal		Shallow marine waters
	Marine		Aquatic bed	Marine aquatic beds
			Reef	Coral reefs
	Intertidal	Rocky	Rocky	marine shores
			Unconsol	Sand/shingle beeches
Marine		Subtidal		Estuarine waters
&	Estuarine		Unconsol	Intertidal mudflats
Coastal		Intertidal	Emergent	Salt marshes
			Forested	Mangrove, tidal forest
	Lacustrine	Permanent		Brackish/saline lagoons
	Palustrine	Seasonal		Coastal fresh lagoons
		Perennial		Permanent river/stream
	Riverine		Emergent	Inland deltas
		Intermittent		Intermittent river/stream
			Emergent	Floodplain wetlands
	Lacustrine		Permanent	Permanent freshwater lakes
		Seasonal		Seasonal freshwater lakes
		Permanent		Permanent/seasonal saline
		Seasonal		Lakes and marshes
Inland				Permanent freshwater ponds and marshes
			Emergent	Open peat bogs, fens
				Alpine/tundra wetlands
	Palustrine	Permanent	Shrub-dom	Shrub-dominated swamps
			Forested	Freshwater swamp forest
				Peat swamp forest
				Freshwater springs, oases
		Seasonal	Emergent	Seasonal freshwater marsh
	Geothermal			Geothermal wetlands
	Aquaculture			Fish, shrimp ponds

		Farm ponds, small tanks
	Agriculture	Irrigated land, rice fields
		Seasonally-flooded arable land
Man-made		
	Salt exploitation	Salt pans, salines
	Urban/Industrial	Reservoirs, barrages
		Gravel pits
		Sewage farms

Annex 5: Database Coding for Ramsar Wetland Type Classification

	Wetland Habitat Types	Code
Marine and Coastal		
Marine	- shallow marine waters	A
	- marine beds	B
	- coral reefs	C
	- rocky shores	D
	- sand/shingle shores (including dune systems)	E
Estuarine	- estuarine waters	F
	- tidal mudflats (incl. intertidal flats & sandflats)	G
	- salt marshes	H
	- mangroves/tidal forest	I
Lacustrine/Palustrine	- coastal brackish/saline lagoons	J
	- coastal fresh lagoons	K
Inland		
Riverine	- deltas	L
	- rivers/streams/creeks: permanent	M
	- rivers/streams/creeks: seasonal/intermittent	N
Lacustrine	- freshwater lakes: permanent	O
	- freshwater lakes: seasonal/intermittent	P*
	- saline brackish lakes: permanent	Q
	- saline brackish lakes: seasonal/intermittent	R*
Palustrine	- saline/brackish marshes: permanent	Sp
	- saline/brackish marshes: seasonal/intermittent	Ss*
	- freshwater marshes/pools: permanent	Tp
	- freshwater marshes/pools: seasonal/intermittent	Ts*
	- peatlands (peat bogs, swamps, fens)	U
	- alpine wetlands	Va
	- tundra wetlands	Vt
	- shrub-dominated wetlands	W*
	- tree-dominated wetlands (incl. swamp forest)	X*
	- freshwater springs (including oases)	Y
Geothermal	- geothermal wetlands	Z

KEY: * Includes floodplains wetlands such as seasonally inundated grasslands (including natural wet meadows), shrublands, woodlands or forest.

Source: Frazier (1994, Pers. Comm.)

	Wetland Habitat Types	Code
Man-made		
Aquaculture	- fish/shrimp ponds	1
Agriculture	- farm ponds, small tanks	2
	- irrigated land (including rice fields)	3
	- seasonally flooded agricultural land	4#
Salt exploitation	- salt pans, salines	5
Urban/Industrial	- reservoirs/barrages/dams	6
	- gravel/brick/clay pits	7
	- sewage farms	8
	- canals	9
No information		0

KEY: # To include intensively managed or grazed pasture or wet meadow.

Annex 6: The Cowardin Hierarchy of Wetlands and Deepwater Habitats

SYSTEM	SUBSYSTEM	CLASS
Marine	Subtidal	Rock bottom Unconsolidated bottom Aquatic bed Reef
	Intertidal	Aquatic bed Reef Rocky shore Unconsolidated shore
Estuarine	Subtidal	Rock bottom Unconsolidated bottom Aquatic bed Reef
	Intertidal	Aquatic bed Reef Stream bed Rocky shore Unconsolidated shore Emergent wetland Scrub-shrub wetland Forested wetland
Riverine	Tidal	Rock bottom Unconsolidated bottom Aquatic bed Rocky shore Unconsolidated shore Emergent wetland
	Lower Perennial	Rock bottom Unconsolidated bottom Aquatic bed Rocky shore Unconsolidated shore Emergent wetland
	Upper Perennial	Rock bottom Unconsolidated bottom Aquatic bed Rocky shore Unconsolidated shore
	Intermittent	Streambed

Lacustrine	Limnetic	Rock bottom Unconsolidated bottom Aquatic bed
	Littoral	Rock bottom Unconsolidated bottom Aquatic bed Rocky shore Unconsolidated shore Emergent wetland
Palustrine		Rock bottom Unconsolidated bottom Aquatic bed Unconsolidated shore Moss-lichen wetland Emergent wetland Scrub-shrub wetland Forested wetland

KEY: Rock bottom = bedrock, rubble
Unconsolidated bottom = cobble-gravel, sand, mud, organic
Aquatic bed = algal, rooted vascular, floating, aquatic moss
Unconsolidated shore = cobble-gravel, sand, mud, organic, vegetated
Streambed = bedrock, rubble, cobble-gravel, sand, mud, organic, vegetated
Emergent wetland = persistent, nonpersistent
Moss-lichen wetland = moss, lichen
Rocky shore = bedrock, rubble
Scrub-shrub wetland = needleleaved evergreen, broadleaved evergreen, needleleaved deciduous, broadleaved deciduous, dead
Forested wetland = needleleaved evergreen, broadleaved evergreen, needleleaved deciduous, broadleaved deciduous, dead

5.6 Coastal and Marine Habitats

5.6.1 Overview

Most of the world's biological diversity at higher taxa levels is marine. Of 33 known phyla, 32 include marine taxa; 15 exclusively (Agardy, 1994). Studies of some marine environments, particularly bottom sediments, show extremely high levels of invertebrate species diversity, the majority comprising previously unknown species (WCMC, 1994). Recent taxonomic advances in marine biology have revealed that many broad-spectrum species are actually arrays of sibling species[5] with narrower and slightly different ecological requirements (Knowlton and Jackson, 1994). This results in a three to five fold increase in species diversity in many marine fauna than previously recognised. These findings highlight the importance of reliable taxonomic classification and its implications for maintaining biodiversity in marine environments.

The rationale for protecting marine biodiversity (as for other forms of biodiversity) can be approached from several directions: protection of fundamental biosphere services (Wilson, 1988); the deep ecology ethos (Nations, 1988); and economic valuation of the environmental products and services (Pearce and Moran, 1994). Whichever approach is taken, standards in biodiversity information management are fundamental in combatting the manifold threats to marine environments.

Reliable classification systems are at the heart of marine conservation, research and monitoring (Maragos, 1992). Data standards serve many purposes, but most importantly to allow researchers to draw accurate conclusions about the rate and magnitude of environmental change. This information is provided to policy-makers to plan and develop socio-economic policies and environmental legislation to protect marine and coastal environments. Compatibility of standards in databases and electronic format facilitates sharing, updating, interpretation and utilisation of data. For example, oil spill contingency planners in emergency situations require rapid access to data to contain the spill and protect vulnerable coastal and marine habitat and fauna.

5.6.2 Classification Systems and Standards

There are currently no widely accepted global marine habitat classification systems. Institutions that develop classification systems do so for a variety of reasons related to their areas of concern or jurisdiction, for example the protection of sea turtle breeding grounds; shorebird breeding or migration stopover sites; and specific geomorphological features such as coral reefs or limestone caves. The Commission on National Parks and Protected Areas (CNPPA) identified the need to develop an appropriate marine biogeographical classification scheme on global, regional and national levels as a basis for ensuring adequate representation of different marine ecosystems in a range of marine protected areas (Hayden *et al*, 1984).

[5]Sibling species are species that are difficult or impossible to distinguish based on morphological characters (Knowlton and Jackson, 1994).

The ocean's complex three dimensional nature requires some departure from the approaches used for most terrestrial systems. The ocean is often divided into: (i) coastal systems (neritic) (eg estuaries, coral reefs, mangroves); (ii) benthic (bottom associated) systems; and (iii) pelagic (open water) systems. The pelagic zone is separated into epipelagic, mesopelagic and bathypelagic divisions. Coastal classification is largely based on landforms and physical processes (Caddy and Bakun, 1994); marine realms have been treated both physically (eg water masses) and biotically (eg species assemblages), with no one method dominating (Hayden *et al*, 1984).

Coasts are dynamic over a range of time scales, from short term fluctuations (over a few weeks or months) to long term changes over thousands of years. Similar processes characterize inter-related shore environments: thus sand dune ecosystems show seasonal changes in productivity, biomass and thus sand-trapping ability, but are also influenced by long-term successional changes in species composition. Dynamics, and the range of possible landform change, must be allowed for inshore management policies. Many coastal problems result from attempts to "fossilize" a particular shoreline configuration or habitat. Such management policies then face expensive remedial action to re-establish quasi-national patterns of landform change and ecosystem function.

Since coasts are dynamic and neither purely terrestrial or purely oceanic, definitions will suffice for its classification. To delineate coastal zones, Clark (1992) discusses using the "25-year flood line", a coastal highway or a 5m topographic line. Classification of the pelagic zone must consider that oceans are contiguous and marine species have generally greater ranges than terrestrial species. The challenge is to design a classification system that facilitates the inclusion of three-dimensional data and covers all the "important" categories while remaining as simple as possible.

Global Scale

Although there is no *one* definitive global classification for coastal and marine systems, important global systems have been developed. Inman and Nordstrom (1971) developed a classification system based on tectonic setting. Briefly summarized it classifies coasts into collision coasts (active coasts), trailing edge coasts (passive coasts) or marginal coasts (back arc basins). In addition, Inman and Nordstrom (1971) identify three coastal morphological length scales, termed first-, second- and third order. First order have dimensions of 100km alongshore, 100km across and 10km in height from ocean floor to the continental summit. Second-order coasts have dimensions of 100, 10 and 1km, and at this level it is valuable to differentiate morphological features such as submarine canyons, estuaries and rocky cliffs. Third-order coasts have dimensions of 1, 0.1, and 0.01km at which level localised coastal processes such as wave and tide action, (eg beaches, inlets, tidal creeks) can be observed (Inman and Nordstrom, 1971).

Coasts are also classified by means of wave processes (Davies, 1980). Low-latitude coasts are mainly influenced by swell waves and high-latitude coasts by protection from waves and ice. Davies divides coasts based on the categories: predominately storm wave environments; predominately protected sea environments; and predominately swell environments.

In 1990, a group of agencies[6] developed a hierarchical classification and conservation criteria for ecosystems in the tropical insular Pacific region (Bailey *et al*, 1991). Their report includes an example of a complete biosphere ecosystem classification system, that can be viewed as a model for systems in other regions. Bailey *et al* (1991) also presents a critique of classification systems and a comparison with Global Marine Classification Systems for the tropical Pacific produced by Crawford and Grossman (1990) (Annex 1). The system has recently been revised by (Holthus, in press) and the major marine ecosystem divisions and sub-divisions are included in Annex 2.

Finally, at the global level it is fundamentally important to establish a framework to which regional classification systems can be attached to the same level of differentiation of distinct types.

National and Regional Scale

The American classification system of wetlands and deepwater habitats describes ecological taxa for use by resource managers, to furnish mapping units with data and to provide uniformity of concepts and terms (Cowardin, 1979)[7]. The system is hierarchical, progressing from systems[8] to subsystems. The classification is generally based on classes, subclasses and dominance types. The five major systems identified are: marine; estuarine; riverine; lacustrine and palustrine. To more fully describe aquatic habitats, modifiers for water regime, water chemistry, and soils are used.

A second example is found in the National Oceanic and Atmospheric Administration (NOAA) 1993 report for the United States, that identifies three general types of information collected to construct the Environmental Sensitivity Mapping for Marine Systems: (i) habitats; (ii) subtidal biological resources; and (iii) human-use resources. In order to meet its primary objective of environmental protection, it classifies marine environments according to "sensitivity" indices of coastal habitats by ranking intertidal shoreline types, degree of exposure, shoreline slope and substrate type.

The Biomar Programme is co-funded by the Commission of the European Communities. The Marine Nature Conservation Review (MNCR), working under the Joint Nature Conservation Committee (JNCC) has developed a structured classification of marine biotopes for the NE Atlantic (Connor *et al*, in press). The classification aims to include all marine and brackish water habitats that occur around the UK and Ireland, and will allow for the inclusion of biotopes from other NE Atlantic coastal areas. The system allows users to make objective

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[6]These included six agencies: the East-West Centre, Environment and Policy Institute (EWC EAPI); the South Pacific Regional Environment Programme (SPREP); The Nature Conservancy, Science and Pacific Divisions (TNC); the USAID Agency for International Development, South Pacific Regional Development Office (AID/RDO/SP); the USDI Fish and Wildlife Service (USDI FWS); and the World Wide Fund for Nature (WWF).

[7]Also refer to section 5.5 Wetlands.

[8]System refers to a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical or biological factors.

inter-site comparisons of data. The classification will be used to develop marine elements of the European CORINE Classification.

One final example is provided by the Intergovernmental Oceanographic Commission (IOC), United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO). It is a long-term Global Monitoring System of Coastal and Nearshore Phenomenon Related to Climate Change. The system is the coastal component of the Global Ocean Observing System (GOOS); itself a part of Global Climate Observing System (GCOS). The table below identifies major fields in the geosphere, biosphere and socio-cultural arena, in which parameters need to be measured to assess changes in coastal zones. This system accommodates data capture from global to sampling levels, and provides a consistent terminology to distinguish between areas chosen for study (Pernetta, 1993):

	Category	**Description**
(i)	Country	Name of country owning waters.
(ii)	Location	General geographic area (scale 100s km)
(iii)	Monitoring Area	Focal area for the programme (scale 10s km) including islands, major reefs.
(iv)	Site	Subset of the monitoring area where studies made (scale 1 km)
(v)	Transect/Quadrat	Number of the replicate survey.

5.6.3 Data Definitions and Models

Standards have yet to emerge for the collection of data on marine and coastal environments, particularly on a global scale. However, some guidelines are presented in Clark (1992) and Pernetta (1993). Moreover, the databases being used for coastal and marine habitats provide some practical examples of data collection requirements.

At the regional level, Bailey *et al* (1991) contains an extensive list of data definitions used in the Tropical Insular Pacific Ecosystem classification that may be useful for other databases projects. UNESCO and the Centre for Oceanological Research and Development (1986) provides an example of a metadatabase (also referred to as a tertiary database) and a standardised data dictionary. The same document discusses database design, and recommends the importance of establishing a data dictionary as soon as the entries within the data become identified since future data security depends on it.

ASFA, MINISIS, and SEAFIS are examples of marine bibliographic databases covering different regions. Examples of shallow marine biodiversity databases are given below:

Name **ReefBase**

Description A global, ecosystem-based database currently being developed at the International Center for Living Aquatic Resources Management (ICLARM), Manila, The Philippines. It will include data covering fisheries, management, species inventories, oceanography and geomorphology at the level of individual reefs and will incorporate reef maps being produced at the World Conservation Monitoring Centre. First release: Early 1996.

Name **FishBase**

Description	A global fisheries and taxonomic database, including distribution datasets and catch statistics, developed at ICLARM. Currently contains data for 12,000 taxa.
Name	**Coral Reef Fish Mapping Database**
Description	A simple relational database being established under the auspices of the IUCN Coral Reef Fishes Specialist Group plotting the known distributions of over 1500 taxa.
Name	**CoralBase**
Description	A global taxonomic database, giving distribution data for all scleractininan coral taxa, produced and maintained by the Australian Institute of Marine Science.
Name	**Biodiversity Map Library**
Description	An ARC/INFO application developed by the World Conservation Monitoring Centre. Currently handles global data relating to habitats, species, protected areas and other regions of conservation concern.
Name	**SPREP Biodiversity Conservation Database**
Description	A regional database currently in the early stages of development. It will include information on species, ecological and genetic diversity, gathered at a national level.

The *Guidelines for Developing Digital Environmental Sensitivity Index Atlases and Databases* (NOAA, 1993) is a starting point from which spill response organisations can begin to reach a consensus on a consistent approach for developing environmental sensitivity maps. The guideline document provides a description of the database structure (field names, formats and description) for Environmental Sensitivity Index (ESI) database files. The ten coastal sensitivity rankings are described below:

ESI = 1	Exposed, impermeable vertical surfaces
ESI = 2	Exposed, impermeable substrates, non-vertical
ESI = 3	semi-permeable substrate, low potential for oil penetration and burial; infauna present but not usually abundant
ESI = 4	Medium permeability, moderate potential for oil Penetration and burial; infauna present but not usually abundant
ESI = 5	Medium-to-high permeability, high potential for oil penetration and burial; infauna present but not usually abundant
ESI = 6	High permeability, high potential for oil penetration and burial
ESI = 7	Exposed, flat, permeable substrate; infauna usually abundant
ESI = 8	Sheltered impermeable substrate, hard; epibiota usually abundant
ESI = 9	Sheltered, flat, semi-permeable substrate, soft; infauna usually abundant
ESI = 10	Vegetated wetlands

A second example of a marine database structure was developed by a project funded by

UNESCO and the Centre for Oceanological Research and Development in the document *Regional Workshop on Marine Science Micro-computer Database Development* (UNESCO, 1986). It presents examples of a primary "attribute" database relating to coral reef ecological characteristics in which measurements on a subset of standard variables are recorded using five fields. In most cases several such databases might be related to one master table which could contain all the results of a particular study or project. Of note, the primary databases could follow a number of formats.

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Annex 1: Global Marine Classification Systems

Author	Level	Level 1	Level 2	Level 3	Level 4	Level 5	Comments
Pielou (1979)	5	Realms (Biosphere): shelf deep ocean	Habitat: pelagic benthic	Life Mode: nekton nueston plankton epifauna infauna	Benthic depth zones and pelagic water mass zones	Subzones based on light penetration and temperature range	Neritic realm unclassified continental shelves are extensions of adjoining terrestrial realms
Ray (1975) Hayden *et al* (1984)	5	Biomes (geographical) : open ocean coastal margin marginal sea marginal archipelago	Realms: 10 units based upon surface currents and related atmospheric winds	Provinces 40 units based upon coastal associations	Habitat (benthic) 30 units based upon dominance of substrate, flora or fauna	Habitat modifiers greater specificity on dominant life forms, sediment size, etc.	Classification based on relationship of physical environment to marine biotic provinces defined emphasis on temperature and boreal biota
Ketchum (1972)	1	Regions 12 units based upon seasonal variation, circulation patterns and key species, eg insular, precipitous mountains, heavy wave action, tropical & subtropical endemism.					Limited to neritic zone of North America based on zoogeography physiognomy currents, and climate
Cowardin *et al* (1979)	5	System "complex": marine lacustrine estuarine riverine palustrine	Subsystem: marine intertidal marine subtidal estuarine intertidal estuarine subtidal riverine tidal riverine lower perennial riverine upper perennial riverine intermittent lacustrine limnetic lacustrine littoral	Class: general appearance of habitat based on dominant life form or substrate composition/ physiography (visible from remote imagery)	Subclass - finer scale description of dominant life form or substrates, eg coral mollusc worm bedrock rubble algal mat, etc	Dominance type taxonomic name of dominant life forms, plant, animal or both	System is open ended below the class level heavily orientated towards continental systems Crawford and Grossman suggests including geological terms in substrate dominated community name
Brigs (1974)	4	Geographic Divisions: continental shelf open sea deep sea	Oceans: Tropical Southern Northern	Regions (9 total): For TROPICAL OCEAN these are Indo-West Pacific Eastern Pacific Western Atlantic Eastern Atlantic	Provinces (30 total) based upon prevailing wind and current patterns and reflected in recruitment patterns of key species		Crawford & Grossman believe the system is impossible to adapt to marine classification scheme useful to conservation, but considerable useful information

Source: Adapted from Crawford and Grossman (1990).

Annex 2: Major Marine Ecosystem Divisions and Sub-divisions

A.B. BENTHIC ECOSYSTEMS

A.B.A. CONTINENTAL SHELF (NON-OCEANIC) ECOSYSTEMS

1. Earthform - high Island

(Geology modifiers: Continental; Volcanic; Limestone; Mixed Geology)

1.1 Coast - Non-Coral Reef

1.1.1 Area - Shore

1.1.1.1 Coastline - Undifferentiated (scale: 10 km)

1.1.1.1.1 Shoreline - Sediment

(Sediment Type modifiers: Calcareous; Terrigenous

1.1.1.1.1.1 Beach Boulder/Cobble

1.1.1.1.1.2 Beach Sand/Gravel

1.1.1.1.1.3 Beachrock

1.1.1.1.1.4 Boulder/Cobble Field

1.1.1.1.1.5 Sand/Gravel Flats

1.1.1.1.1.6 Mud/Silt Flats

1.1.1.1.1.7 Bar and Spit

1.1.1.1.1.8 Mangrove

1.1.1.1.2 Shoreline Solid Substrate

1.1.1.1.2.1 Cliff - High (ht >10m)

1.1.1.1.2.2 Cliff - Medium (ht 2-10m)

1.1.1.1.2.3 Cliff - Low (ht <2m)

1.1.1.1.2.4 Stack

1.1.1.1.2.5 Talus

1.1.1.1.2.6 Bench/Ramp Marine

1.1.1.1.2.7 Notch/Cave - Marine

1.1.1.1.3 Shoreline - Artificial

1.1.1.1.3.1 Seawall/Revetment/Bulkhead

1.1.1.1.3.2 Landfill/Causeway/Groin

1.1.1.1.3.3 Fishpond/Fishtrap/Shipwreck

1.1.1.2 Coastline Cove (scale: 10 km)

(as in 1.1.1.1)

1.1.1.3 Coastline - Bay (scale: 10 km)

(as in 1.1.1.1)

(Salinity modifiers: Marine; Estuarine)

1.1.1.4 Coastline - Coastal Lagoon/Lake/Pond (scale: 10 km)

(as in 1.1.1.1)

(Connectedness modifiers:
Subtidal lagoon/Subtidal Connection;
Subtidal Lagoon/Intertidal Connection;
Intertidal lagoon/Intertidal Connection (Barachois))

(Salinity modifiers: Marine; Estuarine)

1.1.1.5 Coastline - Peninsula (scale: 10 km)

(as in 1.1.1.1)

1.1.1.6 Coastline - Irregular/Discontinuous/Islets

(as in 1.1.1.1)

1.1.2 Area - Nearshore Bottom
(Steepness/slope Gradient modifiers:#...)
1.1.2.1 High Islet - Ocean
(as in 1.1.1.1)

1.2 Coast - Fringing Reef

1.2.1 Area - Shore
(as in 1.1.1)

1.2.2 Area Fringing Reef
(Exposure modifiers: Windward; Leeward

1.2.2.1 Reef Top
(Reef Top Width modifier:#...)

1.2.2.1.1 Reef Top Surface Features
1.2.2.1.1.1 Reef Pavement
1.2.2.1.1.2 Sand/Rubble/Rockflats
1.2.2.1.1.3 Mud/silt Flats
1.2.2.1.1.4 Sand/Gravel Flats
1.2.2.1.1.5 Boulder/Cobble Field
1.2.2.1.1.6 Rubble/Boulder Tract
1.2.2.1.1.7 Coral Bed/Microatolls
1.2.2.1.1.8 Algal Bed
1.2.2.1.1.9 Seagrass Bed
1.2.2.1.1.10Algal Ridge
1.2.2.1.1.11Surge Channel

1.2.2.1.2 Reef Top Subtidal Features
1.2.2.1.2.1 Hoa (Inter-Islet Channel)
1.2.2.1.2.2 Moat and Depression
1.2.2.1.2.3 Reef Pool (depth <5m)
1.2.2.1.2.4 Reef Hole (depth >5m)
1.2.2.1.2.5 Incomplete Reef Top
1.2.2.1.2.6 Dredge Pit/Quarry/Channel/Basin

1.2.2.1.3 Reef Top Supratidal Features
1.2.2.1.3.1 Storm Block
1.2.2.1.3.2 Gravel/Boulder Ridge
1.2.2.1.3.3 Beachrock
1.2.2.1.3.4 Conglomerate/Reef Limestone Platform
1.2.2.1.3.5 Aeolianite
1.2.2.1.3.6 Coral/Algal Dam and Spillway
1.2.2.1.3.7 Mangrove
1.2.2.1.3.8 Fishpond/Fishtrap/Shipwreck

1.2.2.1.4 Passes/Reef Top Openings
(No. Passes modifier:#...) (Depth/Width modifier:#...)
(Amount of Perimeter modifier:#...)
(% of Reef Perimeter modifier:%...)
1.2.2.1.4.1 Pass - Shallow (depth <10m; width <2km)
1.2.2.1.4.2 Pass - Deep (depth >10m; width <2km)
1.2.2.1.4.3 Reef Top Opening - Shallow (depth <10m; width >2km)

1.2.2.1.4.4 Reef Top Opening - Deep (depth >10m; width >2km)
1.2.2.1.4.5 Pass - False
1.2.2.1.4.6 Channel - Fringing Reef
1.2.2.1.4.7 Channel - Artificial
1.2.2.2 Reef Islets
(Reef Islet Size modifier:#...)
(Linear Ocean Extent modifier:#...)
(% of Reef Perimeter modifier: %...)
(No. of Reef Islets modifier:#...)
(Water Body modifiers: Barachois; Anchialine Pond)
1.2.2.2.1 Shoreline - Sediment
(Orientation modifiers: Outer/Ocean; Inner/Lagoon/Shore)
(as in 1.1.1.1.1)
1.2.2.2.2 Shoreline - Solid Substrate
(Orientation modifiers: Outer/Ocean; Inner/Lagoon/Shore)
(as in 1.1.1.1.2)
1.2.2.2.3 Shoreline; Artificial
(as in 1.1.1.1.3)
1.2.2.3 Reef Slope - Outer
(Steepness/Slope Gradient modifiers:#...)
(Substrate modifiers: Calcareous; Terrigenous; Volcanic)
1.2.2.3.1 Reef Slope Features (Non-Terrace)
1.2.2.3.1.1 Spur and Groove
1.2.2.3.1.2 Tunnel (Room and Pillar)
1.2.2.3.1.3 Buttress and Valley
1.2.2.3.1.4 Reef Edge Scarp
1.2.2.3.1.5 Slope - Coral
1.2.2.3.1.6 Slope - Coral/Sediment
1.2.2.3.1.7 Slope - Solid Substrate
1.2.2.3.1.8 Slope - Sand
1.2.2.3.1.9 Slope - Sand/Rubble/Rock
1.2.2.3.1.10Slope - Boulder/Block
1.2.2.3.1.11Submarine cliff
1.2.2.3.1.12Submarine Wall
1.2.2.3.1.13Submarine Notch/Cave
1.2.2.3.2 Reef Slope Terrace/Submarine Platform Features
(Terrace/Submarine Platform Width modifier:#...)
(Surface modifiers: with Furrows)
1.2.2.3.1.1 Terrace/Submarine Platform - Coral
1.2.2.3.1.2 Terrace/Submarine Platform - Coral/Sediment
1.2.2.3.1.3 Terrace/Submarine Platform - Solid Substrate
1.2.2.3.1.4 Terrace/Submarine Platform - Sand
1.2.2.3.1.5 Terrace/Submarine Platform - Sand with Coral Mounds
1.2.2.3.1.6 Terrace/Submarine Platform - Sand/Rubble/Rock
1.2.2.3.1.7 Terrace/Submarine Platform - Boulder/Block
1.2.3 Area Nearshore Bottom (as in 1.1.2)

1.3 Coast - Barrier Reef

1.3.1 Area - Shore
(as in 1.1.1)

1.3.2 Area - Lagoon Fringing Reef
(as in 1.2.2)

1.3.3 Area Lagoon
(Lagoon Size modifier: #...) (Lagoon Depth modifier: #...)
(Lagoon Area modifiers: Sub-Lagoon(s); Perched Lagoon)
(No. of Patch Reefs/Pinnacles modifier: #...)

1.3.3.1 Reef Top- Patch Reef/Pinnacle
(as in 1.2.2.1)

1.3.3.2 Reef Top- Reticulate Reef
(as in 1.2.2.1)

1.3.3.3 Reef Islets - Patch Reefs
(as in 1.2.2.2)

1.3.3.4 Reef Slope - Patch Reef/Pinnacle
(as in 1.2.2.3)

1.3.3.5 Reef Slope - Reticulate Reef Slope

1.3.3.6 Lagoon Floor

1.3.3.6.1 Lagoon Floor- Shallow Lagoon (<10 m deep)

1.3.3.6.2 Lagoon Floor Algal Mound

1.3.3.6.3 Lagoon Floor Deep

1.3.3.8 High Islet - Lagoon
(as in 1.1.1.1, 1.2.2.1-1.2.2.3)

1.3.4 Area - Barrier Reef
(Exposure modifiers: Windward; Leeward)

1.3.4.1 Reef Top
(as in 1.2.2.1)

1.3.4.2 Reef Islets
(as in 1.2.2.2)

1.3.4.3 Reef Slope - Outer
(as in 1.2.2.3)

1.3.4.4 Reef Slope Lagoon
(as in 1.2.2.3)

1.3.5 Area - Nearshore Bottom
(as in 1.1.2)

2. Earthform - Atoll/Table Reef/Low Island (height <10m)
(as in A.B.B.2.)

3. Earthform Submerged

3.1 Reef/Shoal - Nearshore

3.2 Reef/Shoal/Bank - Mid-Shelf

3.3 Reef/ShoalBank - Outer Reef

3.4 Plain - Nearshore

3.5 Plain - Offshore

3.6 Canyon

3.7 Continental Slope

A.B.B. OCEANIC (NON-CONTINENTAL) ECOSYSTEMS

1. Earthform - High Island

(High Island modifier: Almost-Atoll)

1.1 Coast Non-Coral Reef

1.1.1 Area - Shore
(as in A.B.A.1.1.1)

1.1.2 Area - Nearshore Bottom
(as in A.B.A.1.1.2)

1.1.4 Area- Deep Bottom

1.1.4.1 Bathyal (200-4000m)

1.1.4.2. Abyssal (4000-7000m)

1.1.4.3 Hadal (>7000m)

1.2 Coast - Fringing Reef

1.2.1 Area - Shore
(as in A.B.A.1.1.1)

1.2.2 Area Fringing Reef
(as in A.B.A.1.2.2)

1.2.3 Area- Nearshore Bottom
(as in A.B.A.1.1.2)

1.2.4 Area - Deep Bottom
(as in A.B.B.1.1.4)

1.3 Coast - Barrier Reef

1.3.1 Area - Shore
(as in A.B.A.1.1.1)

1.3.2 Area - Lagoon Fringing Reef
(as in A.B.A.1.2.2)

1.3.3 Area - Lagoon
(as in A.B.A.1.3.3)

1.3.4 Area - Barrier Reef
(as in A B.A.1.3.4)

1.3.5 Area - Nearshore Bottom
(as in A.B.A.1.1.2)

1.3.6 Area - Deep Bottom
(as in A B.B.1.1.4)

2. Earthform - Atoll/Table Reef/Low Island (height <10 m)

2.1 Atoll - Many Deep Passes/Open

(Atoll Perimeter Length) modifier:#...)

2.1.1 Area - Lagoon
(as in A.B.A.1.3.3; excluding 1.3.3.7)

2.1.2 Area - Perimeter Reef
(Reef Islet Type modifier: Type 1; Type 2; Type 3; Type 4
(as in A.B.A.1.3.4)

2.1.3 Area - Nearshore Bottom
(as in A.B.A.1.1.2; excluding 1.1.2.1)

2.1.4 Area - Deep Bottom
(as in A.B.B.1.1.4)

2.2 Atoll - Few/One Deep Pass(es) (pass depth >5m)
(as in A.B.B.2.1)
2.3 Atoll - No Deep Pass
(as in A.B.B.2.1)
2.4 Atoll - Completely Land-ringed
(as in A.B.B.2.1)
2.5 Table Reef - Reef Islet with Water Body
(as in A.B.B.2.1; excluding 2.1.1)
2.6 Table Reef - Reef Islet without Water Body
(as in A.B.B.2.1; excluding 2.1.1)
2.7 Table Reef - no Reef Islet
(as in A.B.B.2.1; excluding 2.1.1)

3. Earthform - Submerged
3.1 Submerged Atoll-Reef (upper surface depth <20m)
3.1.1 Near Surface (<200m)
3.1.2 Bathyal (200-4000m)
3.1.3 Abyssal (4000-7000m)
3.1.4 Hadal (>7000m)
3.2 Submerged Table Reef (depth <20m)
(as in 3.1)
3.3 Shoal (depth <20m)
(as in 3.1)
3.4 Bank (depth 20-200m)
(as in 3.1)
3.6 Guyot (depth >200m)
3.7 Ridge
3.8 Plain - Abyssal
3.9 Trench
3.10 Fracture
3.11 Volcano
3.12 Geothermal Vent

5.7 Protected Areas

5.7.1 Overview

There are many thousands of sites legally protected for the purposes of nature or landscape conservation. Of these, there are 9,832 protected areas[9] which meet international criteria, covering 926.3 million ha as listed in the *1993 United Nations List of National Parks and Protected Areas* (IUCN, 1994a). In addition to legally established sites, there are many other "networks", both regional and national which exist and serve conservation interests. Examples include sacred groves of West Africa, indigenous reserves of Latin and South America, and a range of reserves and land use schemes not officially designated but subject to regulations. The discussion which follows on definitions, classification systems, standards, core datasets and database structures is, however, primarily in the context of legally notified protected areas.

Themes within protected areas such as threats, representativeness, and management effectiveness are receiving considerable attention, and are leading to the development of criteria and models from which to assess these aspects across a range of protected areas. The continued development of such models and frameworks will increasingly be represented in national and international database structures.

5.7.2 Classification Systems and Standards

A widely accepted definition of *protected area*, as derived from that of the workshop on Categories held at the IVth World Congress on National Parks and Protected Areas, is *an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means* (IUCN, 1994a). Other, similar definitions are provided within the framework of legal documents such as the CBD (1992). In the context of this Convention, *protected area* is defined as *a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.*

Designations and Categories

- **National**
  At the national level, there are literally hundreds of protected area designations (currently more than 500 in WCMCs Protected Areas Database), the definitions of which correspond to legislative acts and regulations, based on management objectives. Examples include national park, protective zone, game reserve, partial faunal reserve, marine park, landscape protected area, ecological reserve, forest reserve, and natural monument. Sites listed under these various designations are included in publications such as the *1993 United Nations List of National Parks and Protected Areas* (IUCN, 1994a).

[9]Only protected areas over 1000 hectares (10 km^2) are included with the exception of offshore or oceanic islands of at least 100 hectares (1 km^2) where the whole island is protected (IUCN, 1994a).

- **Regional**
  Within the context of regional treaties and conventions, definitions for protected areas have also been provided. Examples include the following.

  The African Convention on the Conservation of Nature and Natural Resources (The "African Convention"), passed 15 September 1968, emphasised the need to establish "conservation areas", and sets out provisions for *strict nature reserve, national park, game reserve,* and *sanctuary*.

  The Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (The "Western Hemisphere Convention"). This convention entered into force in 1940, and established definitions and provisions for *national park, national reserve, nature monument,* and *strict wilderness preserve*.

  The Convention on Conservation of Nature in the South Pacific ("Apia Convention"). Entered into force in June 1990, and definitions are provided for *protected area, national park,* and *national reserve*, the latter including strict nature reserve, managed nature reserve, wilderness reserve, fauna or flora reserve, game reserve, bird sanctuary, geological or forest reserve, archaeological reserve, and historical reserve.

- **International**
  Preliminary, international categories were first published by IUCN in 1973, later followed by the following 10 category system:

I	Scientific Reserve/Strict Nature Reserve
II	National Park
III	Natural monument/Natural landmark
IV	Nature Conservation Reserve/Managed Nature Reserve/Wildlife Sanctuary
V	Protected Landscape
VI	Resource Reserve
VII	Natural Biotic Area/Anthropological Reserve
VIII	Multiple Use Management Area/Managed Resource Area
IX	Biosphere Reserve
X	World Heritage Site (natural)

Following wide use (including as a basis for national legislation) and subsequent review, a new system for categorising protected areas was subsequently developed and endorsed by the IUCN General Assembly in 1994, and is summarised below. This system, developed for classifying national designations according to management objective, illustrates the range of protected area types based on management objective, provides a basis for international comparison, allows assessment of the existing protected areas estate, and facilitates the establishment of a representative network of protected areas. Further, the categories system is intended to operate in the same way in all countries to enable the collection and handling of comparable data and to improve communications between countries. A full description of the management categories and their application is provided in *Guidelines for Protected Area Management Categories* (IUCN, 1994b).

Category I	**Strict Nature Reserve / Wilderness Area: protected area managed mainly for science or wilderness protection**
Category Ia	**Strict Nature Reserve: protected area managed mainly for science**
Description	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Category Ib	**Wilderness Area: protected area managed mainly for wilderness protection**
Description	Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
Category II	**National Park: protected area managed mainly for ecosystem protection and recreation**
Description	Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
Category III	**Natural Monument: protected area managed mainly for conservation of specific natural features**
Description	Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
Category IV	**Habitat/Species Management Area: protected area managed mainly for conservation through management intervention**
Description	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
Category V	**Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation**
Description	Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

Category VI **Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems**

Description Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

It is important that categories are assigned on the basis of the primary management objective as contained in the legal definitions on which it was established; site management objectives are of supplementary value. Therefore, sites are assigned to an international system of categorisation based on management objective, irrespective of title. This means, for example, that two sites called "national park" from two different countries may be assigned a different IUCN category. Table 5.7.2, below provides a matrix showing management objectives and IUCN protected area management categories.

Table 5.7.2 Matrix of Management Objectives and IUCN Protected Area Management Categories

Management Objective	Ia	Ib	II	III	IV	V	VI
Scientific Research	1	3	2	2	2	2	3
Wilderness Protection	2	1	2	3	3	-	2
Preservation of Species and Genetic Diversity	1	2	1	1	1	2	1
Maintenance of Environmental Services	2	1	1	-	1	2	1
Protection of Specific Natural/Cultural Features	-	-	2	1	3	1	3
Tourism and Recreation	-	2	1	1	3	1	3
Education	-	-	2	2	2	2	3
Sustainable Use of Resources from Natural Ecosystems	-	3	3	-	2	2	1
Maintenance of Cultural/Traditional Attributes	-	-	-	-	-	1	2

KEY:
1 Primary objective
2 Secondary objective
3 Potentially applicable objective
- Not applicable

Assignment is not based on management effectiveness considerations, and categorisation of sites is meant to be reflective of the primary management objective, not prescriptive in its application. Categorisation is, therefore, reflective of what a site is intended to be, and not how it is run.

In 1994, a technical workshop entitled *Application of the 1994 Protected Area Categories in the Australian Context* was held in New South Wales (NSW). The goals of this workshop were to become familiar with use of the IUCN categories, and to assess their value and applicability at the national level. Despite a number of issues raised with respect to the categories, overall conclusions from the workshop included: support for the application of the 1994 IUCN Guidelines at national, state and territorial levels; and that the Categories provided an objective means of communicating information on protected areas (Australian Nature Conservation Agency/NSW National Parks and Wildlife Service, 1994).

Of note, however, the Commission on National Parks and Protected Areas (CNPPA) of IUCN, together with the World Conservation Monitoring Centre (WCMC), is working towards developing a separate system for monitoring *management effectiveness*, information on which will also be collected and recorded at the international level. Work is also being done to monitor *threats* to integrity. This is in recognition that categorisation, management effectiveness and threats to integrity need to be considered together in the full evaluation of protected areas.

International Conventions and Programmes
At the global level, two international conventions and one programme are of particular importance. These are *The Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (Ramsar Convention), the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (World Heritage Convention), and the UNESCO *Man and the Biosphere (MAB) Programme*. Each of these conventions and programme sets out the provisions pertaining to the establishment of Ramsar wetlands, World Heritage sites, and biosphere reserves, respectively. Features of each are as outlined:

- **World Heritage Site**
  The Convention provides for the designation of areas of "outstanding universal value" as world heritage sites, the principal aim being to foster international cooperation in safeguarding these important areas. Sites, which must be nominated by the signatory nation responsible, are evaluated for their world heritage quality before being declared by the World Heritage Committee. A natural heritage property nominated for inclusion on the World Heritage List should meet one or more criteria and should also fulfil a number of conditions of integrity; these are outlined in operational guidelines for implementation of the convention.

- **Biosphere Reserve**
  A key component of the MAB programme is the establishment of a global network of biosphere reserves representative of the world's major ecosystems. Biosphere reserves play three basic roles: conservation; logistic (eg training, research); and development, the latter to promote the goals of conservation and sustainable use of ecosystem resources. To meet these roles, biosphere reserves are typically comprised of a core area, buffer zone and transition area.

- **Ramsar Wetland**
  This Convention provides a framework for international cooperation for the conservation of wetland habitats. General obligations are placed on contracting parties related to the conservation of wetlands throughout their territories, with special obligations for those wetlands which have been designated to the List of Wetlands of International Importance. Each state party is obliged to list at least one site, wetlands

being defined by the convention as *areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres* (Ramsar, 1994).

Forest Reserves

Forests have been classified according to management function as outlined in *Forest resources of Tropical Africa, Tropical America and Tropical Asia: regional synthesis and country briefs* (FAO, 1981), *Forest Resource Assessment 1990: Tropical countries* (FAO, 1993) and in the WCMC report "Assessing the Conservation Status of the World's Tropical Forest" (1992). *De facto* definitions are provided for *conservation forest*, *production forest*, and *protection forest*, and have been used to classify forest reserves for global analyses. Key terms are identified as follows:

- **Forest Reserve**
  Generally well-defined, surveyed, demarcated and legally constituted forest under the control of a forest department. All acts of felling, collection of forest produce, grazing and even trespassing are usually prohibited unless expressly permitted by law.

- **Conservation Forests Areas**
  Areas within the forestry sector designated for conservation by law or other regulations.

- **Protection Forests Areas**
  Areas within the forestry sector located on terrain that is too steep or rough, or subject to periods of permanent inundation, which makes forest management impractical due to physical non-productivity.

- **Production Forests** (forests for wood production)
  Forests having terrain and soil conditions suitable for the production of wood and other products on a sustainable basis. The distance to consumption or export centres is not taken into account, which means that economically inaccessible forests are included in this class.

5.7.3 Minimum Data Requirements

At an international level, information on protected areas is maintained by WCMC. Key data for legally designated sites includes: area protected; date of establishment; latitude and longitude; IUCN management category; altitudinal range; and basic biogeographic and habitat information. In addition, information is being collected on budgets and staffing, threats, management effectiveness, and key management contacts. A complete listing of information maintained on sites by WCMC is summarised in the box below.

Site Information Maintained by WCMC

Key data for nationally designated sites includes:

- site name
- designation
- area protected
- year of establishment
- IUCN Management Category
- latitude and longitude limits
- altitude
- level of administrative responsibility
- basic habitat information (only for certain habitat types)
- biogeographic information (after Udvardy)
- relationship to other nationally and internationally designated sites
- text description of key sites (held as WordPerfect documents)

In addition, key data for internationally recognised sites includes: relevant convention or programme; year of recognition; and relationships to nationally and other internationally recognised sites.

Text descriptions of such sites includes information on geographic location, date and history of establishment, physical features, land tenure, climate, vegetation, fauna, cultural heritage, local human population, conservation value and management, visitors and visitor facilities, scientific research activities, staff, budget, management constraints, and key contact addresses. In addition, published and "grey" literature, including nomination forms are held for internationally-recognised sites.

Surrounding this material is a range of supporting information, in particular that dealing with geographic information. In short, there are three basic classifications of countries and other geopolitical units, which work in a hierarchical way. These are:

- **UN Recognised Countries**
  The *UN Terminology Bulletin No.345 - Country Names* and its subsequent amendments list all of those countries recognised by the United Nations.

- **ISO Recognised Geopolitical Units**
  The international standard *Codes for the Representation of Names of Countries (ISO 3166)* and its subsequent amendments (produced by the International Organization for Standardization) includes all of the countries recognised by the United Nations, but also gives separate recognition to geographically disjunct dependencies, or "other areas of geopolitical interest".

Site Information Maintained by WCMC (Continued)

- **Biological Reporting Units (BRUs)**
  These have been adopted by the Taxonomic Databases Working Group. Units are based on ISO units, but break many of the larger units down further by either geographic or political boundaries.

For each of these units the database can incorporate such basics as land area, sea area and population, and as the ISO classification is widely recognised and used, linkages can be created with a range of other datasets. Gross National Product (GNP) and Gross Domestic Product (GDP) are also included in datafiles where appropriate. Provision has been built for a further user-defined level in the geographic hierarchy below the BRU level.

For each geographical level where it is relevant, the information held also includes the following:

- summary of protected areas in each designation
- definition of each designation used
- basic information on relevant management agencies
- basic information on relevant legislation
- involvement in international conventions/programmes
- text description of protected area systems.

The structure of the system has been designed to incorporate a programme of continued enhancement including facilities for maintaining and reporting data on:

- agencies
- budgets and staffing
- species protected area links/species inventories
- threats to the sites
- management effectiveness
- key contacts
- bibliography
- historic data

Core protected area datasets are also outlined in the context of regional and national initiatives. The *Mediterranean Action Plan* (RAC/SPA, 1987), outlines "Area Data Sheet Headings", while the Indian Institute of Public Administration have produced several state directories of national parks and sanctuaries (Pande *et al*, 1991). In both cases, the format complements well the site description headings and information compiled by WCMC. Core data on Arctic protected areas is identified in CAFF (1994), including information on area, latitude and longitude, IUCN category, year established, physical geographical regions, ownership, management authority, main habitat types and special ecological functions (eg main living area of certain species, or wintering sites of seabirds).

A further example is the CORINE (Coordination of Information on the Environment) biotope project initiated in 1985. This experimental initiative is concerned with "gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community". A first stage of the project was to establish a Community network of sources of information and expertise on all aspects of nature conservation. Agreed procedures were then adopted to: allow sites of Community importance for nature conservation to be selected using criteria consistent in all Member States; for information on these sites to be recorded and exchanged in a common format; for the use of agreed data procedures to ensure that the information conforms to those standards; for the interrogation, analysis and dissemination of information from the database; and for the interrogation of these data within the overall CORINE geographic information system. Procedures, including selection criteria for sites and the use of standard nomenclatures developed for the project have been accepted as a basic standard by many international, national and regional organisations responsible for nature protection.

A "site" or biotope is defined as "*an area of land or a water body which forms an ecological unit of Community significance for nature conservation, regardless of whether this area is formally protected by legislation*" (CEC, 1991). Criteria used to select "sites" were concerned with the following characteristics: the presence of threatened species of plants or animals; the presence of sensitive habitat types; the richness of a site for a taxonomic group of species, such as birds, mammals, dragonflies or orchids; and the richness of a site for a collection of habitat types (CEC, 1991).

Within the CORINE database structure, 5,600 biotopes are described, in addition to 13,000 areas classified under various types of protection. Site information collected, and which constitutes a standard site record includes *site identification* (eg coding, designated areas), *site location* (eg latitude/longitude), *ecological information* (eg habitat cover, human activities), *species* (eg mammals, fish, birds, plants), *site description* (eg character, quality, vulnerability, designation, ownership), and *site boundaries*. The field heading "Designated areas" allows for cross-referencing between the main biotopes database and the CORINE designated areas database, the latter being an inventory of all nationally and internationally designated zones (eg nature reserves, national parks, wetlands designated under the Ramsar Convention).

Within *Guidelines for Country Studies on Biological Diversity* (UNEP, 1993a), recommendations are made for the types of data that protected area agencies should be collecting and managing. This includes information on the following:

- information in support of systems plans
- relationships with the surrounding landscape
- basic site information (eg area, current management objectives)
- biodiversity information (eg land use, inventories, status and trends in key species and genetic resources). Wherever possible, this information is to be supplied in map form.

- status and management of individual sites (eg existence of a current management plan), including information on threats, management effectiveness, and monitoring programmes.

- resources, including information on staffing, budgets and training

- benefits - ecological, aesthetic, cultural and economic

- international Conventions and Programmes relating to sites

- bilateral agreements (eg twinning of sites, support and advice)

- transfrontier protected areas (eg including aspects of staff exchange, joint research, and monitoring).

5.7.~~3~~4 Database Structures

WCMC's Protected Areas Database maintains global datasets which have been used in support of protected area programmes in a number of countries. For example, the database has been installed in the US Parks Service, and subsets have been provided to national agencies to assist them in managing information on protected areas (eg Sri Lanka Forest Department). In addition, a virtual library of protected areas information is being developed, and information on a number of protected areas throughout the world is available through the World Wide Web Internet facility.

At a regional level, the CORINE biotopes database is used to collect and manage site information in the European Union. Further, there are some protected areas software packages which are being distributed widely, the template of which is being used to manage country-level information. One example is the MacKinnon-Ali Software System (MASS). This relational database, designed for monitoring the conservation status of species, wildlife habitat and protected areas has been established in several Asian countries.

Currently, however, there is no one protected areas database system which is being applied across all countries. This, in large part, is a result of national institutions defining datasets which meet their own management purposes and needs. Nevertheless, work is currently being undertaken to review common fields in database systems which would allow for comparison and easy exchange of information between national and international agencies. A notable example includes WCMC/Council of Europe discussions to develop *one* pan-European database, which would encompass: the development of a standard list of legal designations; the identification of standard information management practices; establishing a standard list of designated areas; developing a standard list of key species and habitats within designated areas; and coordinating future information management initiatives. This initiative would therefore seek to tie together endeavours such as CORINE and those of agencies such as WCMC, the Council of Europe, the Ramsar Convention Bureau, the World Heritage Convention and MAB Programme secretariats, UNEP, and a range of others in the region.

5.7.5 Protected Area Themes

Some of the current key themes within protected areas include representativeness, integrity, management effectiveness and threats, all of which have implications for the management and analysis of protected areas information.

Representativeness

In the Bali Action Plan, produced by delegates to the 1982 World Parks Congress, a target was set for 10% of each terrestrial ecosystem to be under some form of protection to stem species depletion (Miller, 1984). This target was subsequently endorsed by UNEP and the Bruntland Commission. Following on, the Caracas Action Plan outlined priorities for expansion of the network of terrestrial and marine protected areas worldwide based on the following criteria: (1) inclusion in protected areas of all biological species, ecosystems, communities and habitats, including varieties and genotypes of economic value; (2) ability to provide sustainability; (3) variety of geomorphological and geological formations and historically significant cultural landscapes; (4) degrees of endemism, irreplacability, natural rarity and the presence of threatened species, habitats or formations; (5) viability in relation to local social and economic factors as well as benefits provided to people; and (6) site selection so as to achieve maximum possible sustainable coverage of biological and geomorphological diversity (IUCN, 1993). One of the recommendations subsequently forwarded was that protected areas cover at least 10% of each biome by the year 2000.

Examples of frameworks used to assess representativeness in the context of vegetation, ecosystems and habitats are provided below:

Name	**A Classification of the Biogeographic Provinces of the World**
Description	Prepared by Udvardy (1975) as a contribution to UNESCOs Man and the Biosphere Programme, this scheme divides the world into 8 realms, subdivided into 193 provinces, with each province being characterised by one of 14 biome types. This breakdown allows for a crude analysis of protected area coverage by both province and biome type at the regional/international level. For example, this scheme was used to analyze coverage and gaps in a review of protected areas in the Sahara-Gobian Region (Green and Drucker, 1990). In addition, global vegetation classifications used for assessment purposes include *Vegetation of the Earth* (Walter, 1973), *Ecoregions of the Continents* (Bailey, 1989), and *Carbon in Live Vegetation of Major World Ecosystems* (Olson *et al*, 1983), which are described and cited in Terrestrial Vegetation, Section 5.2.
Name	**Review of the Protected Areas System in the Afrotropical Realm; Review of the Protected Areas System in the Indo-Malayan Realm**
Description	These reviews (MacKinnon and MacKinnon, 1986a, 1986b) assessed protected area coverages and gaps against biogeographic units; in the case of the Afrotropical review, this corresponded to the phytochoria of White (1983), while Udvardy was used as a basis of comparison in the Indo-Malayan review. Priorities for county action are outlined in accompanying documents such as the *Action Strategy* (IUCN, 1987) for the Afrotropical realm.

Name **The IUCN Sahel Studies**

Description Within the context of IUCN's Sahel Programme (IUCN, 1989), protected area coverage was assessed in relation to vegetation zones, phytochoria (areas with distinctive floras of shared origins), wetlands and fauna. In addition, the contribution of protected areas to development in the region was considered.

Name **Review of the Protected Areas System in Oceania**

Description Dahl (1986) rated each island for conservation status on the basis of ecosystem and species richness, endemism, threatened and endangered species, special features, natural vulnerability, natural conservation status, practicality of conservation action, reliability of data, and against a suite of indicators to do with human impacts. Protected area coverage is listed by biogeographic province, by amount of area protected, and by percentage of the island protected, as well as by country. The *Action Strategy for Protected Areas in the South Pacific Region* (SPC, 1985), adopted at the Third South Pacific National Parks and Reserves Conference (1985) and accepted at the South Pacific Conference (1985), sets out objectives for protected area development in the region.

Name **Arctic Landscape Classification System**

Description Using this scheme, the most important habitats not satisfactorily covered in this ecosystem have been identified as marine areas, coasts, fjords and forests (CAFF, 1994).

Name **Physical Geographical Regions**

Description In the Nordic countries and Greenland, protected area coverage is analyzed with respect to physical geographic regions (CAFF, 1994).

Name **National Example: Natural Regions Framework (Canada)**

Description First adopted in Canada in 1971 for the systematic planning of national parks. The Canadian Parks Service divided Canada into 39 terrestrial natural regions and 9 marine regions (later expanded to 29) (Environment Canada, 1991). Parks Canada is committed to representing each natural region with a national park by the year 2000. As a second example, a systematic national ecosystem framework was developed by the Canada Committee on Ecological Classification. This framework divided the country into 15 major terrestrial ecozones and 5 major marine ecozones. These units are further subdivided into other units such as 177 ecoregions and 1,500 ecodistricts. The ecological units are based on biophysical and geographical characteristics. This framework is being used as the basis of developing a national strategy for a diverse range of protected areas.

Integrity

One of the standard measures of integrity is size. In applying the international protected area categories, one of the key criteria is that the size of the protected area should reflect the extent of land or water needed to accomplish the purposes of management. For example, for a Category II area, the boundaries should be drawn sufficiently widely that they contain one or more entire ecosystems which are not subject to material modification by human exploitation or occupation (IUCN, 1994b).

A second view is that the size of a protected area should be determined by key ecological processes and functions, which may be dependent upon abiotic features. Assessments of integrity may therefore be first based on landform features and not biological ones.

In adopting a habitat or species view, work by Soulé (1986) has shown that size of protected areas depends on the key species under protection. Conservation areas need to be large enough to support minimum viable populations of key species, usually taken to be 500 genetically effective individuals. Further, individual protected areas should be large enough to be effective as *in situ* conservation units, should encompass as wide a contiguous range of ecological communities as possible, and safeguards should be taken to ensure that they do not become completely isolated from other natural areas.

Management Effectiveness
One of the major protected area issues, as outlined in the Caracas Action Plan (IUCN, 1993) was how protected area management can be made more effective under current and expected economic conditions. Further, the Action Plan recommended the development of a system for monitoring management effectiveness and threats to protected areas, for application by management authorities.

The ability to assess the effectiveness of management on a global scale is a crucial prerequisite in establishing a meaningful assessment of the health of the world's protected areas, and subsequently, for their periodic review in order to set ongoing priorities and guide international investment. Foster (1991), in his paper on categories, management effectiveness and threats to protected areas, outlines the most relevant elements capable of yielding sufficient information for the assessment of areas at the international level and of modification or elaboration to suit individual needs at system and site levels. Among the nine elements listed are included *management objectives*, the existence of *management plans*, *personnel*, *finance*, and *information feedback*.

Although there is yet to be a systematic attempt to investigate and record management effectiveness in protected areas at the global or regional levels, there has been some useful work done towards developing methodologies for evaluating the effectiveness of management at site level over the past 10 years. Examples are found in Chapter 11 of *Managing Protected Areas in the Tropics* (MacKinnon *et al*, 1986), and in the work of William Deshler *A Systematic Approach to Effective Management of Protected Areas*, and Lesley Molloy *Effective Management of Protected Areas.*

Further, national initiatives aimed at addressing management effectiveness includes work recently done in India. Entitled *Management of National Parks and Sanctuaries in India: A Status Report*, one of the aims of this study was to make recommendations at improving the management of protected areas in the country. Further, for the purposes of determining the state of management, various indicators were used, broadly falling under the headings of *legal status and procedures*, *policy and planning*, *management practices*, and *management facilities* (Kothari *et al*, 1989). Two essential prerequisites identified for the proper management of protected areas are research and monitoring.

Threats
An international system for monitoring threats to protected areas would likely include the following elements:

- development of a quantitative scientific method for classifying the type and intensity of threat
- development of a fully documented database of threatened protected areas
- publication and dissemination of the database as widely as possible to facilitate the alleviation of identified threats to such sites
- stimulation of corrective actions to reverse the effects of threat, and
- monitoring the impact of specific types of threat on national parks and protected areas.

While such a framework is being developed by organisations such as IUCN and WCMC, criteria are being applied in a number of instances to identify sites under threat. For example, the *List of World Heritage in Danger* consists of World Heritage properties which meet a number of requirements. These include: the property being threatened by serious and specific danger; and major operations being necessary for the conservation of the property (UNESCO, 1972). Threats to World Heritage sites fall under four broad categories, namely: *development issues*; *encroachment*; *management of natural resources*; and *management of human resources*. Sites for inclusion on the list usually come about as a result of a consultative decision between the World Heritage Committee and the relevant state party.

The Nature Conservancy, in collaboration with Latin American and Caribbean partners has initiated an emergency effort to safeguard the most important and most imperiled natural areas in the hemisphere. *Entitled Parks in Peril*, the goal of this initiative is to protect 200 key sites, covering more than 100 million acres by the year 2000. The focus of this campaign is to build long-term infrastructure within these protected areas, therein making protection real and lasting. Selection of sites was based on the following criteria: biological significance (eg size, ecological integrity, and proximity to contiguous wild-land areas); socio-economic and cultural value; endangerment (eg threats); and management feasibility/opportunity (TNC, 1990).

Until recently, CNPPA and WCMC collaborated on a project to maintain a prototype register of threatened protected areas. Threat categories, upon which sites were identified, included: inadequate management resources; human encroachment; poaching; mining/prospecting; livestock conflicts; acid deposition/pollution; and exotic species invasion. Six criteria were also developed to evaluate the "most threatened" sites throughout the world. These were: *adequate documentation*; *conservation value*; *imminence* (eg imminent or real prospect of threat); *severity*; *practicability* (eg how amenable to corrective action is the threat); and *need for international support* (CNPPA, 1984). Clearly, some of this preliminary work, as well as that by Machlis and Tichnell (1985) on sources, extent and effects of threats to protected areas; Foster (1991), in his work on categorising and assessing the weight of threats to protected areas; along with various State of the Parks reports prepared by a number of countries, provide a sound basis for the development of an international monitoring system.

Further, UNEP (1993a) in *Guidelines for Country Studies on Biological Diversity*, defines threats to biodiversity in its Technical Annex. In addition, threats to biodiversity, including to protected areas is outlined in UNEPs Environmental Data Reports (1991; 1993b).

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5.8 Species

5.8.1 Overview

Managing information on species is a complex issue, and as information needs and demands grow, the need to follow and develop standards in both information management and information transfer has become increasingly important. Standards may comprise formally recognised agreements, or systems that have become standard as a result of widespread use.

Where a particular organism is concerned, data may be recorded at the taxon, population, genotype or specimen level, and on a wide range of topics such as age, form, lineage, distribution, habitat type and usage. In this review, standards in information management and exchange that have been officially endorsed are discussed. These standards are all relevant at the global level. In addition, other information management practices that have been widely used are listed, as these represent *de facto* standards. Many of these, particularly the use of standard published lists provide regional standards.

This review on species information standards does not attempt to be comprehensive, but rather highlights some existing practices, as well as areas in which there is currently a focus to improve or set standards. Standards in nomenclature are discussed in detail, following which are reviews of published species lists and of organisations that are attempting to set standards.

5.8.2 Nomenclatural Standards

Taxonomic and Systematic Standards

The need for a standard system to record names of living organisms has long been recognised. This is demonstrated by the key importance of current taxonomic and systematic practices, which provide universally accepted nomenclatural standards. The obligatory use of Latin for example, in naming living organisms (and in describing plants new to science), derives from the Latin of the Roman writers about plants, notably Pliny the Elder (A.D. 23-79) (Stearn, 1992).

In the eighteenth century, Carl Linnaeus, the founder of modern animal and plant nomenclature, established the system whereby living organisms are given an official latinized scientific name, following a binomial naming system, a standard that is still adhered to today. Linnaeus' authoritative tenth edition of *Systema Naturae* was published in 1758. This represents an important date, as January 1st of this year is considered the starting point of modern nomenclature. All Latin names given before this date are considered invalid. A comprehensive account of the development of the standard use of latin for plant and animal names, since Roman times, is given in *Botanical Latin* (Stearn, 1992) and *Mammals - Their Latin Names Explained* (Gotch, 1979).

Codes of Species Nomenclature

Building on the universally accepted binomial system of latinised scientific names, official *Codes of Nomenclature* have been drawn up, for different types of organism, to determine standard methods for naming taxa. These codes underpin the science of systematics. Although universally accepted, these codes to not have any legal status in national or international law.

The *Codes of Nomenclature* attempt to avoid the many problems presented by common names in vernacular languages. These include the use of many languages, different alphabets, use of more than one name for an organism and use of the same name by many organisms.

The formation and use of the scientific names are governed by separate codes:

Plants and Fungi	International Code of Botanical Nomenclature (ICBN)
Animals	International Code of Zoological Nomenclature (ICZN)
Bacteria	International Code of Nomenclature of Bacteriology (ICNB)

The codes are similar in approach, with each code following a series of rules, some of which are supplemented by recommendations. However, the codes differ in detail. For example, the use of tautonyms, where the second term repeats the first, (ie *Rattus rattus*) is permissible under the zoological code, but illegitimate under the botanical and bacteriological codes. The zoological code regulates the names of taxa of only one category below the rank of species - the subspecies. Subspecies names therefore consist of three terms called trinomials, (eg *Gorilla gorilla gorilla*). The botanical code by contrast recognises different categories below species level, (eg subspecies or variety), and the word indicative of rank is included as part of the name, for example *Picea engelmannii* ssp. *mexicana*.

The codes may only be modified following procedures determined by the International Botanical Congress, International Congress of Zoology, or International Committee on Systematic Bacteriology, respectively. For more information see Jeffrey (1989).

A further botanical code, the International Code of Nomenclature for Cultivated Plants, governs the naming of plant cultivars. The Handbook on Orchid Nomenclature and Registration extends the Botanical and Cultivated Plant codes to cover problems especially affecting the naming of cultivated orchids.

The Cultivated Code, like the Bacteriological, Zoological and Botanical Codes, does not have any legal status. However, a separate code, "Guidelines for Variety Denominations approved by the Council of the International Union for the Protection of New Varieties of Plants (UPOV)" forms the basis for nomenclature of cultivated varieties of those groups of plants in which plant breeders rights have been recognised. The responsibility for the implementation of these guidelines lies with the government of each of the member states of UPOV through the appropriate statutory body established for the purpose. The function of the variety denomination under the UPOV rules is to enable the plant in question to be catalogued without ambiguity with respect to business transactions involving reproductive material (Jeffrey, 1989).

The crucial importance of standards in nomenclature is also shown by the concept of "type" specimens, that is, those specimens described for the official publication of a new name. Type specimens within a collection are therefore of prime importance (Jeffrey, 1989).

The Convention on International Trade in Endangered Species of Flora and Fauna and Species Information Standards

In 1977 the Special Working Session of the Conference of the Parties to Convention in International Trade in Endangered Species of Flora and Fauna (CITES) recognised the need for the standardisation of Appendices taxonomy. In order to facilitate the work of the Conference of the Parties and to keep the work continuing between meetings, the Conference established a number of committees, sub-committees and working groups. The Nomenclature Committee develops and maintains nomenclatural standard references for animals and plants, where necessary to the level of subspecies. They review the existing CITES Appendices with regard to the correct use of zoological and botanical nomenclature. Upon request from the CITES Secretariat, proposals to amend the Appendices are reviewed to ensure that correct names for species and other taxa in question are used. Further, the Committee ensures that changes in nomenclature recommended by a Party do not alter the scope of protection of the taxon concerned. They also make recommendations on nomenclature to the Conference of the Parties, other committees, working groups and the Secretariat.

The CITES Convention recognised that the taxonomy used in the appendices of the Convention would be most useful to the Parties if it did not change more frequently than necessary, since each change may necessitate amendment of national implementing legislation. The format of the appendices is standardised to eliminate confusion, and the annotation used in one part has the same meaning when used in the sections of the appendices. The appendices are kept as brief and uncluttered as possible to aid in visual scanning of the lists, and to ease their computerisation for customs purposes. Complete checklists of animal species and plant genera are available to assist customs and other enforcement officials in detecting false or invalid taxa used by importers or exporters.

The CITES Parties have agreed to the adoption of a standardised appendices' taxonomy. That is, so far as possible, taxonomy based on rulings of the International Commission on Zoological Nomenclature and International Code for Botanical Nomenclature.

The Nomenclature Committee are responsible for the compilation of a list of taxonomic bibliographic source materials for circulation to the Parties. The Parties have agreed to the removal of all taxonomic synonyms, sub-genera, and other parenthetical taxa from the appendices, and if the identity of a particular taxon is unclear, then it is clarified by footnote references.

Approved standardised taxonomy and list of bibliographic source materials, of animal species and plant genera, are made available, to those Parties requesting such checklists, by the Secretariat.

5.8.3 Standard Lists of Species Names

Despite the existence of detailed nomenclatural codes for all living organism, no universally accepted, standard, comprehensive listings of names yet exist. However, there are published references, mostly concerning major taxa, which are widely accepted and may be considered *de facto* standards. Similarly databases exist, available on-line or on CD-ROM which similarly form a type of *de facto* standard.

Published Lists
Widely accepted references, and databases listing accepted names for animals and bacteria include:

Mammals	Wilson and Reeder (1993)
Birds	Sibley and Monroe (1990 and 1993)
Reptiles	many
Amphibians	Frost (1985) supplemented by Duellman (1993)
Molluscs	Vaughan (1989)
Insects	World List of Insects
Bacteria	List of Valid Bacterial Names (Deutsche Sammlung von Mikroorganismen and Zelkulturen, Braunshweig)

For the plant kingdom, regional *Floras*, such as *Flora Europaea*, *Flora of Tropical East Africa*, and *Flora Mesoamericana* may be considered as *de facto* regional standards.

Electronic Lists
Many specialist systematic databases have been developed for a range of different taxonomic groups including viruses, bacteria, protists, fungi, molluscs, arthropods, fish, plants, fossils etc. As a minimum, these databases provide a standard list of the species known to occur. Many give accepted scientific names, synonyms and common names. Examples of such databases include:

Name **Arthropod Name Index (ANI)**
Publisher (CAB International)

Name **BIOSIS Bacterial Taxonomic Reference File (BIOSIS TRF)**
Publisher (BIOSIS Philadelphia)

Name **CITES Cactaceae Checklist**
Publisher Hunt, 1992

Name **Taxonomic Database for Fishes.**
Publisher Eschmeyer, W.N. (California Academy of Sciences)

Name **International Legume Database and Information Service (ILDIS)**
Publisher ILDIS Phase 1, Version 2.0, ILDIS Coordinating Centre

Name **Index Kewensis**
Publisher Oxford University Press

For a more comprehensive review of electronic lists and databases relevant to biodiversity information management see Biodiversity Application Software, Section 3.2.7. Established taxonomic databases are also reviewed by Bisby (1994).

5.8.4 Organisations and Networks Setting Standards

The rapid increase in global electronic communications is facilitating exchange of species data and encouraging species-related organisations to collaborate into information networks. The importance of standards in the implementation of such networks are discussed by Green and Croft (1994) who define four main types of standards or conventions:

1. Information design standards and information models describe in conceptual terms the information needs of an enterprise. It is the framework in which all data and information are collected, stored and disseminated.

2. Attribute standards define what information to collect. Some information, (eg who,when, where and how) is essential for every data set; other information, (eg soil pH) may be desirable but not essential.

3. Quality control standards provide indicators of validity, accuracy, reliability or methodology for data fields and entries.

4. Interchange standards specify how information should be laid out for distribution. The Standard Generalised Markup Language (SGML) provides an extremely powerful, and flexible standard for formatting information for processing of all kinds. SGML is emerging as a leading international standard for preparing both hypertext and multimedia material for publication. It is also extremely good for interchanging database records. The ISO standard ASN.1 tagged field format also provides a flexible protocol for defining and exchanging electronic information.

Below is an alphabetic list of organisations and networks contributing to the setting of standards in species information management.

Name **BIN21**

Description Establishment of a Biodiversity Information Network (BIN21) has been the focus of two recent international workshops (Canhos *et al*, 1992 and 1994). The aim of BIN21 is to provide an important mechanism for linking information relevant to biodiversity and making it widely available by electronic and other means, without maintaining all the information on one site. The network would itself act as a major focus for information standardization, one of the seven priorities being to "encourage the standardization of methodology of information exchange in collaboration with existing initiatives".

Name **BioNET-INTERNATIONAL**

Description BioNET-INTERNATIONAL (BI) is a global, technical cooperation network (TCN) for biosystematics, with particular concern for arthropods, nematodes and microorganisms. The network was promulgated by CAB International (CABI) in 1991. This was in response to the perceived need for a world wide initiative, and a cost-effective and sustainable mechanism, for establishing and maintaining within developing sub-regions, the requisite biosystematic capabilities to support national programmes for sustainable agricultural development and the conservation and wise-use of the environment and biodiversity (Jones and Cook, 1993).

The network aims to build on the existing strengths of national institutions and countries, so that they corporately can develop and sustain a comprehensive biosystematic capacity.

Name **CODATA**

Description The Committee for Data on Science and Technology (CODATA) of the International Council of Scientific Unions (ICSU) has created a Commission on Standardised Terminology for Access to Biological Data (STABD). The aim of the commission is to focus attention on organisations responsible for setting standards for terms to describe biological entities. This was in recognition of the fact that the work of these organisations is generally little known. Information is being solicited for existing standards for biological terminology, with an indication of which sets of terms are available in electronic form. Each nomenclature committee and a description of its work is included in the Nomenclature subfile of the U.S. National Library of Medicine's Directory of Biotechnology Information Resources. The Commission will attempt to provide wide access to this resource and to develop software that will facilitate direct data entry. A full list of participating organisations is given in Blaine (1992).

Name **International Organisation for Plant Information (IOPI)**

Description The problem of establishing a world plant list is being addressed by the International Organisation for Plant Information (IOPI). IOPI is a collaborative organisation set up by botanists and computer scientists from around the world, with the aim of producing and making available a modern, unified, computerised inventory of the plant species of the world, their distribution and attributes. The objective of the first phase of this world-wide plant information system is to develop a global plant checklist of all vascular plants. Non-vascular plants will be added later. It is intended that the list will present a single preferred taxonomy, selected by an international panel of botanical specialists, and reviewed at intervals. Alternative names (synonyms) for a species will be given if currently used in a taxonomy different from the preferred one. The checklist database will be created by entering records from a succession of incoming datasets, such as those listed above. Currently, the project remains at planning level, with data definitions and standards listed as a priority. More information on progress with the checklist is available through listserv@life.anu.edu.au or via anonymous ftp at life.anu.edu.au (Wilson, 1994).

Name **International Union of Biological Sciences (IUBS)**

Description The IUBS recognised the importance of a standardised world list, passing a resolution to this effect at the 25th General Assembly, in recognition that "such lists are the crucial component of the communication system of biodiversity" (Speers, 1994).

CODATA and the IUBS are currently funding a joint project "Species 2000". This project aims to bring together all the major working taxonomic databases (eg ILDIS, IOPI, DSM, BIOTA) into a loose confederation; the overall aim being to produce a master-list of all species that have currently been described. The initial ongoing phase of the project is the formation of the confederation, and agreement on the taxonomic criteria required of such databases (Duffield, 1994).

Name **Scientific Committee on Antarctic Research (SCAR)**

Description A special case in the setting of standards is shown in the politically unique example of the Antarctic. There has always been a strong element of collaboration between members of the international Antarctic scientific community, and standards for data management are currently being discussed by the Scientific Committee on Antarctic Research (SCAR). The joint SCAR-COMNAP (Committee of Management of National and Antarctic) *ad hoc* Planning Group on Antarctic Data Management are tasked with improving accessibility and comparability of Antarctic Scientific data. This arises out of an Antarctic Treaty Consultative Meeting Recommendation for SCAR to address data issues. As part of their long-term planning, the group will look at data standards. Details on fisheries standards are given in 5.3.6

SCAR has sponsored two programmes within the biological sciences: the Biological Investigations of Terrestrial Antarctic Systems (BIOTAS) and the Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS). The BIOMASS Data Centre faced many problems in standardising, integrating and documenting the data supplied by individual researchers into coherent data sets. A major task of the data centre was to ensure standardisation of the data received from all those nations taking part in the survey, so that accurate use could then be made of the data (Thorley and Trathan, 1993).

Name **Taxonomic Databases for Plant Sciences (TDWG)**

Description The issue of standards for many issues other than nomenclature has been addressed as a serious issue by the Working Group on Taxonomic Databases for Plant Sciences (TDWG) of the IUBS (see above) commission on taxonomic databases. This has entailed both the development of standards in data exchange, world geography and names of taxa (details given below), through a series of international workshops, and the official endorsement of other standard works.

TDWG also endorses other standards. As of July 1994, these covered the following subject areas:

- Names and abbreviations for botanical authors (Brummitt and Powell, 1992)

- Bibliographic citations (Bridson and Smith, 1991)

- Abbreviations for titles of periodicals (Lawrence *et al*,1968)
- Taxonomic literature (Stafleu and Cowan, 1976+)
- Abbreviations for titles of books
- Herbarium Code Designations (Holmgren *et al*, 1990)
- Phytogeographic units (Takhtajan, 1986)
- Economic use descriptors (Cook and Hastings, 1994)
- Data exchange (the DELTA format for recording and exchanging descriptive data) (Dallwitz and Paine, 1986).

The International Transfer Format (which TDWG endorses for data exchange) is discussed in detail below.

5.8.5 TDWG Published Standards

Name **International Transfer Format for Botanic Garden Records (ITF)**

Description In 1987, an internationally agreed standard (Plant Taxonomic Database Standard No.1) was agreed on for the storing of plant names by botanic gardens, and for exchanging specimen data (Botanic Gardens Conservation Secretariat, 1987). The ITF consists of a set of definitions for the fields within each record. In the ITF, most codes are expanded into their full forms, thereby removing the need for international agreement on their values. Space is not a major constraint, as data will normally be exchanged on magnetic tape, diskettes or other removable media, not over telephone lines.

The overriding considerations are to make the ITF as clear, simple and unambiguous as possible. Although designed as a standard for the transfer of data, the ITF by implication sets out the information that a botanic garden database should contain on each plant accession. For each accession, the ITF record contains the basic minimum data required for the purposes of conservation. This consists of:

- file identification data
- accession data
- plant name
- verification data
- sex
- source data
- place of origin
- conservation data.

To ensure consistency, each field is constrained by rules. These rules are of two types: rules of syntax and rules of information. Under the syntax rules, all characters must be written using a limited set of ASCII characters, and must start from the left in a field, with spaces used to fill the field width. The rules of information state that each record must refer to an accession in a Botanic Garden.

Since publication, further meetings have discussed updating and adding to the ITF. At a meeting held in November 1994 at Botanic Gardens Conservation International (BGCI), the importance of variable field length was recognised, and a further 30 fields were proposed, approximately doubling the size of the original ITF. This would make provision to manage information relating to botanic gardens, conservation and the genetic resource/seedbank community. The importance of enabling data from the botanical world to be easily linked to the genebank world, via a standard transfer format was endorsed at a workshop held at CATIE, Costa Rica in October, involving delegates from the botanical community of Central America, as well as plant breeding experts. Details of the additional fields are currently being discussed, including input from the International Plant Genetic Resource Institute (IPGRI), and ratification of the enhanced ITF will be sought at the Fourth International Botanic Gardens Conservation Congress to be held in Perth, Western Australia in November 1995.

Name **World Geographic Scheme for Recording Plant Distributions**

Description This standard (Plant Taxonomic Database Standard No.2) (Hollis and Brummitt, 1992) breaks the world into 622 units known as Basic Recording Units (BRU). At this level, all political boundaries are recognised. In addition, large countries are dealt with at the state or province level, and large offshore islands are dealt with separately. Politically based units are those recognised by the International Standards Organisation (ISO Standard 3166, 1988) which defines three letter country codes. The units in the ISO standard are "countries, dependencies and other areas of special interest for purposes of international exchange, without indicating expression of opinion whatsoever concerning the legal status of any country or territory or of its authorities or concerning the delimitation of its frontiers." The BRUs are arranged in a hierarchy, allowing information to be retrieved at different scales.

At an open TDWG meeting held in September at UNESCO, presentations clearly demonstrated the rapid advancement that has occurred in the area of electronic access to biological information. The meeting recognised the vital importance of a coordinated programme for the development of taxonomic databases for all groups of organisms, such that, even though projects for individual groups will necessarily have different priorities and be at different stages of development, common standards and the facility for exchange of data would be ensured. Emphasis was given to the need to develop the authority files, data models, and data transfer standards necessary to ensure that the rapidly expanding knowledge bases remain easily accessible.

Although they have not been formally published yet, TDWG Subgroups are currently discussing development of standards for:

- an accessions exchange format
- a simple system for use worldwide to categorize the habitat, soil type and landscape in which a plant occurs
- identification of a small set of universal descriptors that can be applied to the life-forms of plants
- Plant Occurrence and Status Scheme (POSS).

5.8.6 Database Models

As with the general adoption of a particular reference, the adoption of a particular database application by many organisations can result in a *de facto* format for data exchange. However, with so many systems currently in use, only two very widespread systems are examined below (for details of other systems see Biodiversity Application Software, Section 3.2.7).

Name	**BG-BASE**
Description	BG-BASE was originally developed to manage the living plant collection of the Arnold Arboretum of Harvard University, but now installed at 53 centres around the world. These institutions comprise botanic gardens, arboreta, horticultural societies, museums, universities and conservation monitoring centres (O'Neal, 1994). The system tracks information to the specimen level, and, with its in-built taxonomic hierarchy, comprises a standard system for data management at the taxon, population or genotype level. Being designed around the ITF (see above), data maintained within ITF determined fields are easily transferable to other systems designed around this transfer format. Data for all fields may be simply transferred between any institution running BG-BASE. Thus, for example, the Royal Horticultural Society in England or National Botanic Garden in Harare may compare their living collection records with WCMCs version of BG-BASE, a global database on threatened plants of the world, to identify those plants within their living collections that are of conservation interest.
Name	**International Species Information System (ISIS)**
Description	The International Species Information System (ISIS) is an international membership organisation of zoos, aquariums, and related institutions, functioning as a computerised global network. 440 member institutions from 51 countries on 6 continents use ISIS to pool and share data on more than 175,000 living specimens and 450,000 of their ancestors, representing over 4,000 species. The central ISIS database allows for access to standardized information. Additionally, ISIS develops PC software, which has now become the standard used by over 375 zoological institutions for in-house specimen

records, veterinary records, and studbook and species management purposes (Swengel, 1993).

5.8.7 Miscellaneous Standards

Microbial Data Standards

At the microbial level, highly detailed standards are given for recording descriptors of strain characteristics or features in *The RKC Code - Coding Microbiological Data for Computers* (McManus and Krichevsky, 1992), which also gives details of data structure. The code, originally developed in 1971 to facilitate computerised management, analysis, and exchange of data on bacterial strains, currently includes over 12,000 strain descriptors. The code has subsequently been expanded to include features specific to algae, protozoa and some fungi. In 1986, an expanded RKC Code was published under the sponsorship of the Committee on Data for Science and Technology (CODATA) of the International Council of Scientific Unions (ICSU) (Rogosa *et al,* 1986). The RKC Code is the standardised vocabulary used in the Microbial Information System (MICRO-IS), a computer program for storage, management, and analysis of data on microbial strains. This is available from the Microbial Strain Data Network (MSDN). As well as comprising a standard, the RKC Code itself depends on other existing standards, for example shape (Systematics Association Committee for Descriptive Terminology) and colour standards (Kelly and Judd, 1955).

Plant Genetic Resource Standards

A comprehensive guide to genetic resource documentation is given by Painting *et al* (1993). They state the need to use common standards in database development, particularly for descriptor lists, coding systems, software and basic system structure. Emphasis is given to the need to record data in an internally consistent standard format, to avoid use of abbreviations, and to record raw experimental data if it is likely to be subject to analysis in the future. This guidebook is a practical measure, aimed at genebank managers, and if widely adopted could again become a *de facto* standard. The guidebook only cites one international standard, the use of ISO codes for the representation of country names (International Standard Codes for the representation of names of countries, 3rd ed., 1988. ISO, International Organization for Standardization).

A pragmatic approach to the development of standards in the management of genebank information is outlined by Peret (1989). A survey was made of European *Allium* and barley breeders, asking them to rate the value of the individual passport characterisation and evaluation descriptors. For both crops, breeders rated descriptors for resistance to diseases and stress as being most important, together with a few agronomic descriptors - this was despite the admitted problems of genotype x environment interactions for these descriptors. A list of selected sets of characters, varying for each species, recommended as a standard for registration in a central database was then drawn up.

A standard can also represent a particular cultivar. For polygenic characters such as height or yield, a well-known standard cultivar is essential as a reference for measuring other cultivars against. For example, the Sunflower Working Group recommends the inbred line HA89 as a common standard for days to flowering and plant height. Each sunflower collection in Europe receives seed originating from the same source, so that the same genotype is used everywhere (Peret, 1989).

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5.9 Threats

5.9.1 Overview

This section attempts to outline in general terms the major known and potential *proximate* threats facing the world's biodiversity, and where applicable detail the existing standards used in their quantification, and minimum data requirements for information managers. There are two basic approaches to examining or measuring threats to biodiversity. One is to assess the impact of individual threats - such as acid rain or ozone depletion - on biodiversity. In practice, however, biodiversity is usually threatened by a combination of many factors acting in concert. The second approach is to assess the threatened status of a particular element of biodiversity, taking into account all the factors impinging on it. The two approaches are reviewed separately in the following sections.

For convenience, biodiversity is sub-divided into three different levels: genes, species, and ecosystems (WCMC, 1992).

5.9.2 Threats to Genetic Diversity

All living organisms contain sequences of DNA called genes in which the blueprints for their construction and functioning are encoded. Many of these genes are polymorphic: that is different forms or alleles of the same gene exist. In most species, each individual member of the population will have a unique combination of these genes and alleles. The number of genes and their different alleles in a species represents its genetic diversity. Genetic diversity is extremely difficult to quantify and is thus not the common currency in which biodiversity is measured.

The genetic diversity of the vast majority of species is currently threatened by the reductions occurring in their populations, brought about by a combination of factors (see Table 5.9.1). A few notable exceptions occur, since populations of some commensal species that are well-adapted to human-modified environments are increasing, as are those of some domesticated and agricultural species. Because the individuals comprising a species are for the most part genetically distinct and unique, a decrease in overall population size, ie the number of individuals, will tend to reduce the genetic diversity of that species. Smaller populations may also be more vulnerable to the effects of in-breeding, which tends to reduce average levels of heterozygosity in sexually-reproducing diploid organisms. This is a direct threat to biodiversity at the genetic level, but may also have indirect, long term consequences to biodiversity at the species/ecosystem level. The pool of genetic variation present within an inter-breeding population is acted upon by selection, leading to differential survival and eventual evolutionary change. Genetically impoverished species may be less able to adapt to future changes in the environment, and therefore more prone to eventual extinction (WCMC, 1992).

Threat Assessment

There are no currently accepted standards for measuring the overall genetic diversity of a population of a species and assessing its threatened status. However, a number of combined demographic/genetic models have been applied to small populations of captive animals to determine the risk to the population of in-breeding and loss of heterozygosity. These measure effects in terms of the eventual survival of the population and the maintenance of its genetic diversity (Lacy, 1993).

The different breeds of domestic animal are one manifestation of genetic diversity within species. An Animal Genetic Resources Programme launched in 1982 by FAO and UNEP has worked on developing methodologies for a global programme for animal genetic resources focusing on preserving the multitude of breeds of domesticated animals. Loftus and Scherf (1993) have assessed the threatened status of the known breeds of ass, buffalo, cattle, goat, horse, sheep and pig.

5.9.3 Threats to Species Diversity

The biological world is most easily visualized in terms of the species inhabiting it. The most commonly accepted definition of a species is that of Mayr (1969), according to whom "species are groups of interbreeding (or potentially interbreeding) natural populations that are reproductively isolated from other such groups". There are nonetheless many alternative views (WCMC, 1992). Species diversity is relatively well-known among certain groups, such as higher vertebrates and some plant families, but it is estimated that millions of other species have yet to be discovered and described by scientists (WCMC, 1992). The threats facing biodiversity at the species level are varied (Table 1) but can be documented in detail, and in some cases quantified, for particular well-studied species.

Threat Assessment

Various programmes have examined and assessed species threatened status at taxonomic and geographic levels. The first and most widely known is the Red Data Book programme introduced by Sir Peter Scott during the 1960s. Red Data Books, compiled by IUCN, developed a system of categorizing the severity of threats facing a species, which estimated the imminence of their extinction. Written accounts of the threats facing individual species were given, together with proposed conservation solutions. Red Data Books were initially compiled on a global basis, but the concept was also adopted at a regional, national or sub-national level. Examples of groups covered include plants (Lucas and Synge 1978), invertebrates (Wells *et al*, 1983), and the primates of Africa (Lee *et al*, 1988). As the volume of information available increased, the traditional Red Data Book approach was to a large extent replaced by a direct listing of globally threatened species, called the IUCN Red List. The most recent global listing for animal species, compiled by WCMC, is the 1994 IUCN Red List (Groombridge, 1993). A global Red List for plants is also under preparation. WCMC maintains a continually-updated database of the world's threatened animal and plant species, and can supply country lists of globally threatened species on request.

In the late 1980s the Species Survival Commission of IUCN began preparing a series of shorter documents focused on particular animal groups, called Action Plans. These assess the conservation status of species and their habitats, and specify conservation priorities. In late 1994 there were around 20 in print, primarily dealing with mammalian groups: the most recent covering dolphins, porpoises and whales (Reeves and Leatherwood, 1994).

The threats to bird species are monitored by an organization called BirdLife International (formerly the International Council for Bird Preservation). One of their most recent publications (Collar *et al*, 1994) summarizes the conservation status of all 1,111 bird species assessed as globally threatened.

IUCN Threatened Species Categories
For almost 30 years IUCN have classified the severity of the threat of extinction faced by species using a system of threat categories which has become an accepted world-wide standard. Species (or in some cases subspecies or groups of species) are assigned a threat category based on a review of the factors affecting them and the extent of the effect that these are having throughout the species range. Key factors examined include changes in distribution and numbers, degree and type of threat, and population biology. IUCN threatened species categories are applied to species on a global scale, and should not be confused with national threat categories which may be assigned by countries preparing Red Lists or Red Data Books dealing with the status of species within their own borders. IUCN threatened species categories have been used in a wide range of publications and listings produced by IUCN, national governments, and NGOs.

Editions of IUCN Red Data Books and the IUCN Red List published up until 1994 used the following threat categories:

- Extinct
- Endangered
- Vulnerable
- Rare
- Indeterminate
- Insufficiently Known
- Threatened
- Commercially Threatened

In some cases intermediate threat categories such as Endangered/Vulnerable were given. This well-known system has recently been revised (Anon, 1994). The new system, accepted by the IUCN council in December 1994 consists of the following categories:

- Extinct
- Extinct in the Wild
- Critically Endangered
- Endangered
- Vulnerable
- Lower Risk (with subcategories Conservation Dependent, Near Threatened and Least Concern)
- Data Deficient
- Not Evaluated

Full definitions of both the old and new IUCN threat categories are given in Annex 1 and Annex 2 respectively.

US Endangered Species Categories
Many governments have adopted the IUCN Red List categories for national listings of protected species. The US however has created its own system of threat categories, defined differently from those of IUCN, listing species (or particular populations) as either Endangered or Threatened under the Endangered Species Act of 1973. An Endangered

species is defined as "any species which is in danger of extinction throughout all or a significant portion of its range", while a Threatened species is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (US Fish and Wildlife Service, 1988).

5.9.4 Threats to Ecosystem Diversity

The highest level at which biodiversity is usually considered is the ecosystem. The classification of the enormous range of variation in the natural environment is even more problematic than the classification of organisms. The world's biomes and major ecosystems are in reality aggregates of a natural continuum of intergrading local ecosystems, habitats, and communities. Whilst genes and organisms are identifiable in the sense that they define themselves through replication or reproduction, ecosystems and habitats do not. Ecosystems are most often evaluated through measures of the diversity of their component species, but there is no consensus among scientific opinion of their precise definition (WCMC, 1992).

Threat Assessment

There are no globally accepted standards for categorizing threats to ecosystems, but Olson and Dinerstein (1994) have recently published a proposed scheme for assessing the conservation potential and degree of threat facing the major ecosystems of Latin America and the Caribbean. Conservation potential is defined as the probability of maintaining original, large-scale ecosystem dynamics over a long period of time. Four criteria are used to quantitatively determine conservation potential:

- presence of large blocks of habitat
- presence of intact watersheds
- design of protected area systems
- management of protected areas.

Threats to ecosystems are defined as those factors undermining the prospects for the long-term conservation of biodiversity. A threat index is calculated based on a suite of negative factors:

- habitat loss
- degree of habitat fragmentation
- habitat conversion rates
- habitat degradation
- wildlife exploitation
- long-term development schemes
- human population density.

Points are assigned for each factor according to a pre-arranged scheme, and the sum of the points used to create an index with a range of from 0-60. These threat factors are weighted differently according to the type of ecoregion under consideration. For example, for tropical broadleaf forests if > 90% of the original habitat has been lost 20 points are scored for the habitat loss factor; while a similar percentage loss of mangrove forests scores 35 points. The overall index reflects past patterns and current trends in habitat loss and modification, together with the probability of future changes in the absence of effective conservation action.

The system is under still review but it or its successor may prove to be of wide conservation value.

A number of other techniques have been used to identify areas of high conservation priority. Whilst not assessing threats to ecosystems *per se*, they could be applied to that end. Two recent initiatives are outlined below.

Name	**Papua New Guinea Conservation Needs Assessment**
Description	This assessment was funded jointly by WWF, TNC and WRI to determine national priorities for the conservation of biodiversity. The technique employed GIS analysis of areas at risk from human activities, using a national workshop of concerned experts as a focal point and catalyst to generate a wide, multi-disciplinary consensus of opinion (Beehler, 1993).

Name	**Australian National Wilderness Inventory**
Description	This study has attempted to assess wilderness quality, predict and monitor the impact of development, and plan for the conservation and protection of wilderness areas, again on a national scale. In this process four indicators are used to derive an index of overall wilderness quality, namely: • remoteness from access • remoteness from settlement • apparent naturalness • biophysical naturalness. Further details of the standards used in the inventory are given in Lesslie *et al* (1993).

The main problem with the use of threat indices for ecosystems is that many of the indicators necessary for their calculation are virtually un-measurable, and must therefore be assessed subjectively. Conclusions drawn from the comparison of threat indices of different ecosystems should therefore be treated with caution. Nevertheless these assessments of threat are an advance on previous work because they explicitly state their assumptions.

5.9.5 Individual Proximate Threats to Biodiversity

The major current proximate external threats to biodiversity together with an estimation of the main levels of biodiversity that they affect are briefly outlined in Table 5.9.3 WCMC (1992) reviewed the threats facing selected groups of higher vertebrates, and found that most species were affected by some form of habitat loss or modification, excess exploitation was the second most frequent factor, and competition from or predation by introduced species was the third.

Obviously there is considerable overlap between the type of threat and the level of biodiversity affected: for example threats to biodiversity at the species level may adversely influence the integrity of an entire ecosystem if the species affected plays a key role in ecological processes, whilst habitat fragmentation which adversely affects a whole ecosystem generally does so by affecting the survival of its component species. Some threats such as climate change can be considered as potentially affecting all elements of biodiversity on a regional or global scale.

The effects of external threats can be exacerbated by "internal" factors - the intrinsic biological features of species or ecosystems. Species with a low reproductive rate, limited distribution, specialized niche, or those at high trophic levels within an ecosystem may be more susceptible to external pressures. Ecosystems in turn may be particularly vulnerable if they are isolated, or are relicts of formerly more widespread ecosystems.

Table 5.9.1: Threats to Biodiversity

Proximate External Threat	Level of Biodiversity Affected			
Impact: * = low; ** = medium; *** = high (as assessed by WCMC staff)	Genetic	Species	Ecosystem	Regional/ Global
Habitat loss (which may also lead to habitat fragmentation): causes include cultivation and settlement, pastoral development, forestry, alterations in fire and hydrographic regimes, erosion, siltation, natural disasters etc.	*	**	***	*
Habitat modification: alteration of habitat "quality" for individual species either directly or indirectly, eg pollution, pesticide use, human disturbance	*	***	**	
Direct take: over-exploitation for commercial or subsistence reasons including meat, fur, hides, live animal or plant trade, and medicinal purposes; persecution and deliberate eradication of pest species, selective harvesting of species	***	***	*	
Introduced species: exotic species introduced either deliberately or accidentally by man may prey on, hybridize with, or out-compete indigenous species, especially on islands	*	***	*	
Indirect take: accidental mortality incurred as an incidental result of human activities, particularly the drowning of aquatic reptiles and mammals in fishing nets	*	***	*	
Disease: in some cases natural diseases are exacerbated by the presence of large numbers of domestic livestock	*	***	*	
Climate change: global warming due to increased levels of atmospheric carbon dioxide	*	**	**	***
Pollution: **Acid Rain**	*	*	**	***
Pollution: **Ozone Depletion**	*	*	**	***
Pollution: **Toxic Contaminants**	*	**	**	***

It is important to distinguish the proximate threats (Table 5.9.1) from their ultimate causes, which include a multitude of external socio-economic factors. Chief among these is undoubtedly the rapid increase in the world's human population, but others include population movement, political instability, governmental financial policies, increasing individual needs etc. Environmental economists have proposed a model of "economic failure", ie the inability of existing markets to capture the "true" value of natural resources, as the root cause of threats to biodiversity (Pearce and Moran, 1994).

One institution involved in research into the "fundamental forces" driving the decline of biodiversity is the Centre for Social and Economic Research on the Global Environment (CSERGE). A symposium was organized on this topic in July 1993 in Cambridge, UK (CSERGE, 1993). Within the remit of biodiversity information management these ultimate causes of the threats to biodiversity can be recognised, but due to limited resources cannot and should not be comprehensively addressed. UNEP (1993) also focuses attention on underlying human causes, whilst WCMC (1992) gives fuller discussion of the proximate threats to biodiversity.

Assessment of Threats
The threats facing the world's biodiversity are so varied that no overall standards exist for their evaluation. In general, countries should seek to maximize their information gathering and analysis on each perceived or potential threat with a view to mitigating or combatting its effects. UNEP (1993) recommend that for each threat occurrence information on the following is necessary in order to determine the appropriate response:

- type of threat
- geographical coverage of country
- source of threat
- likely effect of impact
- severity on a low (1); medium (2); and high (3) scale
- imminence and duration
- reversibility
- feasibility of action to remove threat or mitigate its effects
- any appropriate international protocol to address threat
- international legal implications
- costs of remedial action.

A principle which is widely used in monitoring threats to biodiversity is that of "indicator species", namely those that have been shown to be particularly susceptible to certain changes in the environment. For example, in the Antarctic, terrestrial cyanobacteria species may be useful indicators of UV-B levels caused by ozone depletion (Wyn-Williams, 1994), whilst aquatic invertebrates may be sensitive indicators of levels of acid rain. However, no standard indicator species exist - different species are used to monitor different threats in different parts of the world.

Those proximate threats believed to have a high (or potentially high) impact on biodiversity at the ecosystem and global/regional level are discussed in more detail in the following sections. For the most part, no standards exist for monitoring these threats. However, the general ways by which these proximate factors are suspected to threaten biodiversity are outlined, and some of the key source references and international organizations involved in assessing the extent of these threats are identified.

5.9.5 Habitat Loss and Fragmentation

Habitat loss is widely believed to be the most significant threat facing individual species (WCMC, 1992), and also affects entire ecosystems. Assessments of the threats posed to biodiversity by habitat loss are hampered by the lack of a clear definition of what a habitat/ ecosystem actually is. It is therefore almost impossible to set precise geographical limits to a particular habitat. In practice most researchers define habitats according to their own individual research interests, often oriented towards the ecological requirements of individual species. There is thus usually no clear agreement on measuring existing areas of habitat.

The problem is exacerbated by the difficulty of defining when a habitat has been "lost", ie how much of a habitat or ecosystem has to be changed before it is considered destroyed or converted (WCMC, 1992). Habitat loss is in fact an extreme manifestation of habitat modification, with which it intergrades imperceptibly along a continuum.

The effects of habitat loss may be compounded if habitat fragmentation occurs, ie if the remaining habitat consists of dispersed patches separated by converted areas. Several studies have shown that certain species will be less able to tolerate habitat fragmentation than others, and the effect will operate independently of the species loss predicted by the species-area relationship. Effects are likely to be major, but are currently unpredictable (Simberloff, 1992). Various techniques have been developed for measuring the extent of habitat fragmentation, although how this actually translates in terms of threat to biodiversity is not known.

Threat Assessment

The vast majority of the work on assessing habitat loss has been in relation to tropical forest. FAO, who have carried out the most comprehensive analysis (1991, 1993) produced estimates of forest area and annual deforestation rates for over 85 tropical countries. Their work was largely based on the interpretation of satellite imagery. Forests were defined as:

> *"ecological systems with a minimum of 10% crown cover of trees and/or bamboos, generally associated with wild flora and fauna and natural soil conditions and not subject to agricultural practices".*

Deforestation was defined as:

> *"change of land use or depletion of crown cover to less than 10%". Forest degradation was not reflected in the estimates.*

The average annual rate of deforestation of the world's tropical forests over the period 1981-1990 was estimated as 154,000 km^2, or 0.8% expressed as a compound annual rate of deforestation (FAO, 1993). Degradation which does not cause actual deforestation usually involves one or more of the following factors:

- changes in species composition
- changes in canopy cover
- changes in age-structure of particular species.

IUCN have produced a series of Tropical Rain Forest Atlases which may act as benchmark standards from which future tropical forest loss may be evaluated, (eg Sayer *et al*, 1992). Other habitats for which changes have been assessed on a global or regional scale include temperate forests (UN, 1992), wetlands, (eg Dahl, 1990) and deserts (Middleton and Thomas, 1992).

Several different indices to measure forest fragmentation have been developed in the past few years, two of which (the Perimeter Area Index) and the edge/core ratio (ECR) were used by FAO. Full definitions are given in FAO (1993). These indices could be applied to other habitats.

In addition to these habitat-specific approaches, Hannah *et al* (1994) have attempted to assess human impact on ecosystems on a global scale. Ecosystems were classified as undisturbed, partially disturbed or human dominated. They found that natural habitat has been displaced by human disturbance over nearly 75% of the habitable surface of the planet.

5.9.6 Global Climate Change

Over the past few decades scientists have become aware that emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases: carbon dioxide, methane, chlorofluoro-carbons (CFCs) and nitrous oxide. It is now believed that these increases will enhance the greenhouse effect, resulting on average in a warming of the Earth's surface, and consequent changes in sea levels and global climate.

Most experts agree that ecological systems will be dramatically changed by global warming, to an extent determined by the magnitude and speed of the climatic change. Among the projections are that the ranges of many species will alter latitudinally and altitudinally. For instance, species ranges may shift hundreds of kilometres northwards above the equator (and a similar distance southwards below it). These distributional changes will cause the break-up of existing ecosystems and - hopefully - their eventual reassembly. However, many species will face extinction, either because the climate will become unsuitable for them in all of their present range, or because they will be unable to migrate and "track" the changing climate due to limited mobility or the existence of dispersal barriers such as mountains, rivers, and man-made obstacles. Changes in interspecific competition may also have significant impacts. In the most pessimistic scenarios, the collapse of whole ecosystems such as coral reefs and mangrove thickets is predicted, while other ecosystems at risk include temperate and boreal forest, alpine ecosystems and wetlands (Markham *et al*, 1993).

Threat Assessment

The Intergovernmental Panel on Climate Change (IPCC) was set up jointly by the World Meterological Organization (WMO) and UNEP in 1988. Its remit is to assess scientific information related to climate change, such as emissions of greenhouse gases, predict the likely environmental and socio-economic impacts of climate change, and formulate appropriate response strategies. In 1990, the IPCC predicted a rate of increase of global mean temperature during the next century of about 0.3°C per decade (greater than that seen over the past 10,000 years) and an average rise in mean sea level of about 6 cm per decade (Houghton *et al,*· 1990). Alterations in global rainfall patterns and ocean currents will probably be associated with these changes, but are clouded with uncertainty since they cannot be reliably predicted with contemporary climate models.

Several major international conferences have been held to examine the likely consequences of global climate change, particularly with regard to environmental effects on biodiversity and low-lying coastal areas and countries, and published proceedings are available, (eg Peters and Lovejoy, 1992). A number of countries have conducted reviews of the predicted effects of climate change on national biodiversity, for example the United States (Smith and Tirpak, 1989), Norway (Holten and Carey, 1992), and China (Hulme *et al,* 1992). Other reviews with a regional scope have been published, for example covering the South Pacific (Pernetta and Hughes, 1990), the Caribbean (UNEP, 1989). The predicted global effects of climate change on particular ecosystems has also been examined, eg Arctic terrestrial ecosystems (Oechel and Holten, 1993) and coral reefs (Wilkinson and Buddemeier, 1994). Recognition of the potential magnitude of the effects of global warming on biodiversity helped lead to the signing of the Climate Convention at the Earth Summit in 1992 in Rio de Janeiro.

One concern is that the global system of protected areas may be unable to maintain current levels of biodiversity in the face of climate change. Leemans and Halpin estimate that up to 33% of existing reserves may experience a change in Holdridge Life Zone, leading to loss of biodiversity (WCMC, 1992). WWF have recently thoroughly reviewed the likely impacts of global warming on biodiversity (Markham *et al*, 1993).

5.9.7 Acid Rain

Acid rain, caused chiefly by high emission levels of sulphur dioxide, is a particular threat to industrialized nations and their neighbours. It is a major environmental concern in central and northern Europe and North America. Acidic pollutants can have adverse impacts on biodiversity by altering genetic diversity, reducing reproductive potential, altering intrinsic rates of growth, and by impairing the structure and functioning of ecosystems (Barker and Tingey, 1992). Impacts are greatest where soils are relatively un-buffered. For example, more than 60% of Canada's land area has, at best, only a moderate ability to neutralize acids. Increased acid concentrations can cause the leaching of nutrients from the soil, affect survival of aquatic organisms, and cause aluminium, cadmium, lead and other potentially toxic metals to be more soluble, allowing them to be "mobilized" into water. The end result is reduced levels of biodiversity: it is estimated that more than 55,000 lakes in eastern Canada have lost at least 20% of their potential species complement (Government of Canada, 1991).

Threat Assessment

Relatively few studies have attempted to quantify the actual damage or degree of threat to biodiversity on a national or regional scale that acid rain represents. Some notable exceptions are Rimes (1992) and Farmer (1993), who conducted assessments of the risk to protected nature reserves in the UK, while Tickle *et al* (in press) extend this type of assessment to examine the likely consequences of acid rain for European biodiversity as a whole. Tickle *et al* predict that 70% of European protected areas will be threatened by acid rain in the year

2000. Of the 1300 species known to be affected by acid rain that they considered, 85% (including many species of international conservation concern) had suffered detrimentally. The 15% of species that had increased in range or abundance were mainly common taxa.

A manual on the methodologies and criteria for mapping critical levels and loads of air-borne pollutants and determining geographical areas where they have been exceeded has been published by Umweltbundesamt (1993). The RAINS (Regional Acidification Information & Simulation) model developed by IIASA (Alcamo *et al*, 1990) is currently accepted as the standard for predicting the levels of acid rain in Europe.

5.9.8 Ozone Depletion

The phenomenon of ozone depletion is a relatively recent one. It was first recognised in the late 1970s with the appearance of an "ozone hole" over the Antarctic where lower than normal levels of stratospheric ozone were recorded. Over the past decade and a half in spite of yearly fluctuations there has been a definite trend of decreasing ozone concentrations. Ozone concentrations are measured in Dobson units (DU) and in 1991 the lowest recorded level over the Antarctic was 125 DU, representing less than 50% of the expected range of 300-290 DU (Karentz, 1992). The decrease is believed to be caused by the release of man-made chloro-fluoro-hydrocarbons (CFCs) and other ozone-destroying chemicals into the atmosphere. Ozone depletion is most serious above Antarctica, but has been observed in other parts of the world. For example, up to 8% losses were recorded over Europe in 1992 (Mayer, 1992).

Ozone acts as a radiation filter or "natural sun-screen", which prevents much of the biologically-harmful ultraviolet light entering the atmosphere from reaching the Earth's surface. A decrease in natural stratospheric ozone results in an increase in certain wavelengths received at ground level, particularly ultraviolet B. The adverse effects of UV-B on plant life - including damage to DNA and alterations in growth, metabolism and reproduction - have long been known (see Teramura *et al*, 1991). Phytoplankton are especially susceptible due to their small size but higher plants and other organisms are also affected.

Threat Assessment

No standards exist for the assessment of the threat to biodiversity caused by ozone depletion. UNEP (1991) recently reviewed the known environmental effects of ozone depletion. Many studies have examined the potential threat posed by increased levels of UV-B to particular species. For example, Krupa and Kickert (1989) conducted a review of the susceptibility of important agricultural and crop species to UV-B radiation, using biomass as an indicator of sensitivity. Caldwell *et al* (1982) compared the sensitivities of species in Arctic and alpine ecosystems, concluding that Arctic species were far more susceptible to damage by increased levels of UV-B. Rather less attention has been focused on natural communities.

The impact of ozone depletion on ecosystems has been well-studied in Antarctica (see Weiler and Penhale, 1994). Smith *et al* (1991) estimated that ozone depletion in the Antarctic could cause a 6-12% decline in phytoplankton production in the Southern Ocean. Phytoplankton form the base of the Antarctic food web so a decline of this magnitude may have grave knock-on effects on populations of species at higher trophic levels: zooplankton, krill, fish, penguins, seals and whales. Wyn-Williams (1994) examined the influence of UV-B on Antarctic terrestrial ecosystems. He concluded that the ozone hole over Antarctica has existed for over 10 years without a biological catastrophe on land, and that it is possible that ecosystems will acclimatize to changes in UV-B levels. Nevertheless ozone depletion is expected to worsen over the next few decades, and the consequent effects of even small changes to ecosystems are difficult to predict.

Research on ozone depletion and its biological effects in the Antarctic is largely coordinated by SCAR (the Scientific Committee on Antarctic Research). The European Ozone Research Coordinating Unit, located in Cambridge, UK, is also a key institution involved in assessing the magnitude of the ozone depletion problem and the threats it poses to biodiversity.

5.9.9 Toxic Contaminants

Industrial, agricultural and domestic pollution can take many forms - eg thermal, sonic, altered nutrient balances - but one of the most damaging is the release of toxic contaminants which can become concentrated in their progress through natural food webs. Toxic contaminants can be broadly categorized into those that enter the environment as incidental by-products of industrial manufacturing processes, and those, such as pesticides and fertilizers, that are applied intentionally. Thousands are known, but unfortunately their effects on biodiversity are for the most part unstudied. In the Great Lakes the International Joint Commission, a binational organization involving Canada and the United States has identified the 11 most damaging "critical pollutants" as TCDD, TCDF, Benzo(a)pyrene, DDT and its breakdown products including DDE, Dieldrin, HCB, Alkylated lead, Mirex, Mercury, PCBs and Toxaphene (Government of Canada, 1991).

Threat Assessment

Under contract to UNEP, IIASA (International Institute for Applied Systems Analysis) has prepared various documents detailing standards to be used in environmental reporting at the global, regional and national levels. Fedra (1994) proposes a methodology for linking the issues addressed in Agenda 21 of the Biodiversity Convention (including environmental problems such as land degradation and various forms of pollution) with indicators derived from basic environmental monitoring and statistics (eg measurements of pollution flows).

To be useful, indicators must have a context and reference point, desirable and undesirable values or ranges, and defined thresholds. Concrete indicator values can then be interpreted and their status and trends evaluated. This inevitably introduces an element of subjectivity. In the case of certain pollutants such as DDT or CFCs, scales, ranges and thresholds may be obvious: zero emissions and concentrations are desirable although perhaps not achievable in practice. By contrast, for most environmental variables - such as nutrient levels in a lake - no objective **natural** evaluation scale is available: human perceptions and attitudes are the primary guidelines. Fedra (1994) compares existing State-of-the-Environment (SOE) approaches used by different countries, and discusses tools, methods, and reporting systems.

IIASA has also designed, developed and implemented EARSS (the Environmental Assessment and Reporting System) covering the Asia-Pacific region (IIASA, 1994). EARSS is a set of interactive computer tools, functioning as a repository of environmental information at the indicator level, an interactive assessment tool, and reporting format. The system is intended for scientific and professional staff at the level of national governments, regional organizations and academic institutions that support State-of-the-Environment reporting.

5.9.10 References

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Annex 1: Original IUCN Threatened Species Categories

The following categories and their definitions have been superseded by those in Annex 2.

Extinct (Ex). Species not definitely located in the wild during the past 50 years (criterion as used by the Convention on International Trade in Endangered Species of Wild Fauna and Flora). **Note**: occasionally the category Ex? is assigned; this denotes that it is virtually certain that the taxon has recently become extinct.

Endangered (E). Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction. Also included are taxa that may be extinct but have definitely been seen in the wild in the past 50 years.

Vulnerable (V). Taxa believed likely to move into the "Endangered" category in the near future if the causal factors continue operating. Included are taxa of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously depleted and whose ultimate security has not yet been assured; and taxa with populations that are still abundant but are under threat from severe adverse factors throughout their range. **Note**: in practice, "Endangered" and "Vulnerable" categories may include, temporarily, taxa whose populations are beginning to recover as a result of remedial action, but whose recovery is insufficient to justify their transfer to another category.

Rare (R). Taxa with small world populations that are not at present "Endangered" or "Vulnerable", but are at risk. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

Indeterminate (I). Taxa *known* to be "Endangered", "Vulnerable" or "Rare" but where there is not enough information to say which of the three categories is appropriate.

Insufficiently Known (K). Taxa that are *suspected* but not definitely known to belong to any of the above categories, because of lack of information.

Threatened (T). Threatened is a general term to denote species which are "Endangered", "Vulnerable", "Rare", "Indeterminate", or "Insufficiently Known" and should not be confused with the use of the same term by the U.S. Office of Endangered Species. In this volume it is also used to identify taxa comprised of several sub-taxa which have differing status categories.

Commercially Threatened (CT). Taxa not currently threatened with extinction, but most or all of whose populations are threatened as a sustainable commercial resource, or will become so, unless their exploitation is regulated. This category applies only to taxa whose populations are assumed to be relatively large. **Note**: in practice, this category has only been used for marine species of commercial importance that are being overfished in several parts of their ranges.

Annex 2: New IUCN Threatened Species Categories

The following categories and their definitions were accepted by the IUCN Council in December 1994. Criteria for evaluation of the **Critically Endangered**, **Endangered**, and **Vulnerable** categories are provided immediately afterwards.

THE CATEGORIES

Extinct (EX). A taxon is **Extinct** when there is no reasonable doubt that its last individual has died.

Extinct in the Wild (EW). A taxon is **Extinct in the Wild** when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR). A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by **any of** the criteria (A to E) outlined later.

Endangered (EN). A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by **any of** the criteria (A to E) outlined later.

Vulnerable (VU). A taxon is **Vulnerable** when it is not Critically Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by **any of** the criteria (A to E) outlined below.

Lower Risk (LR). A taxon is **Lower Risk** when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered, **or** Vulnerable, and is not Data Deficient. Taxa included in the Lower Risk category can be separated into three subcategories:

1. Conservation Dependant. Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

2. Near Threatened. Taxa which do not qualify for Conservation Dependant, but which are close to qualifying for Vulnerable.

3. Least Concern. Taxa which do not qualify for Conservation Dependant or Near Threatened.

Data Deficient (DD). A taxon is **Data Deficient** when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. DD is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required. Listing a taxon as DD acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, or if there are reasonable chances of unreported surveys in which the taxon has not been found, or that habitat loss has had an unfavourable impact, threatened status may well be justified.

Not Evaluated (NE). A taxon is **Not Evaluated** when it has not yet assessed against the criteria.

THE CRITERIA FOR HIGH RISK CATEGORIES

Critically Endangered (CR)
A taxon is **Critically Endangered** when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by **any of** the following criteria (A to E):

A Population reduction in the form of **either of** the following:

1. An observed, estimated, inferred or suspected reduction of at least 80% over the last 10 years or three generations, whichever is the longer, based on (and specifying) **any of** the following:
   a) direct observation
   b) an index of abundance appropriate for the taxon
   c) a decline in area of occupancy, extent of occurrence and/or quality of habitat.
   d) actual or potential levels of exploitation
   e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. A reduction of at least 80% projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (c), (d) or (e) above.

B Extent of occurrence estimated to be less than 100km² or area of occupancy estimated to be less than 10km², and estimates indicating **any two** of the following:

1. Severely fragmented or known to exist at only a single location.

2. Continuing decline, observed, inferred or projected, in **any of** the following:
   a) extent of occurrence
   b) area of occupancy

c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3. Extreme fluctuations in **any of** the following:
a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals.

C Population estimated to number less than 250 mature individuals and either:

1. An estimated continuing decline of at least 25% within 3 years or one generation, whichever is longer or

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals **and** population structure in the form of **either**
a) severely fragmented, (ie no subpopulation estimated to contain more than 50 mature individuals
b) all individuals are in a single sub-population.

D Population estimated to number less than 50 mature individuals.

E Quantitative analysis showing the probability of extinction in the wild is at least 50% within 5-10 years or 2-3 generations, whichever is longer.

Endangered (EN)
A taxon is **Endangered** when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by **any of** the following criteria (A to E):

A Population reduction in the form of **either of** the following:

1. An observed, estimated, inferred or suspected reduction of at least 50% over the last 10 years or three generations, whichever is the longer, based on (and specifying) **any of** the following:
a) direct observation
b) an index of abundance appropriate for the taxon
c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
d) actual or potential levels of exploitation
e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. A reduction of at least 50% projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (c), (d), or (e) above.

B Extent of occurrence estimated to be less than 5000km^2 or area of occupancy estimated to be less than 500km^2, **and** estimates indicating **any two of** the following:

1. Severely fragmented or known to exist at no more than five locations:
2. Continuing decline, inferred, observed or projected, in **any of** the following:
   a) extent of occurrence
   b) area of occupancy
   c) area, extent and/or quality of habitat
   d) number of locations or subpopulations
   e) number of mature individuals.

3. Extreme fluctuations in **any of** the following:
   a) extent of occurrence
   b) area of occupancy
   c) number of locations or subpopulations
   d) number of mature individuals

C Population estimated to number less than 2500 mature individuals and **either**:

1. An estimated continuing decline of at least 20% within 5 years or 2 generations, whichever is longer, or

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals **and** population structure in the form of **either**
   a) **severely** fragmented, (ie subpopulation estimated to contain more than 250 mature individuals)
   b) all individuals are in a single subpopulation.

D Population estimated to number less than 250 mature individuals.

E Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or 5 generations, whichever is the longer.

Vulnerable (VU)
A taxon is **Vulnerable** when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by **any of** the following criteria (A to E):

A Population reduction in the form of **either of** the following:

1. An observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer, based on (and specifying) **any of** the following:
   a) direct observation
   b) an index of abundance appropriate for the taxon
   c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
   d) actual or potential levels of exploitation

e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

2. A reduction of at least 20% projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), or (d) above.

B Extent of occurrence estimated to be less than 20,000km² or area of occupancy estimated to be less than 2000km², and estimates indicating **any two of** the following:

1. Severely fragmented or found known to exist at no more than ten locations.

2. Continuing decline, inferred, observed or projected, in **any of** the following:
a) extent of occurrence
b) area of occupancy
c) area, extent and/or quality of habitat
d) number of locations or subpopulations
e) number of mature individuals.

3. Extreme fluctuations in **any of** the following:
a) extent of occurrence
b) area of occupancy
c) number of locations or subpopulations
d) number of mature individuals

C Population estimated to number less than 10,000 mature individuals and **either**

1. An estimated continuing decline of at least 10% within 10 years or 3 generations, whichever is the longer, **or**

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals **and** population structure in the form of **either**
a) severely fragmented, (ie no subpopulation estimated to contain more than 1000 mature individuals)
b) all individuals are in a single subpopulation.

D Population very small or restricted in the form of **either of** the following:

1. Population **estimated** to number less than 1000 mature individuals.

2. Population is characterised by an acute restriction in its area of occupancy (typically less than 100km²) or in the number of locations (typically less than 5). Such a taxon would thus be prone to the effects of human activities (or scholastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.

6 EDUCATION and TRAINING

6.1 Introduction

6.1.1 Overview

Article 12 (Research & Training) and *Article 13 (Public Education & Awareness)* of the CBD recognise the vital importance of education and training by recommending the establishment of programmes for scientific and technical education and training in the identification, conservation and sustainable use of biodiversity, in particular for the specific needs of developing countries. Staff skilled in biodiversity information management are key to successful environmental resource management and biodiversity conservation. Yet "present efforts in education and training to strengthen awareness and understanding of biodiversity conservation are inadequate" (WWF *et al*, 1993). Expertise in biodiversity information management is often in short supply in developing countries. In addition, staff turnover is also a serious problem. Staff that receive specialised computer training as part of a training programme become widely sought after, and often take positions with better paying private companies. In developing countries, few pathways or incentives lead to a career in biodiversity information management.

Education and training in biodiversity information management is typically part of a larger curriculum on the environment. Several institutions offer graduate programmes in environmental resource management, biology or GIS within which biodiversity information management is taught, but is not the focus of the course. Moreover, the information management component of some courses may not be explicitly identified in the associated prospectus. However, there are a few new programmes at established institutions which resulted from the CBD, as well as new funding sources such as the Global Environmental Facility (GEF), USAID's Biodiversity Support Programme and the United Kingdom's Darwin Initiative Grants. Suitable training is also available from a number of bilateral and multilateral organisations, including the United Nations agencies UNITAR, UNEP, UNDP and FAO. These agencies often have rosters of specialist consultants with experience in formal and on-site training.

To address the need for information on education and training opportunities, a listing of institutions with relevant options is presented in Section 6.2. Many such institutions could be included, for instance all those associated with older disciplines such as biosystematics (taxonomy), zoology, botany, geographical information systems (GIS), remote sensing, physical sciences, geography, and conservation. However, for the purposes of this document only those institutions offering specific programmes, courses, or modules in information management aspects are included (ie the collection, organisation, analysis and presentation of biodiversity data).

6.1.2 On-site Training

On-site training in information management has been a widely identified need and fundamental component of institutional capacity building. There are several advantages to on-site training. Firstly, on-site training allows the instructor to observe the employees' work environment and routines. It enables site-specific and relevant examples to be used to demonstrate new techniques and it has the added potential of diagnosing and solving unforeseen difficulties. Staff completing courses at training centres, may use unfamiliar equipment or applications, so that when they return to their workplace, routines learned during on-site training may not function identically. This may lead to frustration and a reliance on previous often inefficient work habits. Finally, on-site training may also be more cost-effective because of the reduced expenditure on staff travel and accommodation.

There are several factors to consider when planning to train staff on-site. For instance, if the training includes a computer-based component, suitable software and hardware may have to be selected via a process of tender (see Selection of Hardware and Software, Section 3.1). Post-training support may also be critical to the long term success of an on-site training course, particularly when software manuals are available only in non-local languages. In remote areas, introductory to advanced level training may undertaken by means of Computer-Based Training (CBT) techniques, where students follow on-line tutorials to reinforce traditional training and gain new skills.

On-site computer training is offered through three key sources: consulting firms; vendors; and multilateral/bilateral agencies. A wide range of on-site training is available from small to medium-sized consulting firms such as FTP International of Finland or the National Computer Training Centre (NCC) of the UK.

6.1.3 Vendor Training

Generally, there is no shortage of product-specific training from vendors of computing equipment. Many manufacturers are able to provide either direct training or provide details of where training can be obtained for their products. Considerations of vendor selection should include the geographic location of the company, their market reputation and longevity, and provision of after-sales training and support. Many vendors have established networks of dealers worldwide.

Two of the largest software companies, Novell and Microsoft have introduced standards for the training that should be undertaken by network administrators and support personnel. These companies offer exams that provide a simple method to determine the effectiveness of the training course. They may also offer consultancy on training needs, whether for individual courses or on training, leading to internationally recognised qualifications such as the Certified NetWare Administrator (CNA) or Microsoft Certified Professional (MCP).

Training in the computer-related aspects of biodiversity information management can be sub-divided into thirteen areas as illustrated in Table 6.1.2.

Training Applications	Popular Products	Vendor Training
1. Operating Systems	DOS/Windows/UNIX/ Mac	IBM/Microsoft/SUN/ MacIntosh
2. Database Software	FoxPro	Microsoft Ltd.
3. Spreadsheet Software	Excel	Microsoft Ltd.
4. Statistical Packages	SAS/STAT	SAS Institute Inc.
	SPSS	SPSS Inc.
5. Automated Mapping (AM)	Accugraph	Accugraph Inc.
6. Image Processing (IP)	EASI/PACE	PCI
7. CAD Packages	AutoCAD	Autodesk Inc.
8. Geographic Information Systems (GIS)	ARC/INFO	Environmental Systems Research Incorporated (ESRI)
9. Biodiversity Applications Software	Linneaus II	ETI
10. Data Capture Tools	GPS	Motorola Inc.
11. Optical Scanner	Zeiss	Carl Zeiss Ltd.
12. Network Applications	Novell/Microsoft	Novell
13. Internet	Internet, WWW, ftp, telnet, gopher, archie	

Table 6.1.2

6.2 Education and Training Opportunities

6.2.1 Approach

Information was collected by surveying educational and training institutions and requesting details in four key areas:

- titles of degree courses, training programmes, short courses, workshops, syllabuses, duration, target group, degree accreditation and location
- references on biodiversity information management, education manuals, guides, studies, research papers, reports and books (hard-copy or electronic)
- training needs assessments, questionnaires, models, methodologies, strategies or frameworks for institutions to follow, as well as any standards developed for training in biodiversity information management

- details about tools being used for biodiversity information management including software, hardware, interactive database programmes, low-tech options and communication technologies (including training networks).

The information was requested by electronic mail and fax. Of the 147 requests sent out to institutions, there was a 31% response rate. Information on listings was also obtained from existing WCMC files and databases. Effort was made to gather information on a global basis. The institutional breakdown by region is as follows: South America (1); Australia (1); Caribbean (1); Asia (5); North America (6); Africa (10); and Europe (18). These figures are biased by existing WCMC institutional links, the promotional investment of educational institutions and time constraints. There is also substantial evidence that funding shortages restrict access to the very technology that allows communication about educational and training resources.
WCMC would be pleased to receive additional information on education and training sources, and training support materials, as well as comments on those profiled in Section 8.2. A selection of reference sources for education and training in biodiversity information management may be found in the Bibliography, Section 7.3.

6.2.2 Summary of Results
Table 6.1 provides a summary of the 42 training and education institutions. To avoid confusion, column titles are explained below:

- **Name** is the full name of the institution offering education or training

- **Formal Training** implies that the institution awards recognised academic degrees upon successful completion

- **Short Courses** are loosely defined as those lasting between one week and two months in duration

- **On-site** summarises the capacity of an institution to provide customised training for clients at a location of their choosing.

It should be noted that several institutions offer field courses in various locations throughout the world, and may have affiliations with universities in different countries.

Name	Formal Training	Short Courses	On-site
African Biodiversity Institute (ABI), Kenya	•	•	
Asian Institute of Technology (AIT), Thailand	•	•	
Biodiversity Foundation for Africa (BFA), Zimbabwe		•	
Centre for Environmental Management and Planning (CEMP), United Kingdom		•	•

Center for International Forestry Research (CIFOR), Indonesia		•	
Clark University, United States	•	•	
College of Geographic Sciences (COGS), Canada	•	•	
Commonwealth Science Council (CSC), United Kingdom	•	•	
Conservation Data Centre, Mahidol University, Thailand	•		
Consortium for International Earth Science Information Network (CIESIN), United States	•		•
Council for Scientific and Industrial Research (CSIR), South Africa		•	
Duke University, The Centre for Tropical Conservation, United States	•	•	
Durrell Institute of Conservation and Ecology (DICE), United Kingdom	•		
Expert Centre for Taxonomic Identification (ETI), The Netherlands		•	
Food and Agriculture Organization of the United Nations (FAO), Italy		•	•
Hull University, United Kingdom	•	•	
Indonesian MAB National Committee (LIPI) & the Indonesian Institute of Sciences, Indonesia		•	
International Centre for Research in Agroforestry (ICRAF), Kenya		•	•
International Centre for Tropical Agriculture (CIAT), Columbia	•	•	
International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands	•		
International School of Nairobi, (Medias France), Kenya	•		
Island Resources Foundation (IRF), US Virgin Islands		•	
Makerere University, Institute of Environment and Natural Resources (MUIENR), Uganda	•	•	

Microbial Strain Data Network (MSDN), United Kingdom		•	
National University of Hanoi, Department of Environmental Sciences, Vietnam	•		
Otley College, United Kingdom	•	•	
Oxford Forestry Institute (OFI), United Kingdom	•	•	•
Rijksherbarium/Hortus Botanicus (RHHB), The Netherlands	•		
Royal Botanic Gardens - Kew, United Kingdom	•	•	
Smithsonian Institute (SI), Conservation and Research Centre, United States		•	•
The Nature Conservancy (TNC), United States		•	
Tropical Biology Association (TBA), United Kingdom		•	
United Nations Development Programme (UNDP) & Global Environmental Facility (GEF), Kenya	•		
United Nations Environment Programme (UNEP)/ INFOTERRA, Kenya	•	•	
United Nations Training Institute for Training and Research (UNITAR), Switzerland		•	•
United States Environmental Training Institute (USETI), United States		•	•
University of Adelaide, Australia	•		
University of Amsterdam, Research School of Biodiversity, The Netherlands	•	•	
University of Birmingham, School of Biological Sciences, United Kingdom	•	•	
University of Botswana, Botswana	•		
University of Edinburgh, Institute of Ecology and Resource Management, United Kingdom	•	•	
University of London, Wye College, United Kingdom	•	•	
University of Nairobi, Kenya	•		

Table 6.2

6.2.3 List of Opportunities

The education and training opportunities of each institution are described using the following template:

Name	The full name, acronym and location of each institution in the listing (in order to contact educational institutions for course and funding information, the address of each organisation may be found in Section 8.2 of this document).
Curricula	The type of degree, diploma or course(s) offered, and where possible includes course duration.
Target Group	The prerequisite academic, age and citizenship requirements.
Courses	The names of degree and short courses.
Educational Resources	References to libraries, computer hardware, software and educational journals.
Notes	Includes course language, language proficiency requirements, institutional affiliations and further details. A "+" symbol is used where additional course(s) are offered but which are not directly related to biodiversity information management. There is a list of key references on education and training as well as a partial list of funding organisations and sources at the end of the section, but candidates are best advised to obtain information by contacting educational institutions in the host country directly.

Name	**African Biodiversity Institute (ABI)** Kenya
Curricula	MSc[1], PhD[2] *Biodiversity*
Target Group	Postgraduates, professionals, overseas students
Courses	Degree course work covers general environmental subjects including environmental and natural resource protection and biodiversity, with emphasis on EIA in agricultural practices, biostatistics and research methodologies, computer studies + Short Training Courses[3]: EIA; biodiversity +
Educational Resources	School of Environmental Field Studies (SEFS)
Notes	1 Any holder of a first class or upper second degree in Biology, Sociology, Botany, Zoology, Entomology, Biochemistry, Agriculture, Forestry, Environmental Sciences or Physical Sciences

from a recognised university.

[2] Open to candidates who hold Masters Degree under Inter-University Programme for Environmental Risk Assessment (IPERA) and/or holders of Masters in environment or basic sciences from recognised universities.

[3] Short courses are conducted at ABI's School of Environmental Field Studies (SEFS) in Jinja, Uganda.

- Candidates for both programmes must have a good working knowledge of English, and be under 35 years of age.

Name — **Asian Institute of Technology (AIT)**
Thailand

Curricula — Certificate, Diploma, MSc, PhD *Interdisciplinary Natural Resources Development and Management Program* +

Target Group — Open to graduates from Asian countries

Courses — Degree Courses: Environmental Remote Sensing; Geoinformation Science.
Previous short courses and workshops: GIS/Remote Sensing for Managing Biodiversity Conservation; Applied Remote Sensing. Certificate short courses: Natural Resources Information Management; Marine Applications of ERS-1 Data; GIS +

Educational Resources — Regional Computer Centre (ARC/Info, Regional Research and Development Centre; Asian Institute of Technology Library and Regional Documentation Centre; Language Centre (Pre-Master Bridging Program)

Notes
- Supported by several international governments and is a UNEP Centre for Excellence.
- Language of instruction is English.

Name — **Biodiversity Foundation for Africa (BFA)**
Zimbabwe

Curricula — Short Courses (approx. 2-3 weeks in duration) *Afrotropical Savannah Biodiversity* +

Target Group — Technical Officers, Researchers (especially from museums and herbaria in southern and central Africa).

Courses Field courses: Inventory and Monitoring of Afrotropical Savannah Biodiversity +

Educational Resources Logistical support: portable computers and printers for field use; Relational Database Management systems (RDM) under development for specimen management based on the Association of Systematics Collections information model for biological collections.

Notes
- Courses involve experimental training in methodology inventory of target groups (eg. vegetation, selected arthropods, soil microfauna, vertebrates). Emphasis placed on collation of digital information in the field.
- These courses form part of the Biodiversity Foundation for Africa's SAVSKILL Programme to monitor savannah biodiversity in south-central Africa, and to simultaneously develop institutional capacities through field training.

Name **Centre for Environmental Management and Planning (CEMP), Aberdeen University Research and Industrial Services (AURIS)**
United Kingdom

Curricula Short courses and conferences: *Environmental Management* +

Target Group Professionals, graduates from developing and developed countries.

Courses Environmental Information Services; Baseline studies and Environmental Monitoring; Pollution assessments; Resource and Land-use planning; Marine and Coastal planning; and Forestry +
Previous courses: 14 annual two-week international seminars sponsored by WHO and UNDP on Environmental Assessment (EA) and Management; 8 two month intense courses on Environmental Assessment and Management; provided specialist training on EA in several countries.

Educational Resources Comprehensive database, well equipped laboratories for analytical work, library

Notes
- Affiliated with Aberdeen University's Environmental Division.
- Courses and conferences also held in Portugal, Italy, Algeria, Brazil, Malta, Hungary, United States, Hong Kong, Iceland, Taiwan, Kuwait, Egypt and India.

Name **Center for International Forestry Research (CIFOR)**
Indonesia

Curricula Short Courses: *Tropical and Temperate Forestry* +
Workshops: Forestry

Target Group CIFOR encourages interaction among trainees from different developing and developed countries.

Courses Course covers forestry principles, economics, planting and design of seed orchards, seed collecting and handling. Course involves field exercises.
In conjunction with USAID, FAO and IUFRO's Special Programme for Developing Countries, a series of workshops were held on Priorities for Policy Research for Forestry and Agroforestry: Bangkok (1992); Nairobi (1992); Costa Rica (1993).

Educational Resources CIFOR's library (CDS/ISIS V 2.3); MARC database
Tree Growth Potential Information System (TROPIS) modelling and database; CIFOR's Research Support and Information Unit; Quarterly newsletter CIFORN; LAN; electronic mail;2 Novell Servers each with CD-ROM servers; GIS; SUN10/51 SparcStations.

Notes
- Courses taught in conjunction with the ASEAN Forest Tree Seed Centre (AFTSC)
- Affiliated with FAO and the International Union of Forestry Research Organizations.

Name **Clark University, Clark Labs for Cartographic Technology and Geographic Analysis**
United States

Curricula MSc (1 & 2 year) programme in *GIS and International Development* +; Short courses (1 week) in *GIS and Image Processing* +

Target Group Development and planning professionals[1] and overseas students

Courses MA courses: Remote Sensing; GIS; Applications of GIS in Development; Development Project Planning and Management; Geodesy; Cartography +
Short course in GIS and Image Processing offered twice a year; customised training courses available[2].

Educational Resources GIS labs (ARC/Info and IDRISI); Centre for Environment, Technology and Development (CENTED); library

Notes
[1] BA or BSc degree or equivalent, TOEFL score 550
[2] Courses cover theoretical and practical aspects of GIS and Image Processing. Sessions consists of 25% lectures and 75% practical exercises.

Name **College of Geographic Sciences (COGS)**
Canada

Curricula Diploma (2 years) *Land Information Technology* +

Target Group Open to students and graduates from developing and developed countries.

Courses Computer Applications for Planning Technologies; Computer Graphics I & II; Planning Context; Mapping and Projections; Remote Sensing and Air Photo Interpretation; Terrain Analysis; Statistical Methods for Planning Technologies; Computer Assisted Mapping; GIS; Environmental and Land Information Systems; Planning and Environmental Law; Site Planning: Environmental Design; Self-directed Studies in IT; Research Project.

Educational Resources Software: DOS/Windows/Unix; WordPerfect 6.0b; dBase IV 2.0;, FoxPRO 2.6; EXCEL 5.0; AutoCad 12; Corel Draw 4.0/5.0; Aldus Pagemaker 4.0; SPSS 4.0; SPSS 6.0 for Windows; PC ARC/Info, ARC/VIEW.
Information technology: Mosaic; Netscape; ftp; telnet; gopher and archie.

Notes
- Prerequisites: Grade 12 (Canada) or equivalent with an overall of at least 60% and academic mathematics.
- Students having a poor capacity in English may be required to take an approved correspondence course during the summer between the two years.

Name **Commonwealth Science Council**
United Kingdom

Curricula Diploma, training workshops and courses in *Biodiversity*

Target Group Professionals and graduates from developing and developed countries.

Courses Examples of courses offered: International diploma course in herbarium techniques in collaboration with Royal Botanical Gardens, Kew, London; Regional training workshop on herbarium curation techniques Lucknow, India; Regional tissue culture training course, University West Indies Biotechnology Centre, Jamaica; International Course on under-utilised Tropical Plant Genetic Resources and their conservation and utilisation, University of Pertanian, Malaysia; Regional training course on fungal identification, Zimbabwe.

Educational Resources Biodiversity flagship programme, various publications

Notes

- Courses taught in English.

Name **Conservation Data Centre, Mahidol University**
Thailand

Curricula BSc, MSc, PhD (1, 2 & 3 years) *Environmental and Resource Studies; Biology* +

Target Group Postgraduates, professionals

Courses Ecology; Conservation Biology +

Educational Resources Conservation database MacKinnon-Ali Software System (MASS) using FoxBase v.2.00 (IBM AT)

Notes

- Supported by World Wide Fund for Nature (WWF)

Name **Consortium for International Earth Science Information Network (CIESIN)**
United States

Curricula Short Courses: *Data Information Resources, Access and Management* +

Target Group Educators, researchers, environmental policy-makers, policy analysts, government agencies, librarians.

Courses Issue Oriented Information Retrieval; The Environment and Sustainable Development; Discovering Environmental Information on the Internet; Guided Tour of the Internet; Using the World Wide Web; Publishing Information on the World Wide Web +

Educational Resources Computer laboratories; Interactive analysis software; *Classroom Earth* educational bulletin board; CIESIN Human Dimensions Quarterly Journal.

Notes
- Courses can be taught at CIESIN headquarters or at other locations where Internet classroom facilities are available.
- Course taught in English.

Name **Council for Scientific and Industrial Research (CSIR)**
South Africa

Curricula Short Courses: *Information Technology Training* +

Target Group Business people, researchers, university students

Courses Introduction and effective use of the Internet; Use of the Net for personal communications; information retrieval; and information publishing +

Educational Resources IBM PC environment (DOS, Windows); US census data; Internet (World Wide Web, NetNews)

Notes
- Courses conducted in English.

Name **Duke University, Center for Tropical Conservation (CTC)**
United States

Curricula MSc (6 months - 2 years) *Environmental Management*; *International Professionals Training Program (IPTP)*; Specialised non-degree training in the School of Environment

Target Group The programme is designed for developing country professionals with at least 5 years experience in the areas of conservation, environmental policy and natural resource management. In exceptional circumstances, applicants with less experience may be accepted. Students must be citizens and residents of countries other than the United States.

Courses Forest Resource Management; Resource Ecology; Ecotoxicology; Environmental Chemistry;Natural Resource Management +

Educational Resources Computer labs, library

Notes	• Part of the Latin American Outreach Project, funded by the Tinker Foundation. • Two to three fellowships offered per year. Fellowship covers tuition, fees, transportation to and from the US, insurance and a monthly stipend. • University participates in the FAO East African Biodiversity Project.
Name	**The Durrell Institute of Conservation and Ecology (DICE)** United Kingdom
Curricula	MSc Course (1 year) *Conservation Biology* +
Target Group	Environmental and social science graduates and conservation professionals from around the world.
Courses	Biodiversity information management aspects are integrated into most modules of the course: Animal and Plant Diversity; Biostatistics and Experimental Design; Restoration Ecology; Evolutionary Ecology; Conservation Genetics; Wildlife Health and Conservation; Conservation Law; Modelling and Management; Corporate Environmental Management; Scientific Environmental Resource Use; Tourism and Conservation; Communities and Conservation, Conflict and Change.
Educational Resources	GIS computer systems (PC and workstation-based ARC/Info, IDRISI, GRASS +); databases (ACCESS, FoxPro, custom software +).
Notes	• The six month taught course is supplemented by weekly *Information Technology Clinics*. E-mail (INTERNET) access is provided for all students. Information systems and database design projects are also pursued by MPhil and PhD students.
Name	**Expert centre for Taxonomic Identification (ETI), University of Amsterdam** The Netherlands
Curricula	Short courses: *Taxonomic Identification*
Target Group	Scientists (taxonomists), environmental resource managers, postgraduates, students from both developing and developed countries.

Courses Short training courses on the use of multimedia interactive computer tools for use in biodiversity documentation.

Educational Resources Computer resources, databases, software and electronic publications on CD-ROM, eg. World Biodiversity Database on-line.
Educational and scientific CD-ROMs with biodiversity information and species identification tools for *in situ* training, referencing and capacity building.
Distribution of software shell Linneaus II for *in situ* multimedia database building. Electronic publishing of regional biodiversity data and species information systems.
Inventory by questionnaire of taxonomic expertise worldwide. Setting up international networks of taxonomists; coordination of digitising biodiversity information; standardisation of data by distribution of standard biodiversity documentation software.

Notes
- Affiliated with UNESCO and the University of Amsterdam

Name **Food and Agriculture Organization of the United Nations (FAO)**
Italy

Curricula Training courses in *GIS/Remote Sensing*, and *Natural Resources Management* +

Target Group Graduates and professionals from developing and developed countries.

Courses GIS and Remote Sensing (data collection, interpretation, updating and information management).
Specialised and customised course development +

Educational Resources PC workstations; plotters; digital scanner; digitisation table; laptop computer; GPS systems; Africa Real Time Environmental Monitoring using Imaging Satellites (ARTEMIS); FAO Remote Sensing Centre.

Notes
- Affiliated with the Africover Project and regional FAO centres in Africa, Asia, Pacific.

Name	**Hull University** United Kingdom
Curricula	MSc: *Global Biodiversity Monitoring and Conservation* + Short Courses: *Aquatic Resources and the Environment* +
Target Group	Postgraduates from developed and developing countries
Courses	Short Courses: Biodiversity and the Species Concept; Monitoring: Plants and Invertebrates; Global Ecosystems: Forests; Global Ecosystems: Grasslands, Deserts, Tundra and Mountains; Global Ecosystems: Island Systems and Oceans; Global Ecosystems: Tropical Coastal Zones; Temperate Coastal Zones; Economics and Biodiversity; Biodiversity and Protection +
Educational Resources	GIS lab; library; International Fisheries Institute
Notes	• Affiliated with Ecosurveys Ltd, UK
Name	**Indonesian MAB National Committee and the Indonesian Institute of Sciences (LIPI)** Indonesia
Curricula	Short course in *Plant Taxonomy* +
Target Group	The 1992 course was attended by twenty-two botanists from Indonesia, Papua New Guinea, Philippines, Thailand and Vietnam, including graduate students in taxonomy at Bogor Agricultural College.
Courses	Plant Taxonomy methods and approaches for the preparation of floras of biosphere reserves and other protected areas in South East Asia. Course included lectures, field visits and practical exercises in plant systematics; evolutionary biology; biodiversity sampling and analyses and botanical nomenclature.
Educational Resources	Library and computer facilities.

Notes
- Technical support for the course from the University of Leiden and UNESCO.
- Similar courses previously held in 1987, 1990 and 1992.

Name
International Centre for Research in Agroforestry (ICRAF)
Kenya

Curricula
Short courses (2 -3 weeks) in *Agroforestry*

Target Group
Course participants should have a Diploma, BSc or MSc related to agroforestry, plus experience in research and development.

Courses
Agroforestry research for development, multipurpose use of trees improvement and management, scientific writing, experimental design, information management, on-farm participatory research methods, characterisation and diagnosis.

Information Management and Dissemination;
Field Experimentation and Data Collection +

Educational Resources
ICRAF has a training materials production unit; library, publications, reviews, and conference proceedings.

Notes
- Affiliated with African Network for Agroforestry Education (ANAFE) and Asia Pacific Agroforestry Network (APAN).
- Courses have been taught in Ethiopia, South Africa, Mexico, Thailand, Benin, Kenya and Cameroon.
- Courses taught in Spanish, French and English.

Name
International Centre for Tropical Agriculture Centro Internacional de Agricultura Tropical (CIAT)
Columbia

Curricula
Advanced courses, seminars and workshops, degree oriented theses: *Tropical Agriculture*.

Target Group
Graduates, professionals from developing and developed countries.

Courses
Communication systems; Geographical Information Systems;
Agro-ecology; Biotechnology +
Areas of course specialisation: food crops; forage legume; grass genera; and soil biota.

Educational Resources

CIAT genetic diversity activities utilise modern, well equipped facilities and infrastructure in five areas: Geographical Information Systems; Genetic Resources Unit; Biotechnology Research Unit; Virology Research Unit; and Commodity Programmes.

Databases for genetic resources, catalogues, maps, botanic core collections and literature sources.
International Exchange Programme of genetic resources and transfer of germplasm samples and data.

Notes

- Courses taught in Spanish.

Name

International Institute for Aerospace Survey and Earth Sciences (ITC)
The Netherlands

Curricula

MSc (7 month and 1 year) in *Environmental Systems Analysis and Monitoring* [1]; *Rural and Land Ecology Survey* [2]; *Forestry for Rural Development* [3]; *Soil Survey and Applications of Soil Information* [4]; *Geoinformation Systems for Cadastral, Urban and Rural Applications* [5]; *Rural and Land Ecology Survey* [6]; *Forest Survey* [7] +

Target Group

Postgraduates and professionals from developing and developed countries.

[1] Course designed for persons training or mid-career topping-up course in environmental sciences who also require training in remote sensing applications, GIS and decision support techniques for environmental monitoring and assessment.
[2] Primarily professionals with a background in the fields of agriculture, rangeland management, landscape ecology, environmental management and related fields.
[3] Course designed for foresters involved in community forestry projects and programmes; officers from related fields engaged in rural development; teachers and trainers in forestry for rural development.
[4] Course intended for soil scientists, agronomists and other professionals trained at the university level and engaged in soil survey work.
[5] Designed for professionals in senior technical or managerial positions in organisations dealing with land related data.
[6] Designed for mid-career professionals requiring training in survey of land cover and land use for rural development, environmental conservation and/or natural resource

management.

[7] Designed for officers employed by forest agencies and staff from forestry training institutes wish to develop their knowledge and skills in forest survey.

Training Resources GIS computer systems; PC-ARC/INFO; ARC/INFO-CAD; dBASE IV; Informix; Oracle; SPSS; ILWIS; Microstation, library, aerospace data, cartography resources

Courses Bio-monitoring for Nature Conservation and Management; Monitoring Land and Water Pollution and Degradation. Each course consists of (i) *Common Base Module* (2 months) comprising environmental concepts, issues and policies; (ii) *Core Module* (3.5 months) focusing on environmental monitoring and decision support techniques; and (iii) *Applied Research Module* (6.5 months) comprised of research and thesis preparation.

Notes

- Proficiency in English is required (minimum requirement Test of English as a Foreign Language (TOEFL) 500 or British Council test 6.0).
- Interpretation of aerial photographs and satellite images is an important part of the course curriculum. Candidates should therefore have good stereoscopic vision as well as normal colour vision.

Name **International School of Nairobi, Medias-France**
Kenya [1]

Curricula Short Courses: *Africa and Global Change*

Target Group University teachers, researchers, engineers of graduate/post-graduate level in all disciplines of natural and social sciences.

Courses Courses: Interactions between terrestrial ecosystems and climate; Coastal zones +
Conferences: Training activities in Africa

Educational Resources Field trips, laboratory demonstrations, micro-computers workstations, satellite imagery and ground-based measurement equipment.

Notes

[1] Courses held in various locations eg. Niger, Kenya.

- Participants are expected to attend lectures, practicals and conferences.
- Courses are taught in English and French.

Name	**Island Resources Foundation (IRF)** US Virgin Islands
Curricula	Short courses: *Development and Environmental Planning*
Target Group	Governments and private non-profit environmental organisations of small tropical islands.
Courses	GIS; Coastal Management +
Educational Resources	Several publications including: Montserrat Environmental Profile; Case Study: From Theory to Practice with Virgin Islands Coastal Management: A Retrospective View; Implementing GIS for Environmental Problem Solving.
Notes	• Branch offices in Washington, D.C. and in St John's, Antigua where IRF's Eastern Caribbean Biodiversity Initiative is coordinated.

Name	**Makerere University, Institute of Environment and Natural Resources (MUIENR)** Uganda
Curricula	MSc, PhD *Environmental Studies* +
Target Group	Postgraduates, overseas students
Courses	Short courses: Environmental Data Management; GIS [1]. Annual Conservation Forum: Natural Resource Management. Previous short courses covered: IT Practices (DOS, Windows); Data Audit; Predictive Techniques for Biodiversity Assessment; Database/GIS Integration; Systems Analysis; and Custom Application Design.
Educational Resources	Remote Sensing/GIS (ARC/Info & dBASE) Laboratory of MUIENR; National Biodiversity Data Bank (NBDB) using *Biodiversity Data Bank (BDB) v.1.0, MapInfo v.3.0*; National Environmental Information Centre (NEIC); Checklists of East African mammals, birds, & flowering plants; Computer cataloguing of Makerere University Zoology Museum and Herbarium; Survey Guide and Reference Manual.
Notes	[1] Short courses were developed and taught by WCMC Project Coordinator on-site.

Name **Microbial Strain Data Network (MSDN)**
United Kingdom

Curricula Short Courses: *Microcomputer use in microbiology* +

Target Group Professionals, post-graduates from a number of developing and developed countries.

Courses Training Course: The use of microcomputers in microbiology for data retrieval and information management[1].

Educational Resources Microbial Strain Database; Training manuals supplied for "Microis" - a database management system for microbiology; survey document of information needs relating to the development of *Information Resource on Release of Organisms into the Environment* (IRRO).

Notes
[1] Previous courses have been taught on-site in Senegal, Zambia and Tanzania.
- Programme sponsored by UNEP and the National Council for Scientific Research, Zambia.

Name **National University of Hanoi, Department of Environmental Sciences**
Vietnam

Curricula MSc (2 year programme) in *Environmental Studies and Natural Resources Management* +

Target Group Graduates, professionals.

Courses Mathematical Modelling and Computer Applications in Environmental Science; Environmental Impact Assessment; Natural Resource and Environmental Management.

Educational Resources Library, computer laboratory.

Notes
- Current Areas of research in the department: Biodiversity; Environmental Monitoring; and Environmental Planning.

Name	**Otley College** United Kingdom
Curricula	Diploma of Higher Education (1 & 2 year): *Conservation and Biodiversity* + Short courses: *Conservation and Biodiversity* +
Target Group	Graduates, preferably from a related discipline and appropriate practical experience. Open to overseas applicants.
Courses	Diploma courses: IT and Data Management; Diversity of Life; Land Use and Administration, Ecology and Conservation; Wildlife Resource Assessment; Environmental Systems; Environmental Assessment. Short courses: Environmental Impact Assessment +
Educational Resources	Library
Notes	• Affiliated with the University of East Anglia.
Name	**Oxford Forestry Institute (OFI),** United Kingdom
Curricula	Short Courses & 1 year: *Research Methods in Forestry and Agroforestry* +
Target Group	Applications are invited from graduates in an agricultural or forest science, with at least three years of post-qualification experience and at least another ten years of remaining service to offer their departments after returning home. The course is primarily intended for people holding or destined for research appointments in forestry. In certain circumstances candidates with other backgrounds may be considered.
Courses	Computing Essentials; Statistical Methods; Basic Experimental Design and Analysis; Motive, Policy, Planning and Administration; Special Problems in Forest Research; Information Retrieval and Special Interests.
Educational Resources	The Oxford Forestry Institute has 35 full-time professional staff (University Lecturers, Research Officers and Research Assistants). The Institute functions within the University's Department of Plant Sciences. The OFI is associated with CAB International, the Plant Sciences and OFI library has developed the world's leading centre for forestry literature.

The University of Reading's Statistical Services Centre provides training programmes, courses and consulting services to clients worldwide. Staff have extensive experience of long-term work in developing countries, for example Mozambique - development of an inter-university link; Nepal - training programmes for an agricultural research centre; Papua New Guinea - three year posting to a university; Sri Lanka - a 15-year linking involving Colombo University and various research institutes; and Zimbabwe - staff exchange with the University.

Notes

- Course members are encouraged to bring their own data sets and statistical, computing or forest research problems, to take advantage of the advice and assistance from course staff.
- The course is taught in English and proof of proficiency may be required where English is not the candidates first language.
- Courses taught in conjunction with Reading University.

Name **Rijksherbarium/Hortus Botanicus (RHHB)**
The Netherlands

Curricula MSc (1 year) *Theoretical aspects of Biosystematics* +

Target Group Postgraduates, professionals, overseas students

Courses Principles of Collection based on Biodiversity Studies[1]; Theoretical Aspects of Systematics[2]

Educational Resources Computer network, including cladistics and GIS packages, databases, herbarium, laboratory facilities

Notes

1 Designed for postgraduates/professionals of Malaysian countries
2 Course consists of 15 discussion meetings, literature study, and computer demonstrations.

Name **Royal Botanic Gardens, Kew (RBGKew)**
United Kingdom

Curricula 1) *Botanical Diversity: Classification, Conservation and Management*. MPhil course (2 years) in association with the Universities of Reading and Birmingham and the Natural History Museum; modules also taught with the Pure and Applied Plant and Fungal Taxonomy MSc course at the University of Reading, and the Conservation and Utilisation of Plant Genetic Resources MSc at the University of Birmingham.

2) Kew Diploma in *Amenity Horticulture Management* (3 years)

3) Internship training programme in the Living Collections Department (three months).

4) International Diploma short courses: (i) *Botanic Gardens Management* (8 weeks); (ii) Plant Conservation Techniques (8 weeks, comprising a 5 week taught module followed by a 3 week project option); (iii) Herbarium Techniques (8 weeks followed by an option of an additional 4 weeks for a project); (iv) Botanic Garden Education (4 week course).

Target Group

1) Trainees from developing and developed countries, to provide the practical and theoretical skills required to inventory, conserve, utilise and manage botanical diversity in a way that permits sustainable development.

2) Candidates with a formal horticultural training to at least NVQ level two (or equivalent), and a minimum of 2 years work experience in a recognised horticultural institute.

3) Overseas students wanting unpaid short training placements at Kew.

4) (i) Tropical or subtropical garden or arboretum managers with a horticultural degree or diploma; (ii) trainees actively engaged in building local capacity and expertise in biodiversity conservation; (iii) students with genuine and practical interest in herbarium management, preferably employed by a recognised institute; (iv) staff, principally nationals from developing countries (although applicants from other countries are welcome), responsible for education in a botanic garden.

Courses

1) Year 1 courses: the major plant groups; the principles and techniques of plant biosystematics; the practice of taxonomy through field and herbarium approaches to analyzing and presenting plant biodiversity data; fieldwork in the tropics. Year 2 courses: data management; ecogeography; field work in the Mediterranean; conservation; *ex situ*, *in situ* and *in vitro* techniques; seed technology and genebank management; population genetics; plant breeding; plant evolution and diversity; conservation management and ecopolicy.

2) The course consists of 3 lecture block trimesters (each 3 months in duration), covering scientific aspects of botany, technical subjects and management studies; practical work experience through various placements in the Living Collections Department at Kew and Wakehurst Place;

tutorials; project work and supervisory management workshops.

3) 80% practical work experience in the gardens and 20% study time.

4) (i) Tropical plant studies; the management of living collections; horticultural techniques; the educational role of botanic gardens and visitor services; personnel management; (ii) Strategy planning for plant conservation; information gathering and management; the balance between *ex situ* and *in situ* methods; applied population biology for conservation; collection and cultivation techniques; seed banking and cryopreservation; micropropagation; management of small populations; habitat management and restoration; international sources of funding; (iii) Structured taught element in herbarium techniques and management.

Educational Resources Unparalleled living plant, herbarium, library and other plant reference collections; computer network facilities and biodiversity databases; modern laboratories, and seed bank.

Notes

- Off-site field work in Mediterranean
- Degrees awarded in association with the Universities of Reading and Birmingham, and the Natural History Museum.

Name **Smithsonian Institute (SI), Conservation & Research Centre**
United States

Curricula 2 and 4 week certificate courses in *Biodiversity Conservation*. Custom-tailored for specific needs of host institutions and agencies +

Target Group Natural resources students, scientists, managers, officers from NGOs, universities, government agencies in developing countries

Courses *Biodiversity Survey and Monitoring Techniques*:
Intensive workshop to teach biodiversity survey and monitoring techniques covering habitat, vertebrate and socio-economic surveys, with emphasis on training of trainers[1].

Management and Analysis of Natural Resources Databases
Database design, data entry, data management and analysis of biodiversity inventories and long-term monitoring data[2].
Previous courses: International Wildlife Conservation Training Courses (captive wildlife management, conservation education and computer applications)

Educational Resources IBM PC compatible micro-computers. Survey equipment, manuals, publications, custom-written and commercial software

Notes
[1] Instruction in English, Spanish, French, German, Hindi, Arabic and use of local interpreters possible.
[2] Instruction in English, German and use of local interpreters possible.

Name **The Nature Conservancy (TNC)**
United States

Curricula Short courses and workshops in *Biodiversity Conservation* +

Target Group Professionals, graduate students from developing and developed countries.

Courses Previous course: Natural Heritage Methodology[1]

Educational Resources Natural Heritage Program Methodology; Natural Heritage Data Centers; Newsletter: Biodiversity Network News; The Biological Conservation Data (BCD) System.
Natural Heritage Network (NHN) has: Operational Standards; Definition Standards; Data Quality Standards; Nomenclature Standards; Design and Development Standards; Training Standards.
Vegetation Classification System

Notes
[1] Intended for new staff or staff who will be establishing a new Heritage Program.
- The Conservancy also conducts frequent site visits to Heritage Programs, has central and regional support centers, and provides on-site training each time a BCD System is newly installed in a data center.

Name **Tropical Biology Association (TBA)**
United Kingdom

Curricula Short Courses (1 month) in *Tropical Biology*

Target Group Graduate Students from developed and developing countries of Africa and Europe.

Courses The Western Rift: Ecology of Forest and Savannah (offered 23 June 1995 to 23 July 1995; 26 July to 25 August 1995)
The Eastern Rift: Ecology of Lakes and Savannah (offered 1 September 1995 to 1 October 1995)

The Borneo Rainforest: An Ecological Introduction (offered 15 June 1995 to 15 July 1995)

Educational Resources Emphasis on field research in tropical biology in Uganda, Kenya and Borneo.

Notes
- Located at the School of Biological Sciences, University of Bristol.
- Regional office established in Nairobi to coordinate TBA's activities in eastern and southern Africa.
- Swiss government supports East African student scholarships
- Affiliated with the National Museums of Kenya, the East African Natural History Society (EANHS) and supported by the Darwin Initiative.
- TBA has signed a formal Memorandum of Agreement with Makerere University, Kampala, Uganda.

Name **United Nations Development Programme (UNDP) and the Global Environmental Facility (GEF)/ East African Biodiversity Project**
Kenya

Curricula MSc, PhD, study tours *Biodiversity* +

Target Group Successful undergraduates from East Africa.

Courses Silviculture; Forest Biodiversity and People; Tortoise Conservation; Coastal Forest Mammals; Coastal Frog Fauna; Forest Planning; Plant Taxonomy; Plant Ecology

Educational Resources Varies with individual academic institutions.

Notes In 1993, 24 Fellowships were awarded for Postgraduate Studies, 12 overseas and 12 in East Africa. The project intends to send more people in 1994 but fewer in 1995.

Name **United Nations Environment Programme (UNEP)/INFOTERRA**
Kenya

Curricula MSc, PhD *Biodiversity* +
Training workshops (1 week) *Information Management*

Target Group National focal points and NGO representatives in Southern Africa.

Courses Previous training workshop for South African sub-regional INFOTERRA network (SASIN) held at Lilongwe, Malawi September 1994.
Previous training course for English speaking NFP managers to examine the mandate, role and structure of INFOTERRA database, presentation and future strategies. Course held in Nairobi October 1994.
Previous follow-up course on Micro CDS/ISIS. Course issues: exchange of experience on courses conducted by participants; installation of ISIS, especially networking; teaching on less used ISIS features; problem solving; teaching methodologies related to ISIS; networking with ISIS; PASCAL programming; selection and preparation of teaching and learning materials.

Educational Resources Computer resources; publications; library access

Notes
- Course to include regional service update, experience exchange and bibliographic database and cataloguing.

Name **United Nations Training Institute for Training and Research (UNITAR).**
Switzerland

Curricula Short courses: *Environment and Development; GIS/Remote Sensing* +

Target Group Scientists, planning researchers, government staff from developing countries to operate and benefit from GIS-based technology

Courses Previous GIS courses held in Uganda and Nepal.

Educational Resources GIS/Remote Sensing software and hardware; PC workstations; plotters; digital scanner; digitisation table; laptop computer; GPS systems

Notes
- Affiliated with the Regional UNEP GRID Centres.
- UNITAR is currently compiling a training directory for Africa

Name	**United States Environmental Training Institute (USETI)** United States
Curricula	Courses: *Customised Environmental Training* +
Target Group	Professionals involved in environmental technology or management and currently employed in public or private sector of a developing country are eligible for USETI training courses.
Courses	Computer Applications to Environmental Management; Total Quality Environmental Management (TQEM); pollution prevention, regulation and development; risk assessment; and decision making.
Educational Resources	Library
Notes	• Regardless of sponsorship all applicants are subject to the same selection process. • Courses are conducted in English.

Name	**University of Adelaide** Australia
Curricula	Certificate Course (5 months) UNEP/University of Adelaide: *Intensive International Postgraduate training course in Environmental Management* +
Target Group	Only candidates officially nominated by their Governments, upon invitation from UNEP to submit nominations, are considered for this course.
Courses	The course is divided into three core modules: Identifying the nature and causes of environmental degradation; Sustainable management of natural resources; Monitoring the environment (includes: Environmental Information Systems, Remote Sensing, GIS and Environmental Indicators.
Educational Resources	Computer laboratory and library.
Notes	• Affiliated with the Asia and Pacific Offices of UNEP.

Name	**University of Amsterdam, Research School of Biodiversity** The Netherlands
Curricula	MSc, PhD *Biodiversity* +
Target Group	All courses are at the graduate level; the target group is primarily for PhD students.

Courses

Postgraduate courses:

Taxonomic Data processing	2 days, Amsterdam
Biodiversity Assessment	5 days, Amsterdam
Biogeography of Marine Plants	15 seminars, Leiden
Mediterranean Plants and Landscape	2 weeks, Leiden
Tropical Flora and Vegetation	16 seminars

Educational Resources

The Expert centre for Taxonomic Identification (ETI) developed a software programme for biodiversity documentation. The software (Linneaus II), runs on simple Windows or MacIntosh computers, is fully interactive and multimedia. Linneaus II includes: (i) a multimedia database for taxonomic, ecological, geographic, molecular and other information (synonyms, references, pictures); (ii) a multi-entry identification programme; (iii) a geographical information system; and (iv) options to enter introductory and educational sections. Data entering and management is simple and user friendly. Dissemination and distribution of documentation is by CD ROM. Networks of experts worldwide cooperate to assemble the information.

Notes

The Netherlands Research School on Biodiversity has a formalised affiliation with the following research institutions: Institute for Systematics and Population Biology, University of Amsterdam; Rijksherbarium/Hortus Botanicus, University of Leaden; Research Group Herbarium, University of Utrecht; Central Bureau of Fungi Cultures, Netherlands Academy of Sciences, Baarn; National Natural History Museum, Leaden; Expert centre for Taxonomic Identification, Amsterdam.

Name	**University of Birmingham, School of Biological Sciences** United Kingdom
Curricula	Short courses; MSc *Biological Sciences*
Target Group	Postgraduates, professionals, overseas students
Courses	Plant Diversity and Utilisation Training Programmes: Masters in Conservation; Genetics. Short Courses: Conservation; Genetics.
Educational Resources	Computer laboratory, library
Notes	• Affiliated with Royal Botanic Gardens, Kew (UK)

Name	**University of Botswana** Botswana
Curricula	MSc (2 year) *Environmental Planning* +
Target Group	Students and professionals from developing and developed countries.
Courses	Research methodology and practical techniques of data collection and analysis; Theory and Practice of Environmental Planning; Spatial organisation of human activities and their environmental impact.
Educational Resources	The Department is located in a new building with well equipped laboratory facilities for soil analysis, remote sensing and planning. Modem and computer facilities are available.
Notes	• Strong emphasis is given to practicals and fieldwork. • Member of Southern African Development Community (SADC).

Name	**University of Edinburgh, Institute of Ecology & Resource Management** United Kingdom
Curricula	MSc (1 year) *Ecology and Resource Management*
Target Group	Graduates, professionals, overseas students
Courses	Resource Management; Ecological Economics; Plant Taxonomy & Biodiversity; Environmental Protection & Management; GIS; and Remote Sensing +
Educational Resources	GIS, computing, field courses and research labs
Notes	Courses are interconnected, allowing an à la carte approach. A course comprises 6 modules (25 weeks) and a substantive experimental training period involving a research project (25 weeks). Shorter courses (12 weeks) are also available.
Name	**University of London, Wye College** United Kingdom
Curricula	Short Courses (two weeks): *Environmental Assessment and Management in Agricultural Development* +
Target Group	Administrators and advisers in environmental agencies and agricultural ministries; senior professionals and consultants working on agricultural projects and in the natural resource sector; planners, economists agriculturalists, foresters, engineers and environmentalists in non-governmental organisations.
Courses	Experience in Assessment and Management; EIA; Lessons in Resource Management; Natural Resource Policy
Educational Resources	Computer facilities, library
Notes	• Optional third week on the course will provide a practical introduction to Geographic Information Systems and the use of computers in environmental management and assessment.

Name	**University of Nairobi** Kenya
Curricula	MSc *Conservation Biology* +
Target Group	Students from developing and developed countries.
Courses	Biology +
Educational Resources	Library, University of Nairobi Computer Science Institute
Notes	• Affiliated resources in Nairobi include African Network of Scientific and Technological Institutions (ANSTI) • Language of instruction is English.

6.3 Funding Sources

The following organisations are listed as potential sources of funds for training in *Awards for Postgraduate Studies at Commonwealth Universities*, Association of Commonwealth Universities, London, UK. Addresses for these organisations are provided in Address List, Section 8.2.

Asian Development Bank (ADB)
British Council (BC)
Carnegie Foundation
Canadian International Development Agency (CIDA)
Commission of the European Community (CEC)
Commonwealth Secretariat
Danish Development Agency (DANIDA)
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)
Finnish Development Agency
Food and Agriculture Organisation of the United Nations (FAO)
The Ford Foundation
Fulbright Scholarships
Inter-American Development Bank
International Federation of University Women
International Tropical Timber Organisation (ITTO)
Organisation for Economic Cooperation and Development
P.E.O. International Peace Scholarships Fund
Rockefeller Brothers Foundation
Swedish International Development Agency (SIDA)
Swiss Development Agency
United Nations Environment Programme (UNEP)
United States Agency for International Development (USAID)

6.4 References

WWF, WRI, TNC and USAID. 1993. *African Biodiversity: Foundation for the Future*. A Framework for Integrating Biodiversity Conservation and Sustainable Development. Biodiversity Support Programme. 149pp.

7 INFORMATION SOURCES

7.1 Electronic Data Sources

7.1.1 CD-ROM and Diskette

The distribution of information on CD-ROM has emerged as one of the major forms of information exchange in recent years, a trend that is set to continue. This is mainly due to the enormous storage space offered by a single CD-ROM disk - currently over 600 Mb - which is quite adequate to store comprehensive collections of journal abstracts, whole learned scientific journals, books, encyclopedias, and other information sources, which up until now have been distributed as on-line databases and printed text.

CD-ROM has spawned a whole industry concerned with the collation of multimedia information sources (text, images, audio, video), and the development of software for searching and viewing the information efficiently. CD-ROM products are used in a wide variety of organisations, eg research institutions, universities, and schools, and are increasingly being used in the home. Thus the level and presentation of material varies according to the target market.

As people's expectation for information increases, CD-ROM has emerged as an excellent alternative to on-line access, video tapes, and the printed word. The user can browse and search the database while familiarising themselves with search techniques, without the pressure of mounting cost as occurs with on-line access. Indeed, in some circumstances CD-ROM is now replacing on-line usage completely. However, while on-line databases normally have frequent updating schedules, updated CD-ROMs may not be released frequently or at all, causing them to become obsolete over time. This may not matter in the case of a children's encyclopedia, but could be harmful in the case of a distribution atlas of forest resources.

CD-ROMs are normally acquired for a one-off charge. This may give the user outright purchase or may be a type of lease agreement. As such they offer more budgetary control and no additional costs are incurred for frequent use. Thus if used frequently, the initial high cost can be recouped. In some cases, favourable charge rates may be offered to developing country customers, and schemes also exist to supply developing country organisations with the CD-ROM (and necessary computer hardware to use it) under overseas aid programmes.

Most CD-ROMs are released for IBM compatible personal computers (IBM-PCs). The minimum specification required to run the CD-ROM is usually a 486 processor with 4 Mb RAM, and of course, a CD-ROM drive conforming to the **ISO 9660** standard (680 Mb capacity). The commonest operating systems for IBM-PCs are DOS and Windows. Those contemplating the purchase of a CD-ROM computer system are advised to consider hardware and software requirements carefully (see Selection of Hardware and Software, Section 3.1).

Although many electronic information sources are now being shipped on CD-ROM, the huge capacity of this medium is rarely used (ie in excess of 600 Mb). In some cases, the information will fit onto a small number of diskettes which can be installed directly onto the hard disk of the user's computer. Provided the requisite hard disk space can be afforded, this solution has the advantage that access to the information is very fast; CD-ROM drives are fantastic for storing huge amounts of data, but are currently much slower than hard disks.

Product Listing
The following is an alphabetic list of CD-ROM and diskette information products relevant to biodiversity information management. It is necessarily a snapshot of what is available in this rapidly developing market. It does not include "proposed" products such as UNESCOs *World Heritage Site* release anticipated in mid-1995. The template used to describe CD-ROM and diskette products should be self-explanatory.

Name	**African Development Indicators**
Publisher	World Bank
Format	Diskette
Description	Statistical data arranged in tables or matrices for 242 indicators of development in 52 African countries are presented. Indicators in 2 groups, economic and financial, social and environmental.
Timespan	1980-90

Name	**AgECONCD**
Publisher	Publisher CAB International
Format	CD-ROM
Description	This products covers aspects of economics and policy related to agriculture, rural development, environment and forestry.
Timespan	1973-
Update	Quarterly

Name	**Agricola**
Publisher	SilverPlatter
Format	CD-ROM
Description	The National Agricultural Library database concentrates on agricultural subjects but includes related material such as ecology. The references are drawn from journals, books, theses, patents, audiovisual materials and technical reports. The CD corresponds to the printed product, Bibliography of Agriculture.
Timespan	1970- (various timespans available)
Update	Quarterly

Name	**Agris**
Publisher	SilverPlatter (Supplier)
Format	CD-ROM
Description	The FAO produces an on-line product by this name in addition to the CD-ROM and the printed product *Agrindex*. Centres in over 100 countries contribute to the product. The coverage is primarily agricultural but relevant aspects include economics, development, forestry, aquatic sciences and fisheries and natural resources. The principal sources ares books, journal articles and conference proceedings. Searchable in English, French, Spanish.

Timespan	1986-
Update	Quarterly

Name	**AGRISEARCH**
Publisher	SilverPlatter (Supplier)
Format	CD-ROM
Description	This CDROM product brings together five databases on research and development projects in agriculture, food and nutrition: **CRIS** produced by US Department of Agriculture describes projects within the Department and other agricultural, forestry and veterinary institutions. **ICAR** produced by the Canadian Agricultural Research Council, a bilingual database of Canadian research projects. **AGREP** produced by the Commission of the European Communities, the Agricultural Research project database contains records of European research in agriculture, fisheries, food science, and forestry. **ARRIP** the Australian Rural Research in Progress database covers recent Australian research in agriculture, horticulture, forestry, fisheries, food technology and soil science. **SIS** produced by the Special Program for African Agricultural Research, contains records for research in all areas of agriculture, with emphasis on the sustainable use and development of renewable natural resources.
Timespan	Up to 10 years
Update	Annual

Name	**AGROSTAT-PC**
Publisher	FAO (Supplier)
Format	Diskette
Description	Provides access to worldwide time series statistics on agricultural production and trade; land use and inputs; nutrition; forestry; and population. AGROSTAT-PC is designed to supplement FAO's print publications and to provide faster dissemination of data for longer time periods.
Timespan	1961-
Update	Annual

Name	**Animals - a multimedia experience**
Publisher	Software Toolworks
Format	CD-ROM
Description	The data provided by San Diego Zoo concentrates on 3 themes, interrelationship of animals, impact of human beings on their environment, state of endangered species. The principal audience is the general public.
Cost	$100

Name	**Antarctica - digital database**
Publisher	British Antarctic Survey (see SCAR Secretariat)
Format	CD-ROM
Description	The database is a seamless digital map of Antarctica with the most up-to-date and complete coastline of the continent from which can maps can be generated, used as a topographic framework and provide a common base for spatial data. Requires PC ArcView, PC ARC/INFO, PC ArcCAD software.
Cost	£100

Name	**Aquatic Sciences and Fisheries Abstracts (ASFA)**
Publisher	SilverPlatter
Format	CD-ROM
Description	This is another product of cooperation between UN agencies and national research centres and which corresponds to three printed products *Aquatic Sciences and Fisheries Abstracts, Biological Sciences and Living Resources and Ocean Technology Policy, and Non-Living Resources.* As the titles of the printed products imply the main subject areas covered are global developments in management of marine, freshwater and brackish water environments. The main sources are journal articles, books, conference proceedings and technical reports.
Timespan	1978-
Update	Quarterly

Name	**Biological and Agricultural Index**
Publisher	H.W. Wilson
Format	CD-ROM
Description	The CD-ROM corresponds to *Biological and Agricultural Index,* which comprehensively indexes over 200# key scientific journals. The main pertinent areas covered are: agriculture, biology, botany, ecology, entomology, fishery sciences, forestry, genetics and zoology.
Timespan	1983-
Update	Monthly

Name	**Biological Abstracts/RRM on Compact Disc**
Publisher	SilverPlatter (Supplier)
Format	CD_ROM
Description	The corresponding printed product is the pre-eminent source of literature on biological subjects, *Biological Abstracts/RRM (Reports, Reviews, Meetings).* As such its coverage includes agriculture, botany, ecology, environmental biology, forestry, genetics, systematic biology and zoology. The coverage is drawn from journals, books, papers from meetings and symposia and reports. Reviews of books can be used to determine the relevance of sources for purchase.
Timespan	1989-
Update	Quarterly
Cost	Dependent on length of back file taken.

Name	**CABCD (CAB Abstracts)**
Publisher	SilverPlatter (Supplier)
Format	CD-ROM
Description	In this form all the CAB Abstracts journals are included. The subject coverage is agriculture and forestry including economics. Separate CD services are produced on some topics eg *TREES-CD*, *PlantGene-CD* which cover much longer time periods. (See separate entries)
Timespan	1984-
Update	Annual
Cost	(1993-1995) £5,500

Name	**CIMMYT's Maize Germplasm Database**
Publisher	CIMMYT
Format	CD-ROM
Description	This product covers genetic information about more than 10,000 maize cultivars. The data is gathered from an impressive range of international agricultural organisations.
Timespan	1940-87

Name	**Compact International Agricultural Research Library Basic Retrospective Set 1962-1986**
Publisher	CGIAR
Format	CD-ROM
Description	This bibliographic and reference database corresponds to the publications of International Agricultural Research Centres full text, references, statistics and graphics. The main subject covered is forestry. Searchable in English, French or Spanish.
Cost	$1950

Name	**Directory of Country Environmental Studies**
Publisher	World Resources Institute
Format	Diskette
Description	The diskette corresponds to the printed document of the same name but includes material from both the 1993 and the previous edition. The directory lists selected environmental and natural resource assessments, profiles and strategies for developing countries. These may relate to biodiversity, forestry and natural resources, land forms and use. Searchable in English, French or Spanish.
Cost	nominal charge

Name	**Earth Summit**
Publisher	IDRC
Format	CD-ROM
Description	All documentation relating to the United Nations Conference on Environment and Development conference is included. The documentation includes the texts of the conventions, Agenda 21, reports of NGOs, and documentation from the preparatory stages, such as the country reports. Searchable in English, French,

	Spanish.
Timespan	1992
Cost	$495

Name	**Endangered and Threatened Species**
Publisher	Quanta Press
Format	CD-ROM
Description	This CD contains both text and images for all plants or animals listed in the Endangered Species Act. The coverage also includes wildlife recovery programs, status reports, scientific names and major programs.
Cost	$50

Name	**Families of Flowering Plants**
Publisher	CSIRO, Australia
Format	CD-ROM
Description	The CD is aimed at those attempting to identify and classify flowering plants. It uses an interactive program, INTKEY. For every level there are morphological descriptions. The CD includes comprehensive information on plant distribution.
Cost	US $180

Name	**Fish of the North-Eastern Atlantic and the Mediterranean**
Publisher	UNESCO
Format	CD-ROM
Description	For approximately 1500 species of fish species name, habitat, distribution is given in full-text format with images where appropriate.
Cost	$200

Name	**Fish & Fisheries Worldwide**
Publisher	NISC
Format	CD-ROM
Description	This product depends on information provided by US Fish & Wildlife Service, JLB Smith Institute of Ichthyology, National Fisheries. The main aspects of interest are fish ecology, distribution, economic aspects.
Cost	$695

Name	**Fishbase**
Publisher	ICLARM
Format	CD-ROM
Description	This database includes information on all aspects of ichthyology and of fish as resources, eg nomenclature, distribution, ecology, reproduction, ecology, mortality.
Update	Annual
Cost	$95

Name	**GEOBASE**
Publisher	Elsevier Science
Format	CD-ROM
Description	This CDROM combines six printed sources on a family of disks. Three speciality subsets of the data are available on separate disks, two of which are relevant viz: Geography (human and physical geography including international development) and ECODISC, focusing on all ecological sciences. Material covered is drawn from journals, books and reports.
Timespan	1980-
Update	Quarterly

Name	**HEMDisk**
Publisher	UNEP-HEM
Format	Diskette
Description	The information on this diskette corresponds to three publications, ie *Directory of Organisations and Institutes Active in Environmental Monitoring*, *A Survey of Environmental Monitoring and Information Management Programmes of International Organisations* and *A Survey of Organizations and Laboratories Manufacturing Supplying or Using Reference Materials for Environmental Measurement*. The main access point in the printed publications is by institution name: in electronic format searching is greatly enhanced.
Cost	nominal charge

Name	**Index Kewensis on CD-Rom**
Publisher	Oxford University Press
Format	CD-ROM
Description	The reference work is the most comprehensive registry of plant names, including family, genus and species. As the original publication and all 19 supplements are on one CD-ROM searching is greatly enhanced.
Timespan	1893-
Cost	£995

Name	**Life Sciences Collection**
Publisher	SilverPlatter (Supplier)
Format	CD-ROM
Description	The CD product corresponds to 20 different abstracts journals whose coverage includes entomology, ecology, agriculture. The product is promoted to those looking for an interdisciplinary approach to the life sciences.
Timespan	1982-
Update	Quarterly

Name	**Multimedia Encyclopedia of Mammalian Biology**
Publisher	McGraw-Hill
Format	CD-ROM
Description	This corresponds to the 1990 edition of *Grzimeks Encyclopedia of Mammals*. In addition, it includes video and audio sequences which were mainly provided by the BBC Natural History Unit.

Cost	£299
Name	**Natural Resources Metabase**
Publisher	NISC
Format	CD-ROM
Description	The database is compiled from more than 40 US and Canadian government databases. This compilation concentrates on the effects on natural resources (wetlands, Pacific islands, ecosystems, national parks, endangered species etc) of human actions and changes in natural phenomena primarily in the US, Canada and the Pacific.
Timespan	1989-
Cost	$665 p.a
Name	**Oceanographic & Marine Resources volume 2**
Publisher	NISC
Format	CD-ROM
Description	The bibliographic references cover selected material from 1807 to 1959 and completely from 1960 to date. The relevant subject areas are marine resources, law and policy.
Cost	$445 p.a.
Name	**PlantGeneCD**
Publisher	CAB International
Format	CD-ROM
Description	This joint CAB International and International Board for Plant Genetic Resources product covers the literature of plant breeding, genetic resources. The main sources are journal articles, books, reports and conference proceedings.
Timespan	1974-
Update	Quarterly
Name	**PROSPECT (Programmed Retrieval of Species by the Property and End-use Classification of their Timbers)**
Publisher	Oxford Forestry Institute
Format	Diskette
Description	Primarily it is a database of wood properties which has been developed to support the requirements of those involved in forest management, timber conversion and utilisation. At present it does not include information on the conservation status of the trees. Much of the data on over 1000 species is derived from the literature held in the Oxford Forestry Institute.
Cost	£400
Name	**SESAME**
Publisher	CIRAD
Format	CD-ROM
Description	This bibliographic database covers French-language literature, although most have English titles added, on sub-tropical and tropical agriculture and rural

development. Many of approximately 150,000 references are unique to the source. Indexing is by a thesaurus in both English and French.

Cost	Up to FFr 2,500. Special rates apply outside Europe and North America.

Name	**Smithsonian on Disc - Catalog of the Smithsonian Institution Libraries on CD-ROM**
Publisher	GK Hall
Format	CD-ROM
Description	Some of the 16 libraries of the Smithsonian hold material very relevant to conservation of biological diversity. Although a US institution, its coverage extends far beyond national boundaries.
Cost	c $1100

Name	**TREECD**
Publisher	CAB International
Format	CD-ROM
Description	This product, comprising one CD, corresponds to the abstracting service *Forestry Abstracts* since its inception in 1939 and includes all *Forest Products Abstracts* and *Agroforestry Abstracts*. In all over 300,000 abstracts are included.
Timespan	1939-
Update	Annual

Name	**TROPAG AND RURAL**
Publisher	SilverPlatter (Supplier)
Format	CD-ROM
Description	In printed form *Abstracts on Tropical Agriculture* and *Abstracts on Rural Development in the Tropics* cover the same ground. The subject area, as the name suggests, is literature about practical aspects of agriculture in tropical and subtropical regions and rural development including economic policy and planning, environment and natural resources. The product's strength is its coverage of these subjects in France and Francophone developing countries.
Timespan	1975-
Update	Six-monthly

Name	**Wildlife Review and Fisheries Review**
Publisher	NISC
Format	CD-ROM
Description	As the name suggests, the printed products *Wildlife Review* and *Fisheries Review*, form the basis for this CD-ROM, which covers international literature on mammals, birds, amphibia and reptiles, habitats, management techniques, natural history, hunting and propagation. Good taxonomic and geographic indexing helps searching. No Abstracts.
Cost	$695 p.a.

Name	**Wildlife Worldwide (National Information Services Corporation)**
Publisher	NISC
Format	CD-ROM
Description	The product corresponds to '*Wildlife Review*', the indexing service produced by US Department of the Interior, National Biological Survey and on-line sources eg Waterfowl and Wetlands. The product covers the literature on mammals, birds, reptiles and amphibians. No abstracts of the literature are provided.
Cost	$695 p.a.

Name	**World Resources Data Base diskette**
Publisher	World Resources Institute
Format	Diskette
Description	This source gives a substantially expanded version of the data in part 4 of the printed volume of *World Resources*. One can browse or extract data with the aid of a number of mathematical or statistical functions from more than 500 variables (eg forests and rangeland, biodiversity, landcover, agriculture, number, species density, protected areas, trade, habitats) for almost 200 countries.
Timespan	Varying between 1 year and 40 years are included.
Cost	Nominal charge

Name	**Zoological Record on Compact Disc**
Publisher	SilverPlatter, Microinfo (Supplier)
Format	CD-ROM
Description	This product corresponds to the print one, *Zoological Record*, which concentrates on every major area of zoology with emphasis on animal biology. In addition to covering over 6000 international serials conference proceedings, books and reports are carefully screened for inclusion.
Timespan	1978-
Update	Quarterly
Cost	1994 annual subscription £2500

7.1.2 On-line Services

The capacity of computers to send and receive information over telecommunications paths has led to a revolution in on-line information access in recent years. The growth began in the early 1970s, and thus much of the scientific and bibliographic data available occurs from that time. Initially, abstracts of scientific journal articles were not available, records being carefully indexed according to thesauri and classification systems to aid retrieval. However, abstracts became commonly available from the early 1980s.

The commercial on-line industry grew steadily through the 1970s and 1980s with substantial increases in the number and type of databases available, for example business databases, newspapers, shopping, plus a large number of database hosts (companies whose computers held a large number of databases for searching by the public). Now the industry is going through a period of change with the merger of several major competitors. For example, *Dialog* and *Data-Star* operate two separate host systems with different command languages, but are now both owned by *Knight-Ridder*.

On-line searching is often regarded as expensive, with typical costs ranging from £1.50 per minute upwards. The total cost of a search comprises three elements: the metered connect-time to the database; the cost of displaying or printing information (and associated royalties); the telecommunications costs in establishing a connection. Some services may be accessed "off-line", which effectively charges the user only for time taken to retrieve their precise information needs, rather than the cost of browsing also.

Although most of the databases described in the first section are described as "commercial" this refers only to the service provider. Many databases have been developed by non-profit making organisations, for example *CAB Abstracts* by CAB International with substantial government backing.

Further, many more organisations are now able to provide their own services over public networks such as the Internet, allowing efficient access to their data files. Indeed, there is huge interest in both receiving and providing information over the Internet at present, in both the commercial and non-profit domains (see Internet Communications, Section 3.3).

To access commercial on-line databases some equipment is essential, and training is highly desirable, namely:

- a computer equipped with a communications package
- a modem and telephone account **or** a direct connection to the Internet via a suitable communications gateway
- an account with the service provider (host) and password.

On-line searching gives access to a far wider range of literature than all but the largest libraries can afford to collect. Most services concentrate on standard literature, eg books, conference proceedings, and journal articles, and specifically exclude grey literature such as reports from small organisations, unpublished reports, and material which may be difficult to obtain. Nevertheless, published literature which is not readily available may sometimes be supplied by the service provider for an additional charge.

On-line Services Listing
The following is an alphabetic list of on-line database services relevant to biodiversity information management (major on-line services such as *CompuServe* and *America On-line* are not included since their main emphasis is not environmental information). No single service covers all aspects of the subject and thus there is significant overlap between them. Emerging disciplines such as economic valuation of biological resources, do not always sit comfortably in the coverage of scientific databases and are not adequately covered at present. The template used to describe on-line services should be self-explanatory.

Name	**Abstracts on Tropical Agriculture**
Provider	ORBIT
Type	Bibliographic
Description	The material is drawn from journal articles, books, conference proceedings and theses covers tropical and sub-tropical agriculture and rural development. Aspects of particular interest include: aquaculture, forestry, agroforestry.
Timespan	1975-

Name	**Agricola**
Provider	DIMDI, Data-Star/Dialog
Type	Bibliographic
Description	The content is bases on the acquisitions of the US National Library of Agriculture and its co-operating institutions. The documents include books, pamphlets, conference proceedings, reports, journal articles. Subject coverage: botany, entomology, conservation, forestry, natural history, wildlife and zoology. The database contains approximately 2.5m documents.
Timespan	1979-

Name	**AGRIS International**
Provider	Data-Star/Dialog, DIMDI, ESA-IRS
Type	Bibliographic
Description	The printed version of this file is *Agrindex* produced by FAO. Coverage is primarily agricultural but relevant aspects include economics, development, forestry, aquatic sciences and fisheries, natural resources. Principal sources are books, journal articles and conference proceedings. The system, to which over 100 centres contribute, is co-ordinated by the FAO.
Timespan	1975 to date

Name	**Aquatic Sciences and Fisheries**
Provider	Data-Star/Dialog, DIMDI
Type	Bibliographic
Description	This is another product from the FAO stable which corresponds to several printed products. Covers aquaculture, ecology, limnology and resource management as applied to aquatic environments and fisheries. Main sources are journal articles, books, conference proceedings and some technical reports.
Timespan	1978 to date

Name	**Base de Dados Tropical**
Provider	Internet
Description	This is not a database but instead a host or server on which many Latin American directories (especially Brazilian), catalogues for microorganisms, full-text publications and discussion lists.

Name	**Biological and Agricultural Index**
Provider	BRS
Type	Bibliographic
Description	Corresponds to the printed service *Biological & Agricultural Index*. Covers a

	core of English-language serials on zoology, marine biology, microbiology, forestry, ecology and biology, botany.
Timespan	1983 to date

Name	**BIOSIS Previews**
Provider	Data-Star/Dialog, DIMDI
Type	Bibliographic
Description	Contains bibliographic details of published journal articles, relevant books, conference proceedings on all aspects of the life sciences. These citations are from *Biological Abstracts* and *BioResearch Index.* Of particular relevance to conservation of biodiversity are reports of new species in the literature, habitats, conservation, resource management, nature study, aquatic & terrestrial wildlife management, forests and forestry. Abstracts are available for material from *Biological Abstracts* since 1976, and certain types of material.
Timespan	1969-

Name	**CAB Abstracts**
Provider	Data Star/Dialog, CAN/OLE, DIMDI
Type	Bibliographic
Description	Bibliographic details of articles, proceedings and some books related to all aspects of agriculture, entomology, crops, dairy science and forestry. This database is based on the array of abstracts journals produced by CAB International. An unusual constituent is tourism, leisure and recreation. Other relevant parts include tropical oil seeds, arid lands, plant genetics, rural sociology and agricultural economics. Abstracts are not available for older material.
Timespan	1972-

Name	**GEOBASE**
Provider	Data-Star/Dialog, ESA-IRS
Type	Bibliographic
Description	The database claims to cover the worldwide literature on geography, both physical and human, ecology and includes such as aspects as remote sensing. Main sources are journals, books, conference proceedings and in the last five years PhD theses. Small but highly relevant selection of material on nature conservation, species conservation, and restoration ecology.
Timespan	1980-

Name	**ILDIS (International Legume Database and Information Service)**
Provider	At the time of writing, the on-line launch of ILDIS through BIDS is imminent. Access to users outside the UK is through the Internet.
Type	Data, properties, bibliographic
Description	Currently the database contains information for the legumes of Africa, the Americas including the Caribbean. The information includes classification and taxonomy, distribution, uses, habitats and bibliographic details.

Name	**International Veterinary Information Centre (IVIC)**
Provider	GTI Veterinary Systems
Type	Veterinary
Description	Provides comprehensive information on veterinary care and animal husbandry including drug function, prices and availability; veterinary practice guidelines; bibliography; and training options.

Name	**Life Sciences Collection**
Provider	Data-Star/ Dialog, STN International
Type	Bibliographic
Description	This file corresponds to a series of abstracting journals produced by Cambridge Scientific Abstracts. Particularly relevant to biological diversity are ecology, entomology, genetics and microbiology. The main source of references is journal articles with selective coverage of books and conferences.
Timespan	1978-

Name	**MINE - Microbial Information Network Europe**
Provider	DIMDI, Deutsche Sammlung von Mikroorganismen und Zelikulturen GmbH
Type	Full text, reference
Description	Descriptions of strains and cultures of bacteria, fungi and yeasts held in the national culture collections of 11 European countries.

Name	**Oceanic Abstracts**
Provider	Data-Star/ Dialog, STN, ESA-IRS
Type	Bibliographic
Description	Covers a wide range of topics related to marine sciences eg oceanography, marine biology. Besides drawing from the primary literature some limited circulation reports and legal aspects are covered.
Timespan	1964-

Name	**Remote Sensing On-Line Retrieval Systems**
Provider	ORBIT, ESA-IRS
Type	Bibliographic
Description	Bibliographic references to articles, conference proceedings relating to remote sensing techniques and applications. 35mm slides are also included.
Timespan	1972 -

Name	**SciSearch**
Provider	Data-Star/Dialog, DIMDI
Type	Bibliographic
Description	Corresponds to *Science Citation Index* which covers a wide very range of scientific subjects. Of relevance to conservation of biological diversity are aspects of life sciences, and agriculture. Abstracts have been included since 1991.
Timespan	1974-

Name	**UBIB UNESCO Bibliography**
Provider	ECHO
Type	Bibliographic
Description	The aspects pertinent to biological diversity are science, culture education documents including journal articles which have been published by Unesco. approximately 50,000 records, but no abstracts.

Name	**Zoological Record On-line**
Provider	Data-Star/Dialog
Type	Bibliographic
Description	Covers all aspects of zoology, with better coverage of lesser-known zoological journals than BIOSIS Previews although the time between appearance of the primary source and its addition to the database is measurably longer. The most relevant aspects are habitat, new species, ecology, zoogeography. Abstracts are not available but detailed hierarchical indexing.
Timespan	1978-

7.1.3 Network Based Special Interest Groups

With the growth of computer networks, especially the Internet, it has been possible to link people together who share common scientific, social or political interests. These linkages, namely **listservers** and **network news**, utilise e-mail to facilitate the sending and receiving of messages. In addition there are archives of data and information which may be accessed from a variety of Internet resources including **Gopher**, **WAIS**, and **World Wide Web** (see Internet Communications, Section 3.3).

Internet Listservers

Listservers are discussion groups for e-mail users. With a simple method for subscribing and unsubscribing they have proved to be very popular. Listservers are described in more detail in Internet Communications, Section 3.3. This list has been derived from *A Biologist's Guide to Internet Resources* (Smith, 1993), last-modified on 10 November 1993.

KEY:

- A the listserver maintains some files for this mailing list
- G the mailing list has a gateway to a Usenet newsgroup
- K the listserver is Anastasios Kotsikonas' program, which differs from the standard listserver of Eric Thomas
- M a "moderator" decides whether submissions will be released or not

(a) Agriculture and Animal Husbandry

ag-econ@ERS.bitnet	Agricultural Economics and ERS Test List
ag-exp-l@vm1.nodak.edu	Agricultural Expert Systems
ageng-l@ibm.gwdg.de	Agricultural Engineering and Intel. Control
agric-l@UGA.cc.uga.edu	Agriculture Discussion
aqua-l@vm.UOGUELPH.ca	Aquaculture Discussion List
camel-l@SAKFU00.bitnet	Discussion Forum on Camel Research
dairy-l@UMDD.umd.edu	Dairy Discussion List
gardens@UKCC.uky.edu	Gardens List

hort-l@VTVM1.cc.vt.edu		Va Tech Horticulture Dept. Announcements
hortpgm@VTVM1.cc.vt.edu		Va Tech Horticulture Dept. Program
mgarden@WSUVM1.csc.wsu.edu		Master Gardeners
newcrops@vm.cc.purdue.edu		Discussion list for New Crops
spud@WSUVM1.csc.wsu.edu		Potato Research
rusag-l@UMDD.umd.edu		Russian Agriculture
vetcai-l@KSUVM.ksu.edu		Vet. Medicine Computer Assisted Instruction
vetlib-l@VTVM2.bitnet		Veterinary Medicine Library issues and info.
vetmed-l@UGA.cc.uga.edu		Veterinary Medicine (Peered)

(b) Anthropology and Archaeology

anct-ne@vm.byu.edu		Ancient Near Eastern Studies
anthro-l@UBVM.cc.buffalo.edu		General Anthropology Bulletin Board
arch-l@TAMVM1.tamu.edu		Archaeology List
humevo@GWUVM.gwu.edu	M	Human Evolutionary Research Discussion
indknow@UWAVM.u.washington.edu		Indigenous Knowledge List
native-l@TAMVM1.tamu.edu		Issues Pertaining to Aboriginal Peoples
pacarc-l@WSUVM1.csc.wsu.edu		Pacific Rim Archaeology Interest List
pan@GWUVM.gwu.edu		Physical Anthropology News List

(c) Biology

bee-l@albany.edu		Discussion of Bee Biology
bio-dost@ege.edu.tr		Biologists in Turkey
bioesr-l@UMCVMB.bitnet		Biological applications of Electron Spin Res.
biomch-l@nic.surfnet.nl		Biomechanics and Movement Science
bnfnet-l@FINHUTC.hut.fi		Biological Nitrogen Fixation Forum
cp@opus.hpl.hp.com		Carnivorous Plants
entobr-l@BRUFMG.bitnet		Entomology in Brazil (in Portuguese)
entomo-l@vm.UOGUELPH.ca		Entomology Discussion List
ethology@FINHUTC.hut.fi	G	Ethology
herm@ege.edu.tr		Medicinal and Aromatic Plants Discussion
iapwild@vm1.nodak.edu		International Arctic Project Wildlife
l-etho@UQAM.bitnet		Ethologistes/Ethologists
iopi@life.anu.edu.au	M	Int. Organization for Plant Information
iubs@life.anu.edu.au	M	Int. Union of Biological Societies
lactacid@SEARN.sunet.se		Lactic Acid Bacteria Forum
micronet@vm.UOGUELPH.ca		Fungus and Root Interaction Discussion
rmbl-l@umdd.umd.edu		Rocky Mountain Biological Laboratory
socinsct@albany.edu		Social Insect Biology Research List
thphysio@FRMOP11.cnusc.fr		Thermal Physiology

(d) Biostatistics

biomet-l@ALBNYDH2.bitnet		Bureau of Biometrics at Albany
bmdp-l@vm1.mcgill.ca		BMDP Software Users

edstat-l@jse.stat.ncsu.edu	KG	Journal of Statistics Education List
morphmet@CUNYVM.cuny.edu		Biological Morphometrics Mailing List
pstat-l@IRLEARN.ucd.ie		Discussion of Stats and Programming
qmlist@tbone.biol.scarolina.edu	K	Quantitative Morphology List
sas-l@UGA.cc.uga.edu	G	SAS Discussion (Peered)
saspac-l@UMSLVMA.umsl.edu		SAS Public Access Consortium
spssx-l@UGA.cc.uga.edu	G	SPSSX Discussion (Peered)
stat-l@vm1.mcgill.ca	G	Statistical Consulting

(e) Computational Biology

complex@life.anu.edu.au	M	Complex systems
cybsys-l@BINGVMB.cc.binghamton.edu		Cybernetics and systems
dynsys@gibbs.oit.unc.edu	GK	Ergodic Theory and Dynamical Systems
ecosys-l@vm.gmd.de		List for ecosystem theory and modeling
glosas-l@acadvm1.UOTTAWA.ca		Global Systems Analysis and Simulation List
inns-l@UMDD.umd.edu		International Neural Network Society
ndrg-l@WVNVM.wvnet.edu		Nonlinear Dynamics Research Group
neural-n@ANDESCOL.uniandes edu.co		Artificial Neural Networks Discussion

(f) Conservation and Environmental Studies

apaspan@GWUVM.gwu.edu		APA Scientific Grassroots Network
aquifer@IBACSATA.bitnet		Pollution and grondwater recharge
aseh-l@TTUVM1.bitnet		American Soc. of Environmental Historians
bene@straylight.tamu.edu		
cites-l@wcmc.org.uk		Convention on International Trade of Endangered Species
cmts-l@cornell.edu		Chemical Management and Tracking Systems
consbio@UWAVM.u.washington.edu		Conservation Biology List
conslink@SIVM.si.edu		Discussion on Biological Conservation
cturtle@NERVM.nerdc.ufl.edu		Sea Turtle Biology and Conservation List
envst-l@BROWNVM.brown.edu		Environmental Studies Discussion List
icam-l@IRMFAO01.bitnet		Integrated Coastal Area Management
itrdbfor@asuvm.inre.asu.edu		Dendrochronology Forum
laspau-l@HARVARDA.harvard.edu		Latin America Scholarship Program
natura-l@UCHCECVM.bitnet		Ecology and Envir. Protection in Chile
nciw-l@YALEVM.cis.yale.edu		Nutrient Cycling Issues - Worldwide
sopren-l@secom.ufpa.br		SOPREN discussion re: Amazonia (in Portuguese)

(g) Ecology

biosph-l@UBVM.cc.buffalo.edu	G	Biosphere, ecology, Discussion List
biodiv-l@bdt.ftpt.ansp.br		Biodiversity networks

bird_rba@ARIZVM1.ccit.arizona.edu		National Birding Hotline Cooperative
birdband@ARIZVM1.ccit.arizona.edu		Bird Bander's Forum
birdchat@ARIZVM1.ccit.arizona.edu		National Birding Hotline (Chat Line)
birdcntr@ARIZVM1.ccit.arizona.edu		National Birding Hotline (Central)
birdeast@ARIZVM1.ccit.arizona.edu		National Birding Hotline (East)
birdwest@ARIZVM1.ccit.arizona.edu		National Birding Hotline (West)
birdtrip@ARIZVM1.ccit.arizona.edu		Special BIRDCHAT LOGO Project
ecolog-l@UMDD.umd.edu	G	Ecological Society of America
firenet@life.anu.edu.au		Discussion of fire in landscape ecology
ots-l@YALEVM.cis.yale.edu		Organization for Tropical Studies
polpal-l@vm.UOGUELPH.ca		Pollination and palynology list
sinoecol@MIAMIU.bitnet		Sino-Ecologists Club Overseas Forum
twsgis-l@vm1.nodak.edu		The Wildlife Society: GIS and Remote Sensing

(h) Environmentalism and Technology Transfer

ae@JSUVM1.bitnet		Alternative Energy Discussion List
bpwsp-l@ALBNYDH2.bitnet		Bureau of Public Water Supply Protection
comdev@vm.ecs.rpi.edu		Communication & international development
devel-l@AUVM.american.edu	G	Technology Transfer in Int. Development
energy-l@TAUNIVM.tau.ac.il		Energy List
envbeh-l@POLYVM.bitnet		Forum on Environment and Human Behavior
hydrogen@URIACC.uri.edu		Hydrogen as an alternative fuel
intdev-l@URIACC.uri.edu		International development
meh2o-l@TAUNIVM.tau.ac.il		Middle East water
odp-l@TAMVM1.tamu.edu		Ocean Drilling Program Open Discussion
pacific@BRUFPB.bitnet		Forum on Pacific Ocean and Islands
recycle@UMAB.bitnet		Recycling in Practice
sfer-l@UCF1VM.cc.ucf.edu		South Florida Environmental Reader
techtr@ARIZVM1.ccit.arizona.edu		Technology Transfer
water-l@@WSUVM1.csc.wsu.edu		Water Quality Discussion List

(i) Geology and Geography (including GIS)

acdgis-l@AWIIMC12.imc.univie.ac.at		Geographic Information Systems
astra-ug@icnucevm.bitnet		ASTRA joint database project users group
canspace@UNBVM1.bitnet		Canadian Space Geodesy Forum
climlist@OHSTVMA.acs.ohio-state.edu		Climatology Distribution List
coastgis@IRLEARN.ucd.ie		Coastal GIS Distribution List
cpgis-l@UBVM.cc.buffalo.edu		Chinese Professionals GIS Use List
geoged@UKCC.bitnet		Geography Education List
geogfem@UKCC.bitnet		Discussion list for Feminism in Geography
geograph@SEARN.sunet.se	G	Geography
geology@PTEARN.fc.ul.pt		Geology Discussion List
geonet-l@IUBVM.ucs.indiana.edu	M	Geoscience Librarians & Information...

georef@UNALCOL.bitnet		Sistemas de Info. Geo-Ref. (GIS in Spanish)
gis-l@UBVM.cc.buffalo.edu	G	Geographic Information Systems
idrisi-l@toe.towson.edu		Idrisi Discussion List
imagrs-l@earn.cvut.cz		Image Processing of Remotely Sensed data
kyugis-l@UKCC.bitnet		Kentucky Universities Geographic Info...
maps-l@UGA.cc.uga.edu		Maps and Air Photo Systems Forum
quake-l@vm.nodak.edu		QUAKE-L Discussion List
seism-l@BINGVMB.cc.binghamton.edu		Seismological Data Distribution
seismd-l@BINGVMB.cc.binghamton.edu		Seismological Discussion
stat-geo@UFRJ.bitnet		Forum of Quantitative Methods in Geosciences
tgis-l@UBVM.cc.buffalo.edu		Temporal Topics on GIS List
ucgia-l@UBVM.cc.buffalo.edu		Univ Consort for Geo Info & Analysis List
uigis-l@UBVM.cc.buffalo.edu	G	User Interfaces for Geographic Info. Sys.
ukgeg@UKCC.bitnet		Kentucky Universities Geography Discussion
vigis-l@UWAVM.u.washington.edu		Virtual Reality and GIS

(j) Marine Biology

brine-l@UGA.cc.uga.edu		Brine Shrimp Discussion List
crust-l@SIVM.si.edu		Crustacean Biology
deepsea@uvvm.UVIC.ca		Deep Sea and Vent News
diatom-l@IUBVM.ucs.indiana.edu		Research on the diatom algae
hypbar-l@TECHNION.technion.ac.il		HyperBaric & Diving Medicine List
marine-l@vm.UOGUELPH.ca		Marine Studies/Shipboard Education
marmam@uvvm.UVIC.ca		Marine Mammal E-Mail Discussion List
medsea-l@AEARN.bitnet		Marine Biology of the Adriatic Sea List

(k) Molecular Biology

biotech@UMDD.umd.edu	G	Biotechnology Discussion List
confocal@UBVM.cc.buffalo.edu		Confocal Microscopy List
cyan-tox@GREARN.csi.forth.gr		The Cyanobacterial Toxins Discussion List
dis-l@IUBVM.ucs.indiana.edu		Drosophila workers to receive DIS Newsletter
ebcbbul@HDETUD1.tudelft.nl		Computers in Biotechnology, Rsch. and Edu.
ebcbcat@HDETUD1.tudelft.nl		Catalogue of "Biotechnological" software
embinfo@IBACSATA.bitnet		EMBNet (European Molecular Biology Network)
emflds-l@UBVM.cc.buffalo.edu		Electromagnetics in Med., Sci. & Com.
forumbio@scf.fundp.ac.be		Forum on molecular biology
genetics@INDYCMS.iupui.edu		Clinical human genetics
lpn-l@BROWNVM.brown.edu		Laboratory Primate Newsletter List
nibnews@ccsun.unicamp.br		NIBNews (Biology and Medical Informatics)

rbmi@FRORS13.bitnet		Molecular Biology Research Group

(l) Taxonomy and Systematics

class-l@ccvm.sunysb.edu		Classification and phylogeny estimation
mollusca@ucmp1.berkeley.edu		Mollusc evolution, taxonomy, natural history
muse-l@HARVARDA.harvard.edu		Muse Software Discussion List
museum-l@UNMVMA.unm.edu		Museum discussion list
roots-l@vm1.nodak.edu		Genealogy list
taxacom@HARVARDA.harvard.edu		Taxonomic and systematic collections list

(m) Teaching and Research

bibsoft@INDYCMS.iupui.edu		Discusssion of citation and bibliography
biocis-l@SIVM.si.edu		Biology Curriculum Innovation Study
biopi-l@KSUVM.ksu.edu		Secondary Biology Teacher List
conslt-l@IUBVM.ucs.indiana.edu		Research and Practice in Mentoring
darwin-l@ukanaix.cc.ukans.edu		History and Theory of the Historical Sciences
grants-l@JHUVM.hcf.jhu.edu		NSF Grants & Contracts
hpsst-l@QUCDN.queensu.ca		History and Philosophy of Science
job-list@FRORS12.bitnet		Job offers from EARN Institute members
methods@vm.ecs.rpi.edu		Research methodology
navigate@UBVM.cc.buffalo.edu	M	Navigating The Internet Workshop List
newedu-l@vm.usc.edu		New Paradigms in Education List
nihggc-l@UBVM.cc.buffalo.edu	M	NIH Grants and Contracts Distribution List
nsf-l@YALEVM.cis.yale.edu		NSF Information List
pcorps-l@CMUVM.bitnet	G	International Volunteers Discussion Group
scifaq-l@YALEVM.cis.yale.edu	G	Science FAQ List
scifraud@uacsc2.albany.edu		Discussion of Fraud in Science
vpiej-l@VTVM1.cc.vt.edu	G	Electronic journal discussions
wisenet@UICVM.uic.edu		Women In Science and Engineering NETwork

Newsgroups of Special Interest
Although newsgoups are available via the Internet, their origins predate the latter by several years. The vast majority of news is supplied by the alternative **Usenet**, which remains very popular. Network news is discussed in more detail in Internet Communications, Section 3.3.

The following list has been derived from the *A Biologist's Guide to Internet Resources* (Smith, 1993).

KEY:
F - indicates an FAQ is available
M - the newsgroup is moderated (edited)
G - the newsgroup has a gateway to a parallel mailing list

alt.agriculture.*		[2 groups]
alt.bbs.internet	F	Announcements of new Internet services
alt.cyb-sys		Cybernetics and Systems
alt.internet.access.wanted	F	Help getting full Internet access
alt.internet.services	F	Announcements of new Internet resources
alt.native		Indigenous peoples
alt.sci.*		[6 groups]
alt.earth_summit		Discussion of the Earth Summit
alt.sustainable.agriculture	G	Sustainable agriculture
bionet.agroforestry	G	Agroforestry research
bionet.announce	FGM	Announcements
bionet.biology.computational	GM	Comp. and math. applications in biology
bionet.biology.n2-fixation	G	Biological nitrogen fixation
bionet.biology.tropical	G	Tropical biology and ecology
bionet.chlamydomonas	G	Chlamydomonas discussion
bionet.cellbio	G	Cell biology discussion
bionet.drosophila	G	Drosophila discussion
bionet.general	FG	General discussion
bionet.genome.*	G	[3 groups: Arabidopsis and chromosomes]
bionet.immunology	G	Research in immunology
bionet.info-theory	FG	Information theory applied to biology
bionet.jobs	G	Job opportunities in biology
bionet.journals.contents	GM	Biological journal TOCs
bionet.journals.note	G	Publication issues in biology
bionet.metabolic-reg	G	Metabolic regulation and thermodynamics
bionet.molbio.ageing	G	Cellular and organismal ageing
bionet.molbio.bio-matrix	G	Computer searches of biological databases
bionet.molbio.embldatabank	G	Info about the EMBL Nucleic acid database
bionet.molbio.evolution	G	Evolution, especially molecular
bionet.molbio.gdb	G	The GDB database
bionet.molbio.genbank	G	The GenBank nucleic acid database
bionet.molbio.gene-linkage	G	Genetic linkage analysis.
bionet.molbio.genome-program	G	Human Genome Program issues
bionet.molbio.methds-reagnts	G	Tips on lab techniques and materials
bionet.molbio.hiv	G	The molecular biology of HIV
bionet.molbio.proteins	G	Proteins and protein database searches
bionet.molbio.rapd	G	Randomly Amplified Polymorphic DNA
bionet.molbio.yeast	G	Yeast researchers' discussion
bionet.mycology	G	Mycological research discussion
bionet.neuroscience	G	Research issues in the neurosciences
bionet.photosynthesis	G	Photosynthesis research
bionet.plants	G	Plant biology, inc. genetics and ecology
bionet.population-bio	G	Population biology, especially theory
bionet.sci-resources	GM	Information about funding agencies, etc
bionet.software	G	Software for biology, esp. free/shareware
bionet.software.*	G	[3 groups: acedb, gcg, and sources]

bionet.users.addresses	G	Help locating biologists who use e-mail
bionet.virology	G	Research in virology
bionet.women-in-bio	G	Discussion by and about women in biology
bionet.xtallography	G	Protein crystallography
bit.listserv.biosph-l	G	Biosphere, ecology, Discussion List
bit.listserv.devel-l	G	Tech. Transfer in Internat. Development
bit.listserv.ethology	G	Ethology List
bit.listserv.geograph	G	Geography List
bit.listserv.medforum	MG	Medical Students Discussion
bit.listserv.uigis-l	G	User Interface for GIS
bit.listserv.vpiej-l	G	Electronic Publishing Discussion List
bit.org.peace-corps	G	International Volunteers Discussion Group
comp.infosystems.gis	FG	Geograpical Information Systems
comp.infosystems.gopher	F	The Internet gopher access tool
comp.infosystems.wais	F	The Internet WAIS access tool
comp.infosystems.www		The Internet WWW access tool
comp.soft-sys.sas	G	SAS Discussion
comp.soft-sys.spss	G	SPSS Statistical Discussion
comp.text.tex	F	TeX, LaTeX and related text format systems
comp.theory.cell-automata	G	Cellular automata research
comp.theory.dynamic-sys	G	Ergodic theory and dynamic systems
comp.theory.self-org-sys	G	Topics related to self-organisation
embnet.news.admin	G	EMBnet news helpline for administrators
embnet.general	G	General discussion
embnet.net-dev		Network development discussion
embnet.rpc		Technical discussion of data transfers
info.grass.programmer	GM	GRASS GIS programmer issues
info.grass.user	GM	GRASS GIS user issues
info.ietf	GM	Internet Engineering Task Force
info.nsf.grants	GM	NSF grants announcements
info.wisenet	G	Women in Science and Engineering Network
news.announce.newusers	FM	FAQs for new users of Usenet
news.answers	FM	All FAQ documents
news.lists	FM	Statistics and data about Usenet
sci.answers	GFM	FAQs pertaining to science
sci.anthropology	—	Anthropology discussion
sci.archaeology		Archaeology discussion
sci.bio	F	General biology discussion
sci.bio.ecology	G	Ecological research (sponsored by ESA)
sci.bio.technology	G	Any topic relating to biotechnology
sci.environment		Discussion of environmental issues

sci.geo.*		[3 newsgroups]
sci.image.processing	F	Scientific image processing
sci.nonlinear		Nonlinear dynamical systems
sci.research.careers		Discussion of research careers in science
sci.stat.consult	G	Statistical consulting
sci.stat.edu	G	Journal of Statistics Education List
sci.stat.math		Mathematical statistics
sci.techniques.xtallography		Crystallography techniques
sci.*		[60 other newsgroups]

Special Usenet Hierarchies and Gated Mailing Lists

This section has also been derived from *A Biologist's Guide to Internet Resources* (Smith, 1993). There has been a growing trend in the past few years to set up transparent "gateways" between mailing lists and newsgroups (ie Internet listservers and Usenet), and to create Usenet newsgroup hierarchies that are outside the main stream. Both being new concepts, the two trends often go together.

None of the Usenet newsgroup hierarchies mentioned below are main-stream; that is they do not conform to all Usenet conventions, and consequently are carried by no more than 30-50% of Usenet sites. This is not necessarily a bad thing, since few or no readers at most sites are biologists, and e-mail subscriptions are available for many groups. If your site carries Usenet, but not these hierarchies, a simple request to your Usenet administrator might be all that's needed to get them.

bionet.*

Each of these newsgroups has two gateways to mailing lists, to save on trans-Atlantic transmission costs. For an e-mail subscription to any bionet.* newsgroup, if you live in the Americas or the Pacific Rim, send e-mail to biosci-server@net.bio.net with the text 'help' (leave the Subject line blank; this is an automated server). If you live elsewhere, send e-mail to biosci@daresbury.ac.uk (a person will respond). Brief descriptions of some of these groups are given in the BIOSCI FAQ, posted in bionet.announce and available on net.bio.net in the directory /pub/BIOSCI/ or by e-mail from the BIOSCI staff at biosci@net.bio.net.

bit.listserv.*

As their names imply, the bit.listserv newsgroups started out as (and remain) automated mailing lists. Most of these mailing lists became so successful that gateways to Usenet were added by popular demand.

comp.theory.*

Send e-mail to Erik Fair, fair@apple.com, or see the list of mailing lists posted in news.answers for details about e-mail subscriptions.

embnet.*

The European Molecular Biology Network (EMBnet) runs a group of Usenet newsgroups that are distributed in Europe. E-mail subscriptions are available from nethelp@embl-heidelberg.de, and these newsgroups can be read and searched via gopher and WAIS on nic.switch.ch. Send general e-mail queries to embnet@comp.bioz.unibas.ch.

info.*

These groups are mailing lists with gateways to Usenet at the University of Illinois. For e-mail subscription information, ask your local Usenet administrator to get these groups.

Journal Tables of Contents

Various Usenet newsgroups and mailing lists provide tables of contents (TOCs) for current issues of a few journals of interest to biologists. Tom Schneider distributes Unix AWK scripts for converting many of these TOCs into BibTeX-style bibliography records: these scripts are posted in the Usenet newsgroup bionet.journals.note. The journal TOCs available in bionet.journals.contents include:

Anatomy and Embryology
Applied Microbiology and Biotechnology
Applied and Environmental Microbiology
Binary
Biotechniques
CABIOS
Cell and Tissue Research
Chromosoma
Current Genetics
EMBO Journal
Environmental Physiology
European Journal of Biochemistry
European Journal of Physiology
Experimental Brain Research
Histochemistry
Human Genetics
IEEE Engineering in Medicine and Biology
Immunogenetics
Journal of Bacteriology
Journal of Biological Chemistry
The Journal of Membrane Biology
Journal of Molecular Evolution
Journal of Virology
MGG - Molecular and General Genetics
Mammalian Genome
Microbial Releases

Molecular Microbiology
Molecular and Cellular Biology
Nucleic Acids Research
Photosynthetica
Plant Cell Reports
Planta
Protein Science
Roux's Archives of Developmental Biology
Theoretical and Applied Genetics

The CONSLINK listserver mailing list keeps a large bibliography of conservation biology research papers on its archive for instructions on accessing listserver archives).

The American Physiological Society offers TOCs for the following journals via gopher on gopher.uth.tmc.edu (port 3300):

Advances in Physiology Education
American Journal of Physiology (6 consolidated journals)
Journal of Applied Physiology
Journal of Neurophysiology
News in Physiological Sciences
Physiological Reviews
The Physiologist

Other publishers supporting Internet access to information about their publications include:

Publisher	Address	Access
Addison-Wesley	world.std.com	ftp
O'Reilly & Associates	gopher.ora.com	gopher
Kluwer Academic Publishers	world.std.com	ftp

List of Archives
Computer sites supporting some sort of public access to biodiversity-related information are listed here, together with means of access. As before, the list was derived from *A Biologist's Guide to Internet Resources* (Smith, 1993):

KEY:
e - e-mail file requests
E - email search requests
f - anonymous FTP
g - gopher server
G - gopher server plus WAIS index searches
t - public telnet access
T - public telnet access plus e-mail returns of search results
W - WAIS server plus WAIS index searches

Internet Node Name	Topic/Agency	Access
ftp.bio.indiana.edu (IN USA)	IUBIO Genbank, FlyBase	fG
ncbi.nlm.nih.gov (MD USA)	NCBI	f
ftp.embl-heidelberg.de (Germany)	EMBL Data Library	Efg
coli.polytechnique.fr (France)	EMBLnet	G
ftp.bchs.uh.edu (TX USA)	Genbank, PIR	fG
helix.nih.gov (MD USA)	Genbank, PDB, PIR etc	G
ncifcrf.gov (MD USA)	Biol. Information Theory	f
finsun.csc.fi (Finland)	Prosite, Rebase-Enzyme	G
pdb.pdb.bnl.gov (NY USA)	Protein Data Bank	G
ftp.tigr.org	Inst. for Genomic Rsch.	f
golgi.harvard.edu (MA USA)		f
megasun.bch.umontreal.ca	Molecular evolution	G
nic.funet.fi (Finland)		
gopher.csc.fi (Finland)		
nic.switch.ch (Switzerland)	EMBnet	fG
rdp.life.uiuc.edu	Ribosomal DB Project	f
world.std.com	A major entry-point	fG
sunsite.unc.edu (NC USA)	Many subjects	EfGt
gopher.ciesin.org	Earth Sciences	G
locus.nalusda.go (USA)	Nat. Agri. Library	G
s27w007.pswfs.gov (USA)	Forest Genetics	G
biomed.uio.no (Norway)	Genome data	T
biox.embnet.unibas.ch (HE)	Genome data	G
gopher.gdb.org (MD USA)	GDB Genome Data Bank	G
weeds.mgh.harvard.edu (MA USA)	Arabidopsis, C. elegans	G
mendel.agron.iastate.edu (IA USA)	Soy genome	G
greengenes.cit.cornell.edu (NY USA)	Triticeae genome	G
teosinte.agron.missouri.edu (USA)	Maize genome	G
gopher.duke.edu (NC USA)	Chlamydomonas	G
picea.cfnr.colostate.edu (CO USA)		f
poplar1.cfr.washington.edu (WA USA)	Populus genetics	f
esusda.gov (USA)	USDA Extension Service	G
infoserver.ciesin.org	CIESIN Global Change	G
mobot.org (MO USA)	Missouri Bot. Garden	f
life.anu.edu.au (Australia)	Bioinformatics	fG
igc.org (CA USA)	EcoNet	f
gopher.yale.edu (CT USA)	Ecol. Data Exchange	g
lternet.edu (WA USA)	LTERnet	G
spider.ento.csiro.au (Australia)	Entomology	f
gopher.uth.tmc.edu (port 3300)	Physiology	G
envirolink.hss.cmu.edu (DE USA)	Environment	GT
ecosys.drdr.virginia.edu (VA USA)	Ecosystems	GT
sparc.ecology.uga.edu (GA USA)	Ecology, Coweeta LTER	G
ngdc1.ngdc.noaa.gov (USA)	Paleoclimatology	f
huh.harvard.edu (MA USA)	Harvard Univ. Herbaria	fG

simsc.si.edu (DC USA)	Smithsonian Inst.	f
ucmp1.berkeley.edu (CA USA)	Vertebrate museum	G
bdt.ftpt.br (Brazil)	Biodiversity	fG
coli.polytechnique.fr (France)	Molecular evolution	G
fconvx.ncifcrf.gov (MD USA)	Mathematical Biology	f
cheops.anu.edu.au	Radiocarbon Abstracts	fGW
bluehen.ags.udel.edu (DE USA)	Entomology	G
minerva.forestry.umn.edu (MN USA)	Forestry	G
ucsbuxa.ucsb.edu (CA USA)	Biology	G
evolution.genetics.washington.edu	Evolution	f
evolution.bchs.uh.edu (TX USA)	Evolution	f
wigeo.wu-wien.ac.at (Austria)	Geography	G
geogopher.ucdavis.edu (CA USA)	Geology	G
isdres.er.usgs.gov (VA USA)	US Geological Survey	f
pippin.memst.edu	CERI Earthquake Center	G
cdiac.esd.ornl.gov	CDIAC	f
saturn.soils.umn.edu (MN USA)	Geology	G
kiawe.soest.hawaii.edu (HA USA)	Generic Mapping Tools	f
tycho.usno.navy.mil	U.S. Naval Observatory	t
nssdca.gsfc.nasa.gov	NSSDC On-Line Service	t
granta.uchicago.edu (IL USA)	Physics Resources	G
xyz.lanl.gov (NM USA)	LANL Nonlinear Science	G
mentor.lanl.gov (NM USA)	LANL Physics	G
info.mcs.anl.gov (IL USA)	Argonne National Lab.	f
stis.nsf.gov (DC USA)	Nat. Science Foundation	fG
rtfm.mit.edu (MA USA)	Usenet FAQ repository	ef
jse.stat.ncsu.edu (NC USA)	Journal of Stat. Educ.	fG
ftp.sas.com (NC USA)	SAS-related information	f
zaphod.ncsa.uiuc.edu (IN USA)	Supercomputing	f
lupulus.ssc.gov	Young Scientists Net.	f
ksuvxa.kent.edu	Directory of lists	f
sun.soe.clarkson.edu	LaTeX tools	f

Special Interest Organisational Networks

These networks are based on an organisation or secretariat. They maintain a membership or loose grouping of interested users. The following list all are using or soon plan to use the Internet as their main mechanism for conducting dialog and disseminating information:

Name **Biodiversity Information Network (BIN 21)**

Description BIN21 supports the aims of the Convention on Biological Diversity that came into force on December 1993. It is developing a series of nodes on the Internet throughout the world which will promote and deliver data, software and information which is expected to support the execution of the Convention.

Contact BIN21 Secretariat.

Name	**BioNET-International**
Description	Global Technical Cooperation Network for the biosystematics of anthropods, microorganisms and nematodes. It is particularly interested in establishing and maintaining biosystematic capabilities in the developing world.

Name	**CIESIN**
Description	CIESIN wishes to provide access to and enhance the use of information worldwide, advancing understanding of human interactions in the environment and serving the needs of science, and public and private decision making. It has done this by setting up an Information cooperative, which is bonded by a WWW server and a metadatabase (Catalog Server) available over the Internet.

Name	**Earthwatch**
Description	Earthwatch, the United Nations system-wide environment assessment activity, is an international, non-governmental organisation which supports important field research worldwide in the Earth, life and human sciences. It does this through the financial support of projects from a network of regional centres in California, Australia, Europe and Russia.

Name	**European Centre for Nature Conservation**
Description	ECNC's aim is to further the cooperation in the development and exchange of information, expertise and research with regard to European nature conservation. It intends to be a clearing house for ideas and data though is not yet established on any network.

Name	**Foundation For Ethnobiology (FEb)**
Description	Rescue operation to record and evaluate the knowledge and appreciation of the environment that other cultures have accumulated over thousands of years of human existence. They are proposing the Internet as a repository for their outreach and data holdings.

Name	**GreenNet**
Description	Long established network, now accessible via Internet, that disseminates information concerning the environment, peace issues, human rights and development. It distributes a useful tri-monthly newsletter, GreenNet News.

Name	**Microbial Strain Data Network (MSDN)**
Description	Database of microbial research and culture collections. Subscription to the database is necessary. Supported by CEC, UNESCO, UNIDO, US EPA, US NIDR, US NSF, USDA and Environment Canada.

Name	**Sustainable Development Network (UNDP SDN)**
Description	This provides gopher, ftp and mail services to facilitate and promote connectivity between users and suppliers of information of direct relevance to sustainable development and in particular with the purpose of supporting the preparation and implementation of Agenda 21.

Name **UNEP GRID**
Description Established in 1985, the Global Resource Information Database (GRID) is a component of Earthwatch, providing a network of cooperating environmental data centres. There are at present ten centres collecting, archiving and disseminating environmental information in digital format. Its mission is to bridge the gap between environmental research and environmental management.

Name **UNEPNET**
Description Network for the collection and dissemination of information on the environment produced in Latin America and the Caribbean. It consists of a primary node in Mexico and secondary nodes throughout the region. Access is currently via dial-up.
Contact UNEP (Mexico).

7.1.4 Metadatabases

The concept of a metadatabase is described fully in Metadatabase Development, Section 2.3.4. Below is an alphabetic list of major metadatabases implementations at the current time:

Name **CIESIN**
Description CIESIN is a private, non-profit organisation established in 1989. Its mission is to provide access to and enhance the use of information worldwide, advancing understanding of human interactions in the environment and serving the needs of science and public and private decision making.

The Consortium is developing simplified data query software which integrates many different data systems in the United States and other countries, making them accessible to a wide range of users through a single access point.

To carry out its mission, CIESIN is building an organisational and technical infrastructure that will serve global environmental change research scientists and the broader community of policy analysts, resource managers, educators, and the general public. At its hub is the Information Cooperative: a distributed archive that allows user communities to catalog and share data and information electronically among major international data archives and resource centres.

Participation in CIESIN's Information Cooperative provides organisations with a mechanism for disseminating their data and information to a broad audience while retaining ownership and responsibility. Each participating organisation also acquires access to data, information, technologies, and expertise from CIESIN and from other organisations.

The CIESIN Catalog Service allows search and retrieval of metadata concerning the environment. Data available through the system will consist primarily of CIESIN holdings and the holdings of CIESIN's Information Cooperative partners and those that are referenced by the U.S. Global Change Master Directory. The Catalog Service is accessible via the Internet as well as modem dial-in access and is based on a distributed network of *servers*.

Metadata information stored in the databases of servers is currently in Directory Interchange Format (DIF) or full-text format. Thus far, DIF has been a focus of the CIESIN Catalog Service due to its wide acceptance as a metadata standard in the environmental community. Currently, servers have been implemented to provide access to *directory*-level metadata.

Institutions or countries wishing the make their environmental metadata accessible to the CIESIN community should contact the CIESIN Customer Service (see Address List, Section 8.2).

Name **EEA**

Description The establishment of the European Environment Agency (EEA) was agreed upon at a March 1990 meeting of the European Ministers' Environment Council in Bruxelles. EEA was conceived as a smaller coordinating unit of a large decentralised network.

The EEA's main aim is to assist in harmonising data and to distribute to European Union institutions, Member States and the public, information about the environmental data which exist in Member States and which are relevant to the Union. The Agency will achieve this through close cooperation with the Member States and relevant international institutions, who actually collect and hold the data.

To perform its tasks, the Agency must have at its direct disposal a limited nucleus of European environmental data and a wide knowledge of sources to other relevant environmental data in Member States and international organisations. It must also create tools and guidelines to assist the harmonisation. The Agency needs to know who holds data, about what and how the data are accessible.

Collecting and distributing knowledge about relevant sources of environmental data and information is to be done through a Catalogue of Datasources (CDS), based on collaboration mainly between the Agency, the National Focal Points of the Member States and a limited number of international organisations. For the EEA-CDS system, a database is currently being built and served by the Agency Task Force staff.

Name **ELC**

Description The Environmental Law Centre (ELC), the *legal arm* of the IUCN Secretariat, monitors and maintains databases on legal trends and developments in the environmental field, including international agreements, binding instruments of international organisations, national legislation and legal literature. It also develops specific databases (eg; on species protection); contributes to the work of other organisations working in this field; supports activities of other IUCN components; and develops and carries out specific legal activities (eg; drafting international treaties).

The Environmental Law Information System (ELIS) is developed, maintained and operated by the Law Centre staff and is geared to give information to people throughout the world. ELIS is composed of the following four main databases:

- national legislation (approx. 37,000 records)
- international treaties (approx. 800 records)
- supranational instruments (approx. 350 records)
- law and policy literature (approx. 39,000 documents).

Name **GENIE**

Description The Global Environmental Network Information Exchange (GENIE) is still under development and will be a vital part of the UK contribution to international science programmes including projects within the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), and the Human Dimensions of Global Environmental Change Programme (HDGECP).

GENIE is based on the design of a metadata retrieval and management system produced by the Midlands Regional Research Laboratory (MRRL), and is intended to be a fully-distributed system designed to allow those with knowledge of data holdings to make their knowledge available to other researchers. Although no single centre will hold all the information available in the system as a whole, GENIE will assist users to answer a variety of queries.

The GENIE project will provide a user-sympathetic system for locating and accessing relevant information on Global Environmental Change. The software is designed to run on a range of hardware platforms in order to provide information on data availability, location, currency and quality, as well as offering links to other international data directories. The system will have a flexible and intuitive user interface that will allow both enquirers and data suppliers to interact using their own terminology.

Name **GLIS**

Description The Global Land Information System (GLIS) is an interactive computer system developed by the US Geological Survey (USGS) for scientists seeking information and access to data pertaining to the Earth's land surface that can be used in continental and global scale Earth science and global change studies. GLIS can be characterised as a metadata system containing both descriptive information and query functions that allow scientists to assess the potential utility of data sets, determine their availability, and place on-line requests for related data products. Both textual and graphical user interfaces are provided, and scientists can access GLIS through either wide-area network or dial-up communications interfaces.

Name **INFOTERRA**

Description The Stockholm Conference on the Human Environment, convened by the United Nations in 1972 to consider the condition of the environment, called for an international mechanism for the exchange of environmental information. The result was The International Referral System (IRS), later renamed The Global Environmental Information Exchange Network or INFOTERRA, which was established in 1975. The main direction given to INFOTERRA was to develop a mechanism to "*facilitate the exchange of environmental information within and among nations*".

INFOTERRA began its operations in 1977 with a dozen partner countries. It was, from the start, designed as a decentralised information system operating through a worldwide network of national environmental institutions designated and supported by their governments as national focal points and coordinated by UNEP Headquarters in Nairobi. Today, this linking structure consists of 165 national focal points, 11 regional service centres, and 34 special sectoral sources. In the early years INFOTERRA operated only as a referral system. However, following the recommendations of an independent assessment of the system done in 1981, INFOTERRA evolved and expanded its services to include substantive information and document delivery.

The INFOTERRA national focal points are usually situated in the information and documentation sections of environment ministries, and national environmental protection agencies which are often also the focal points for national information networks. They act as the primary access points through which queries from users are channelled to INFOTERRA sources and through which users receive their replies.

Each national focal point compiles a "*Who's Who*" of environmental expertise in their country, and selects the best sources for inclusion in INFOTERRA's main publication the *International Directory of Sources*. These are constantly monitored and updated. The International Directory of Sources exists in both printed form and as a database. For this reason the International Directory is often referred to as the INFOTERRA Database. It is a referral system which helps to access more than 7,000 sources of information on over 1,000 environmental subjects. The sources are located in government ministries and documentation centres, research institutes, universities, non-governmental and international organisations, United Nations agencies and private consultancies. Regional service centres have been set up, within key national focal points, to act as centres for regional co-operation for the exchange of information and for the development of sub-networks to facilitate this exchange.

In addition to the International Directory, INFOTERRA periodically publishes specialised directories and sourcebooks like the Thesaurus of Environmental Terms, Operations Manual, quarterly Bulletins, and the technical Exchange of Environmental Experiences Series. The Thesaurus, in particular, is set to become an increasingly important publication as the movement to exchange environmental information gathers momentum. Organisations, such as CIESIN and EEA, who are in the latter stages of implementing their own systems to catalog environmental data held by institutions, are finding that consistency in the use of terminology is perhaps the main obstacle to information exchange. CIESIN have their own short lists of recognised terminology that they inherited from NASA (the organisation that defined the Directory Interchange Format). But these are primarily of relevance to space science and for environmental metadata they are suggesting that the INFOTERRA Terms are used.

The direction for INFOTERRA over the next decade has been further defined by the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. Chapter 40 of UNCED's global plan of action, Agenda 21, addresses the importance of information for decision making. Part A of that chapter is mostly concerned with data collection, but Part B entitled *Improving information availability* specifically cites expansion of the INFOTERRA system to a world mandate.

Name **IPGRI**

Description Established in 1991, the International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organisation operating under the aegis of the Consultative Group on International Agricultural Research (CGIAR). IPRGI's mandate is to advance the conservation and use of plant genetic resources for the benefit of present and future generations.

IPGRI intends to expand its information service to better meet the needs of the plant genetic resources community. Existing services and databases held by other institutions already cater to many of these needs. Wherever appropriate, IPGRI will refer users to such sources.

IPGRI maintains a database on the known Directories of Germplasm Collections. These directories list the germplasm holdings of specific crops and food plants in institutes around the world. The information aids scientists in making contact with other workers involved in the same crop.

Name **UNEP GRID**

Description The UNEP/GRID Meta-Database (MDb) was designed both with GRID's own data management needs in mind, as well as to offer those outside GRID with a window on their data holdings. Thus the structure of the MDb reflects mostly the GRID internal needs of data cataloguing/handling. At the uppermost level "Data Sets" are referenced; that is, a coherent collection of data on a certain theme and from a certain source and at a particular point in time. Some examples would be "World Boundary Databank", "NOAA Global Vegetation Index (GVI), First Generation" and "UNESCO (White's) Africa Vegetation Map". At the next level down are found all the individual "members" of each data set, which are equivalent to data files. For example, WBDb-II is composed of various boundary types and regions of the world.

The members are further decomposed into three major types - that is, raster, vector and (raw) satellite data members. Thus, the metadata holdings are focused on the cataloguing of information on *geo-referenced* data. In the future, the number of these types may be expanded to include, for example, maps, statistical/tabular data sets etc.

While it is possible to access the GRID MDb via the standard computer networks (Internet; BITNet/EARN), it is not yet open for public access. Thus far, only a handful of internal users (from other GRID sets) and a limited number of external evaluators have been given access; requirements are ability to run Telnet and access to a 3270 terminal emulator.

Users who wish to use the GRID MDb without having to connect via network have a diskette version being developed for use on IBM-style personal computers, with the same easily-used menu system to guide enquiries. This version runs on any PC with a hard disk, including portables, will not require licensed software.

Name **UNEP HEM**

Description The HEMDisk is a floppy disk that has been prepared is distributed by the United Nations Environment Programme, Office of Harmonization of Environmental Measurement (HEM), in Munich Germany. The HEM Office is part of the Global Environmental Monitoring System (GEMS) and a component of Earthwatch. The information on the disk is indexed as a "Folio Views Infobase".

The information contained in HEMDisk is derived from three surveys conducted by HEM since its inception in 1989. The latest edition was published in April,1992, often referred to as the "Green Book" for the colour of its covers. This directory identifies environmental monitoring agencies, particularly those with international scope, outlining their organisational objectives, the nature of the monitoring programmes, and providing a contact address.

The UNEP HEM directories are global in scope and emphasise international programmes and organisations. Some national bodies are included, but primarily those which have strong international connections, or whose work is of international significance. In terms of subject matter, the term "environment" is used very broadly, although sectoral research - such as in geology, biology, chemistry - is excluded. These more specialised areas are well covered by existing meta-information systems which record current research and the published literature. The emphasis in the HEM directories is on the integration and application of science to the measurement and monitoring of the present state or change in the environment and related work on harmonisation.

The directories were assembled mainly through the mechanism of a questionnaire, either sent directly to selected agencies, or made available more generally at conferences and meetings. In most cases, therefore, the information was supplied directly by officials of the organisation or programme.

The HEMDisk files contain entries for 95 Programmes, 103 Environmental Monitoring Institutions and 54 Institutions dealing with Reference Materials. The information is enhanced with the addition of keywords, from the INFOTERRA Thesaurus of Environmental Terms to facilitate retrieval.

The format adopted for the metadata parallels that of the "Directory Interchange Format" (DIF) of NASA.

Name **WFCC**

Description The World Federation for Culture Collections (WFCC) is a 200-member federation of the International Union of Microbiological Societies. Microbiologists in 55 countries working in research, education, and industry are encouraged to cooperate in the study of procedures for the isolation, culture, characterisation, conservation, and distribution of microorganisms. The aim is to establish an effective network of individuals and institutions possessing collections of microorganism cultures and cell lines and to facilitate communication between collection owners and users.

The long-term goal of the Federation is to create a global network of information services charged with compiling and disseminating data on cultures; address practical questions such as the impact of postal regulations, quarantine rules, patent laws, and public health concerns on culture distribution.

The WFCC pioneered the development of an international database on culture resources worldwide. The result is the World Data Center for Collections of Microorganisms (WDCM). This data resource is now maintained at RIKEN, Japan and has records of nearly 400 culture collections from 55 countries. The records contain data on the organisation, management, services and scientific interests of the collections. Each of these records is linked to a second record containing the list of species held. The WDC database forms an important information resource for all microbiological activity and also acts as a focus for data activities amongst WFCC members.

Computerised Information Services operated by the Federation also include the Microbial Strain Data Network (World Data Center for Collections of Microorganisms) for communications purposes. Publications include the *World Directory of Collections of Microorganisms* and the *Living Resources for Biotechnology*.

Name **WORLD DATA CENTRES**

Description World Data Centres were originally established to store information from ICSU's 1957 International Geophysical Year. An ICSU-WDC Panel is responsible for coordinating the activities of the individual data centres. Currently, 27 WDCs are active collecting, archiving, and disseminating data which encompass most facets of the global environment. WDCs are generally co-located with national data centres and are funded by the respective nation. The USA (designated WDC-A) sponsors nine centres, while Russia (WDC-B) operates two and 16 other WDCs (WDC-C) are located in other nations, including China, Japan, Switzerland and the UK.

Data are acquired from various sources and managed according to internationally recommended procedures. For example, the WDC for Greenhouse Gases (WDCGG) in Japan, collects its data from world-wide sources pertaining, in particular, to atmospheric concentrations of CO_2, CH_4, CFCs, and NO_x. Generally information can be obtained from these centres for a small cost.

Given the recent advancements in computer technology, the ICSU WDC Panel is developing a revised workplan for the Centres. In particular, emphasis is being placed on the improved electronic exchange of datasets. Some of the larger data sets are available on CD-ROM.

7.2 Libraries

The subject of biodiversity encompasses a wide range of disciplines and impinges on many aspects of life. Directories of libraries tend to have a bias towards libraries located in the western world with the exception of libraries which form part of universities. This point is highlighted when one looks at the entries under "wildlife conservation" in the *World Guide to Special Libraries* (Bartz, 1990) where the great majority of entries occur under Australia, Canada and the USA.

Most wildlife conservation libraries were founded in the 1960s or later. It is interesting to note that of the wildlife conservation libraries mentioned, only those based on natural history societies (eg Sierra Club), game conservation, hunting and fishery organisations were founded prior to 1950. Libraries serving agriculturists also have a much longer history as have forestry libraries both of which are concentrated in UK, USA, Canada, Germany and Netherlands.

When undertaking research one must not overlook national collections of relevant published material. However, it is assumed that researchers are familiar with their national resources. National libraries are often the depository for copies of works published in the country where such arrangements are in force. In addition to collecting all works published in that country some national libraries are charged with collecting all material published by a national wherever the work is published and/or attempting to acquire all material published about the country. Some types of organisations which may hold good collections are:

- international organisations

- government departments eg forestry, agriculture, environment, natural resources, culture, overseas aid departments

- universities or seats of higher learning eg those conducting courses on subjects which impinge positively or negatively on the conservation of biological diversity, eg forestry, agriculture, aquaculture, wildlife management, biological sciences, in addition to conservation.

- learned Societies, Research Institutes, local natural history societies, botanical or zoological societies

- cultural organisations, eg museums, botanic gardens

- non-governmental organisations.

One emerging type of library, falling within the national resource category, is that of libraries attached to national parks. Examples include collections in Everglades National Park and Kakadu National Park. These libraries may hold material which pertains to one site but may have international significance in one aspect of conservation management eg tourism, indigenous peoples, exotic species.

Libraries the world over are experiencing financial constraints. Thus whilst most libraries will try to help outside enquirers, if you would like to visit please remember to write or telephone to arrange a mutually convenient time. Financial pressures tend to focus activities such as collection-building to meet the needs of the primary user group, and foster networking and cooperation between libraries. In this context some libraries or parts of their collections are now referred to as "information centres", "resource centres" or "documentation centres" where the emphasis is placed more on the information delivery rather than simply organising and storing information.

The following list identifies some main libraries which have substantial holdings at the supranational level. The following list is intended to give a starting point.

Libraries of International Organisations

Name	**BirdLife International (BLI)**
Description	An extensive collection of publications and reports on birds with worldwide coverage. The Library's first responsibility is to staff and research workers but visitors can be accommodated.
Contact	Ms S. Squire

Name	**Consultative Group on International Agricultural Research (CGIAR)**
Description	Many of the organisations under the this umbrella have libraries collecting and disseminating material on specialised aspects of food production and forestry. Some of these are:

- Center for International Forestry Research (CIFOR)
- International Center or Tropical Agriculture (CIAT)
- International Maize and Wheat Improvement Center
- International Potato Center (IPC)
- International Plant Genetic Resources Institute (IPGRI)
- International Laboratory for Research on Animal Diseases (ILRAD)
- International Livestock Center for Africa (ILCA)

For example, IPGRI has a small library, 90% of which relates to genetic resources of food plants and crops; CIFOR has a small library still in the early stages of development but intending to concentrate on forestry research with emphasis on forestry and agroforestry.

Contact Ms Yuni Soeripto.

Name **FAO David Lublin Memorial Library**

Description This is a very large library, holding over 1 million volumes and 7,000 serials, which supports the organisation's remit of improving production in all areas of agriculture, forestry, and fisheries including conservation and management of plant and animal genetic resources. The library produces several specialist databases in conjunction with other organisations and current awareness products, eg FAO Documentation on Forestry.

Name **ICIMOD**

Description One of the main activities of this Centre has been to build up its library and so it has a good collection on the theme of mountain areas. The Centre has prepared a number of bibliographies on aspects of life in mountain areas.

Name **International Center for Living Aquatic Resources Management (ICLARM)**

Description The Ian R. Smith Memorial Library and Documentation Center concentrates on coastal area management, aquaculture and fisheries literature and databases.

Contact Ms Rosalinda Temprosa

Name **United Nations (UN)**

Description The UN Headquarters Library in Geneva is there to serve the delegations, Secretariat and other official groups of the UN. As such it has an extensive collection of publications by the UN and its specialised agencies. These collections include statistics, environmental policy, conservation.

Name **UN Economic Commission for Asia and the Pacific**

Description This Library has an excellent collection of monographs and serial titles on natural resources, agricultural development relating to Asia. Dissemination is by means of a 6-monthly publication.

Contact Chief Librarian

Name **UN Economic Commission for Latin America**
Description The library has a good collection of documents covering natural resources, agriculture and UN documents.
Contact Chief Librarian

Name **UNEP**
Description This collection has a broad remit to collect and make available material on environmental matters to the UNEP Secretariat and delegations. Many programmes incorporate and elements of biodiversity conservation eg terrestrial ecosystems, oceans and coastal areas, desertification.
Contact Mrs Mary Rigby

Name **World Conservation Union (IUCN)**
Description The main focus of this library's holdings are: sustainable development, biological diversity, natural history, aquatic & terrestrial and ecology and ecosystems.
Contact Head Librarian

Name **World Resources Institute (WRI)**
Description A not-for-profit organisation with a substantial literature collection on biological diversity and related aspects whose resources may be consulted by appointment.
Contact Mr S Boltick

Government Libraries

Name **CSIRO Black Mountain Laboratory (Australia)**
Description This research institute has one of the best collections in Australia covering land use, agriculture, botany, entomology.

Name **Institut francais de Recherche Scientifique pour le Developpment en Cooperation (ORSTOM)**
Description This French government institute, whose remit is natural resource management and environmental protection, has major programmes in 45 developing countries. Specialist libraries are maintained as part of the institutes in many countries to support the research activities in natural resource utilisation, botany, zoology and ecology.

Name **International Development Research Centre (IDRC)**
Description This Canadian library places strong emphasis on disseminating information about the parent's research on sustainable solutions to development problems. It has an extensive collection of books and reports dating from 1970, basic bibliographic information is available through BIBLIOL (see Online Services, Section 7.1.2)
Contact Cathi Corbett

Name **National Library of Agriculture (NAL)**
Description The National Library of Agriculture in the USA is one of the world's leading collections of agricultural literature and related subjects. These include biodiversity, wildlife management, microbiology, natural history, natural resources, conservation, forestry and zoology.

Name **Natural Resources Institute (NRI)**
Description The Natural Resources Institute in the UK has a large library specialising in tropical agriculture, contributing to a number of international databases of forestry, forest products, and aquaculture.

Academic Libraries

Name **Asian Institute of Technology (AIT)**
Description The Institute maintains the Library and Regional Documentation Center which comprises five specialised information centers, including Environment, Resources and Development. The Institute has a very active GIS programme.

Name **Oxford Forestry Institute (OFI)**
Description Although the Institute has a small collection, the main collection resides in the Plant Sciences Department Library of the University of Oxford. This library has an extensive collection dealing with all aspects of plant sciences including forestry and is held in conjunction with CAB International.

Name **Pacific Information Service**
Description This service is based on the resources of the University of the South Pacific, Suva and covers a wide range of subjects including natural resources, plant resources.

Libraries of Cultural Organisations

Name **National Museums of Kenya (NMK)**
Description This library acts as a regional centre for information East Africa, in particular, and Africa in general. It has a substantial collection, which is primarily to support the work of the Museum staff and East African Natural History Society but access is easily arranged for other researchers.
Contact Ms Asha Owano

Name **Natural History Museum (NHM)**
Description The Natural History Museum in the UK claims to have the world's largest natural history library, comprising 4 sub-libraries. Botany, Entomology, General and Zoology, Palaeontology & Mineralogy. The resource is available to the Museum staff, research workers and the public for enquiries and visits by prior arrangement.

Name	**Royal Botanic Gardens, Kew (RBGK)**
Description	The library is based on collections acquired in the mid-19th century having as its core collection works on botany and especially taxonomy with collections on economic botany, medicinal plants and landscaping. The collection aims to cover all plants and fungi. Library is intended to serve staff of RBG but researchers may apply to use the Library.
Contact	Miss S M D FitzGerald

Name	**Smithsonian Institution**
Description	Among the 18 libraries forming the library resource of this great institution is the National Museum of Natural History, an institution with formidable resources in zoology, botany, geology, and natural sciences and libraries serving these specialities.

7.3 Bibliography

The terms "biological diversity" and "biodiversity" first made their appearance in scientific papers in the mid-1980s, and in book titles in 1988. Biodiversity, as opposed to "biological diversity" has become the more common of the terms since 1990 and in conventionally published literature.

The term biodiversity is used to encompass a range of aspects and so many relevant publications may be found in the literature of the biological sciences and the related applied sciences, for example zoology, botany, genetics, natural history, forestry, agriculture, wildlife management, and conservation biology. For aspects such as attitudes to conservation, economics of biodiversity or project management one may also need to look at the social science literature.

Perhaps more than most sciences, there is a substantial body of knowledge and experience to be found in the grey literature. For example, reports from consultancy groups, field workers, research workers undertaking a particular project, pressure groups, non-governmental organisations and reports to government departments. Most of this knowledge is never formally published and often is extremely difficult to trace and thus to obtain copies. Often the grey literature may be prepared for a very limited audience and it may never be intended to be publicly available: one may only identify this grey literature by talking to workers with similar interests and by contacting relevant organisations. Those wishing to identify are encouraged to seek help from national or international organisations listed in Address List, Section 8.2.

The bibliography presented below not only lists those texts cited in the current series of documents, but also a wider selection of background reading. However, any such list is inevitably selective, and the basic objective was therefore to identify key recent publications which have a good international or regional coverage.

The bibliography is divided up to reflect the contents of this Resource Inventory document, with another of additional sections for documents which were difficult to place elsewhere.

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7.4 Periodicals

The 32nd edition of *Ulrich's International Periodicals Directory 1993-94* (Bowker, 1993) lists approximately 250 serial publications under the heading "conservation". This list selects key learned journals. Many organisations produce newsletters whose principal function is to disseminate information about the projects or the originating institution, for example the newsletters from the Specialist Groups of the IUCN Species Survival Commission.

Name	**Ambio**
Code	ISSN 0044-7447
Publisher	Royal Swedish Academy of Sciences
Frequency	8 issues per year
Cost	$170 per year (1994), reduced rates for personal subscriptions

Name	**Biological Conservation**
Code	ISSN 0006-3207
Publisher	Elsevier Applied Science
Frequency	12 issues per year
Cost	£600 per year (1995)

Name	**Biodiversity and Conservation**
Code	ISSN 0960-3115
Publisher	Chapman and Hall
Frequency	8 or 10 per year
Cost	£190 per year (1994) strictly personal subscriptions are substantially cheaper.

Name	**Biological Conservation Newsletter**
Publisher	Smithsonian Institution
Frequency	Monthly
Cost	Free

Name	**Biology International**
Code	ISSN 0253-2069
Publisher	International Union of Biological Sciences
Frequency	Variable
Cost	Free to members of the Union, or $40.00 to individuals

Name	**Conservation Biology**
Code	ISSN 0888-8892
Publisher	Blackwell Scientific
Frequency	Quarterly
Cost	$200 for non-US institutions, personal subscriptions available to members of the Society for Conservation Biology

Name	**Conservation Indonesia**
Code	ISSN 0853-3768
Publisher	WWF Indonesia
Frequency	Quarterly

Cost	$45 per annum

Name	**Environmental Conservation**
Code	ISSN 0376-8929
Publisher	Elsevier Science
Frequency	Quarterly
Cost	$197

Name	**Global Biodiversity**
Code	ISSN 1195-3101
Publisher	Canadian Centre for Biodiversity at Canadian Museum of Nature
Frequency	Quarterly

Name	**Journal of African Ecology**
Publisher	Blackwell Scientific
Frequency	Quarterly
Cost	£130 per year (1994)

Name	**Journal of Tropical Ecology**
Code	ISSN 0266-4674
Publisher	Cambridge University Press
Frequency	Quarterly
Cost	£90 per year (1994). Personal subscriptions may be available

Name	**Natural Resources**
Code	ISSN 0028-0844
Publisher	Parthenon
Frequency	Quarterly

Name	**Oryx**
Code	ISSN 0030-6053
Publisher	Blackwell Scientific
Frequency	Quarterly
Cost	£80
Note	Probably the oldest journal of conservation, being produced by the Flora and Fauna Preservation Society.

Name	**Parks**
Code	ISSN 0960-233X
Publisher	Commission on National Parks and Protected Areas (CNPPA) of IUCN
Frequency	Three issues annually (February, June, and October)
Cost	(Subscription) £18 plus postage per volume; reduced rate of £12 plus postage per volume for 10 or more copies.
Notes	Each volume consists of three issues. Each issue of Parks addresses a particular theme.

Name	**Tigerpaper**
Code	ISSN 1014-2789
Publisher	FAO Regional Office for Asia and the Pacific
Frequency	Quarterly
Cost	$12

Name	**Tropical Biodiversity**
Code	ISSN 0854-1566
Publisher	Indonesian Foundation for the Advancement of Biological Sciences
Frequency	Quarterly
Cost	$200 per year 1994. Discounts available for institutions in developing countries and individuals.

Name	**International Journal of Geographic Information Systems**
Code	ISSN 0269-3798
Publisher	Taylor and Francis Ltd
Frequency	Bi-monthly
Cost	£77.60 ($134) to Individuals; Institutions £164 ($284)
Notes	Covers theory, research and development, and application of GIS, inclusive of associated soft and hardware.

Name	**Geojournal**
Code	ISSN 0343-2521
Publisher	Kluwer Academic Press
Frequency	12 per year
Cost	Fl. 1656
Notes	International Journal of physical, biological, social and economic geography, and applications in environmental planning and technology.

Name	**Cartographica**
Code	ISSN 0317-7173
Publisher	University of Toronto Press
Frequency	Quarterly
Cost	Can $ 35. (institutions Can $ 60., students Can $ 25.)

Name	**GeoInfo Systems**
Code	1051-9858
Publisher	Advanstar Communications, Incorporated
Frequency	10 per year
Cost	US $ 59. (foreign US $ 117)
Notes	Application of GIS and related Spatial Information Technologies.

Name	**GIS Europe**
Publisher	Longmans Geoinformation (GIS World Incorporated)
Frequency	10 per year
Cost	£12

Name	**GIS World**
Code	ISSN 0897-5507
Publisher	GIS World Incorporated
Frequency	12 per year
Cost	US $ 72
Notes	Covers news, technical developments and events relating to the field of GIS.

7.5 References

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8 REFERENCE MATERIALS

8.1 Profiles of Key Organisations

The profiles below were compiled from current sources at WCMC. Effort has been made to portray the organisations accurately, although some errors will inevitably have occurred. The potential list of institutions to profile was very large, and the list below therefore reflects a cross-section, rather than a complete list, of key organisations relevant to biodiversity information management.

Name **BirdLife International (BLI)**

Description Birdlife International is an international charity founded in 1922. It is a federation of 360 member organisations in 100 countries. It is dedicated to saving the worlds' birds and their habitats.It conducts research in the status and threats to birds throughout the world; works to protect endangered birds and promotes public awareness of their ecological important and lobbies policy makers on issues relating to bird conservation. BirdLife's conservation programme targets priorities for world bird conservation and currently has over 60 key field and research projects in developing countries. BLI compiles the internationally renowned Bird Red Data Books.

Birdlife International also publishes "World Birdwatch" newsletter four times a year; various technical publications and monographs, an annual report and a publications list.

Name **CAB International**

Description CAB International is an international intergovernmental organisation which provides research information, scientific and development services for agriculture, forestry and related disciplines throughout the world. It is owned by its 34 member governments.

It has the worlds largest bibliographic database (CAB Abstracts) of relevant research and development publications. CABI's resources and activities include:

- customised database derivatives in the form of printed and electronic publications diagnostic identification services for harmful and beneficial organisms
- authoritative and up-to-date information on harmful and beneficial organisms
- field surveys of pests and natural enemies and advice on the assessment of economic and environmental impacts, and
- biological control programmes.

CABI has four constituent institutions namely, the International Institute of Entomology; International Mycology Institute; International Institute of Biological Control; and the International Institute of Parasitology.

Name **Conservation International (CI)**

Description Conservation International was founded in 1987. It acts as "*a catalyst for conservation action*" in Latin America, "*working with people and sovereign nations as partners within the context of local socio-political and economic realities.*" Main focus is on developing national conservation data centres, fellowships for conservation leaders, and creating and managing ecosystem reserves. CI is best known for carrying out "debt-for-nature" trades in Bolivia and Costa Rica, in which CI purchased part of the countries' foreign debt at a discounted rate. In exchange for CI's agreement to cancel the debt, the governments agreed to establish legal protection for conservation areas.

Conservation International publishes *TROPICUS Newsletter* and monographs including *The Debt for Nature Exchange.*

Name **Consortium for International Earth Science Information Network (CIESIN)**

Description CIESIN is a private, non-profit organisation established in 1989. It's mission is to provide access to and enhance the use of information worldwide, advancing understanding of human interactions in the environment and serving the needs of science and public and private decision making.

CIESIN is developing simple data query software which integrates many different data systems in the United States and other countries, making them accessible to a wide range of users through a single access point.

To carry out its mission, CIESIN is building an organisational and technical infrastructure that will serve global environmental change research scientists and the broader community of policy analysts, resource managers, educators, and the general public. At its hub is the Information Cooperative: a distributed archive that allows user communities to catalog and share data and information electronically among major international data archives and resource centres.

Participation in CIESIN's Information Cooperative provides organisations with a mechanism for disseminating their data and information to a broad audience while retaining ownership and responsibility. Each participating organisation also acquires access to data, information, technologies, and expertise from CIESIN and from other organisations.

The CIESIN Catalog Service allows search and retrieval of metadata concerning the environment. Data available through the system will consist primarily of CIESIN holdings and the holdings of CIESIN's Information Cooperative partners and those that are referenced by the U.S. Global Change Master Directory. The Catalog Service is accessible via the Internet as well as modem dial-in access and is based on a distributed network of *servers*.

Metadata information stored in the databases of servers is currently in Directory Interchange Format (DIF) or full-text format. Thus far, DIF has been a focus of the CIESIN Catalog Service due to its wide acceptance as a metadata standard in the environmental community.

Institutions or countries wishing the make their environmental metadata accessible to the CIESIN community should contact the CIESIN Customer Service (see Address List, Section 8.2).

Name **Consultative Group on the International Agricultural Research (CGIAR)**

Description The International Agricultural Research Centres (IARCs), supported by the Consultative Group on International Agricultural Research (CGIAR), have been active in the international coordination of activities concerned with plant resources, particularly gene banks.

CGIAR was founded in 1971, and consists of a consortium of donor countries, foundations and development banks, jointly sponsored by the World Bank, the Food and Agriculture Organisation (FAO) and the United Nations Development Programme (UNDP). The establishment of this international network was motivated by international concern over the problems of genetic erosion in cultivated species and the loss of related wild species of flora.

At present there are 13 IARCs supported by the CGIAR. Most of these centres have specific responsibilities in crop varietal development and germplasm conservation. A few of these centres also serve as an international base for specific crops and actively collect on a worldwide basis. The collection efforts of the CGIAR network were initially focused on crop plants and were based on the economic importance of the crop, the quality of existing collections and the degree of threat to the crop. The most important of these IARCs is the International Board of Plant Genetic Resources (IBPGR) in Rome, Italy.

Name **Convention on Biological Diversity (CBD) Secretariat**

Description Article 24 of the Convention on Biological Diversity states " At its first ordinary meeting, the Conference of the Parties shall designate the secretariat from amongst those existing competent international organisations which have signified their willingness to carry out the secretariat functions under this Convention." The first meeting of the Conference of the parties was held in November 1994 and no decision was taken.

When the country and location for the secretariat are decided upon, the responsibilities will include:

- to perform the functions assigned to it by any protocol

- to prepare reports on the execution of its functions under this convention and present them to the Conference of the Parties, and

- to coordinate with other relevant international bodies and, in particular to enter into such administrative and contractual arrangements as may be required for the effective discharge of its functions.

Name **Environmental Change Network (ECN)**

Description Founded in 1992, the Environmental Change Network is the United Kingdom's multi-agency research programme coordinated by the Natural Environment Research Council (NERC). It is designed to collect, store, analyze and interpret long-term data based on a set of key variables which drive and respond to environmental change at a range of terrestrial and freshwater sites across the UK.

ECN data will be used:

- to identify and quantify natural and man-induced environmental factors
- to distinguish short-term fluctuations from long-term trends
- to predict future change

ECN has approximately 50 terrestrial and freshwater sites throughout England, Scotland, Wales and Northern Ireland. Sites range from upland to lowland, moorland to chalk grassland, and include both small and large lakes and rivers. ECN sites are owned and managed by more than 15 different organisations, including government departments, research councils and other statutory authorities.

ECN uses standardised measurements and ECN methods of data collection are based on agreed protocols. Measurements relate to variables expected to be important in driving environmental change and to ecosystem variables likely to respond or be sensitive to such change. They include:

- climate
- air quality
- water flow and quality
- soil development and chemistry
- vertebrates
- invertebrates
- site management
- managed and semi-natural vegetation.

ECN is based at the Merlewood Research Station of the Institute of Terrestrial Ecology in the UK. The latter undertakes specialist ecological research in all aspects of the terrestrial environment and seeks to understand the ecology of species and of natural and human communities. Using advanced computer technology to interpret research findings, ITE scientists can advise on the ecology, management and protection of the environment. The work undertaken includes: monitoring ecological aspects of agriculture; improving productivity in forestry; controlling pests; managing and conserving wildlife; assessing the causes and effects of pollution; and rehabilitating degraded sites. There are three research stations in England (including Merlewood) and one in Scotland.

Name **Environmental Resources Information Network (ERIN)**

Description ERIN was established in July 1989 by the Australian Commonwealth Government. The organisations mission was to provide spatially related environmental information of sufficient extent, quality and availability to support decision making.

Since its establishment, ERIN has built a strategic framework for an environmental information system for the Australian continent and the marine environment of interest to the Australian government. Considerable work has been done on priority components within that framework, both within the ERIN Unit and by collaborating agencies, *inter alia*:

- topography at 1:250,000 scale (coastline, roads, rivers etc.)
- soils and soil landscapes, geology and climate
- point-based distributions of Australian "Rare or Threatened Plants"
- point-based distributions of Australian "land cover" plant species
- biodiversity data sets including birds
- fortnightly (cloud minimised) continental coverage of satellite imagery (NOAA and AVHRR) from February 1991 (for environmental monitoring, particularly of land cover, fires and floods)
- regional studies of priority areas, eg Cape York Peninsula, Murray-Darling Basin
- studies of environmental regionalisation and assessments of protected area representativeness
- integrated relational databases including: management information system; taxon authority files; specimen and site record databases; data dictionary and catalogue
- extensive work on data quality control and standards (eg site attribute standards)
- extensive work on issues of custodianship, intellectual property and data licensing
- modelling and analysis tools, eg species distribution modelling (BIOCLIM, GARP)

- an open systems computing infrastructure comprising networked UNIX workstations, Pcs and Macs

- a prototype network linked to nature conservation agencies in all Australian States and Territories

- full Internet access including comprehensive information services maintained on World Wide Web and gopher including: legislation; government policy and operational documents; scientific and technical papers; images; on-line database retrieval, mapping and modelling; WAIS text searching; animation; etc.

Name **European Environment Agency (EEA)**

Description The establishment of the EEA was agreed upon at a March 1990 meeting of the European Ministers' Environment Council in Brussels. EEA was conceived as a smaller coordinating unit of a large decentralised network. As well as EEA, the EU also established a European Environment Information and Observation Network (EEION) at the same time. Together, the Agency and the Network are to provide the European Union and its member states with objective and reliable information and assessments about the state of the environment in Europe. EEION is to be coordinated by the EEA and participants will come from three different backgrounds:

1. a national focal point is to be set up in each member state
2. various national information networks, and
3. institutions will be given responsibilities for specific task and projects. These will be termed Centres of Excellence.

In the first years of its operation emphasis will be placed on providing information which can be directly used in environmental policy implementation. Such areas include:

- air quality and atmospheric emissions
- water quality, pollutants and water resources
- the state of soil, flora, fauna and of biotopes
- land use and natural resources
- waste management
- noise emissions
- environmentally hazardous chemical substances
- coastal protection.

Upon its implementation, EEION will coordinate and provide Member States with objective, reliable and comparable information at the European level to enable them to take the necessary measures to protect the environment as well as assess the results of measurements they have taken.

EEA will be open to other non-EU Members. Already interest has been shown by EFTA, Eastern and Central European nations as well as by the OECD and ESA. ESA will be of particular importance as information provided by the ERS-1 satellite is crucial to assessing the state of the environment. Within the EU, JRC and EUROSTAT have also expressed an interest in co-operating close with EEA. JRC for example, will play an essential role in researching, developing and harmonising new environmental measurement methods and the standardisation of data.

Name **Food and Agriculture Organisation of the United Nations (FAO)**

Description The Food and Agriculture Organisation of the United Nations (FAO) was established in 1945 and has 160 member states. FAO carries a major programme for the agricultural community on behalf of governments and development agencies; collects, analyzes, disseminates information; advises governments on policy planning; and provides opportunities for governments to meet and discuss food and agriculture problems.

The major FAO units concerned with environmental and natural resource problems and issues are: the Interdepartmental Working Group on Environment and Sustainable Development; Forestry Department; Fisheries Department; Agriculture Department; and the regional commissions and technical committees.

Name **ICSU/CODATA**

Description CODATA is a scientific committee of the International Council of Scientific Unions (ICSU). It was implemented to address data quality and utilisation on an international level. In this respect, CODATA was given several general objectives:

- to improve data quality and accessibility, as well as the collection, management and analysis methodology

- to facilitate international cooperation among those collecting, managing and using data, and

- to promote an increased awareness in the scientific and technical community of the importance of these activities.

In order to address and achieve these objectives, CODATA initiated several projects, including:

- coordinating multinational programmes
- establishing format standards to promote compatibility of databases
- developing guidelines for the presentation of data in the primary literature
- training and education programmes
- organising conferences and workshops

Only recently has CODATA begun formally addressing environmental data in a comprehensive fashion. To date, it has been concerned with all types of quantitative data collected from a wide variety of monitoring sources and disciplines. The following is a list and brief description of current CODATA projects:

- Chemical Thermodynamic Tables - a standardised, computer based mechanism for the collaboration of thermodynamic data centres in five countries

- Fundamental Physical Constants - a task group of physics and metrology experts is responsible for maintaining this database of fundamental constant which are generally accepted

- Biological Macromolecules - a project addressing the improved coordination of protein and DNA sequence data compiling institutions

- Working Group on Access to Data - a group charged by ICSU with examining and reporting on problems in freedom of access to scientific and technical data by the International Scientific Community.

Name **Indonesian Institute of Sciences (LIPI)**

Description Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Sciences) was founded in 1967. It is a government agency established to promote the development of science and technology, to serve as the national centre for regional and international scientific co-operation, to organise national research centres. There are 19 attached centres including: Centre for Research and Development in Biology, Centre for Research and Development in Oceanology, and the Centre for Analysis of Development in Science and Technology.

LIPI is involved in joint conservation and biodiversity projects with the Center for International Forestry Research (CIFOR) of Malaysia, The Nature Conservancy, the Smithsonian Institute, MAB UNESCO, and ITC of The Netherlands.

In 1989, the need to establish a National Biodiversity Database (NBD) to support development and conservation planning in Indonesia was identified. Development of the NBD concept advanced when The Nature Conservancy was asked to provide technical assistance in the development of a proposal an implementation plan for the NBD. LIPI hosted a National Biodiversity Workshop in Jakarta in 1991 which provided instrumental planning information the National Biodiversity Database (NBD). The NBD is held at the Scientific Information and Documentation Center of LIPI which is experienced in managing scientific data and has the necessary support and infrastructure.

Name **Instituto Nacional de Biodiversidad (INBio)**

Description On June 5, 1989, a Presidential Executive Decree established the INBio Planning Commission with representatives from different government agencies, institutions of higher education, and conservation NGOs. The INBio Association was legally registered on 26 October 1989 and is governed by an Assembly of Founders and a Board of Directors. INBio is a non-profit, private organisation for the public good. This legal structure enabled INBio to satisfy the critical need for an organisational flexibility specifically designed to handle the very rapidly expanding field of biodiversity management and to confront many of INBio's tasks such as: the large and complex inventory process, publicising Costa Rican diversity, the promotion of non-destructive use of biodiversity by the commercial world, networking internationally with a multitude of other biodiversity management institutions, and the urgency of planning and fund-raising.

INBio operates under the assumption that a tropical society will conserve a major portion of its wild biodiversity only if protected areas can generate enough intellectual and economic income for its own upkeep. INBio, based on a partnership of cooperative support and guidance with the Ministry of Natural Resources, Energy and Mines (MIRENEM), has agreed to carry out the processes of inventory, biodiversity prospecting and information management and dissemination of Costa Rica's biodiversity.

In keeping with the new Costa Rican conservation strategy, examples of current key programs are:

- The National Biodiversity Inventory
- Biodiversity Prospecting Program
- Biodiversity Information Management Program
- Biodiversity Information Dissemination Program.

Name **International Centre for Living Aquatic Resources Management (ICLARM)**

Description The International Centre for Living Aquatic Resources Management was founded in 1977. ICLARM conducts and fosters research and training in aquaculture, fisheries management, and coastal area management. The Centre works to resolve critical technical and socio-ecological constraints to increased production, improved resource management, and equitable distribution of benefits.

ICLARM publishes *Naga, The ICLARM Quarterly*; bibliographies; educational materials; technical reports; and conference proceedings.

Name **International Institute for Applied Systems Analysis (IIASA)**

Description IIASA was founded in 1972 by the USA and USSR, as well as the participation of the governments of 14 other Eastern and Western nations. Its research efforts are primarily related to the development and use of scenarios and computer models. These activities include: environment; systems and decision sciences; technology, economy and society; and population.

Each programme in turn, is responsible for a number of projects. The Environment Programme is currently involved in a number of projects including:

- Biosphere Dynamics (BIO) Project
- Transboundary Air Pollution (TAP) Project
- Water Resources (WAT) Project
- Environmental Monitoring (MON) Project
- Climate Change (CLI)

Data and information management are an integral part of model and scenario development. Within the Environment Programme, TAP is in the process of developing a Database Information System. This database would not only serve practical needs as establishing cause-and-effect relationships in mapping critical loads for sulphur and nitrogen under EC Convention on Long Range Transboundary Air Pollution.

IIASA is a member of such organisations as ICSU, SCOPE and IFIAS. It collaborates extensively with such programmes as IFIAS's Human Dimensions of Global Change and ICSU's International Geosphere-Biosphere Programme (IGBP). The Environment Programme actively contributes to and/or works with institutions such as UNEP/WMO Intergovernmental Panel on Climate Change (IPCC), WMO's World Climate Programme (WCP) as well as many others (UNEP HEM, 1994).

Name **International Institute for Environment and Development (IIED)**

Description IIED was founded in 1971. It is a non-membership organisation, and is governed by an international board. It promotes the sound management and sustainable use of natural resources. Conducts policy research both independently and on behalf of donors, governments, and international aid agencies with particular emphasis on working at the local level with community groups in developing countries.

Research is carried out by seven programmes in the Institute:

- Drylands (focus on soil and water conservation and assessment studies in Africa)

- Forestry and Land Use (concentrating on the tropics)

- Human settlements (covering housing and health, basic services, population and urban change, and human rights)

- Southern Networks (focus is on Africa, working building South-South links between NGOs at the sub-regional level

- Economics (defining and applying concepts of sustainable development)

- Sustainable Agriculture (training, advice, and research in developing countries).

In 1988, an IIED office opened in Latin America. IIED cosponsors include the London Environmental Economics Centre at University College, University of London.

Name **International Organization for Standardization (ISO)**

Description ISO is a world-wide federation of national standards bodies from 90 countries. The scope of ISO covers standards in all fields except for electrical and electronic engineering which are the responsibility of the International Electrotechnical Commission (IEC). The results of ISO technical work are published as International Standards; mid-1990 more than 7,500 standards had been published, and are listed in the ISO Catalogue.

ISO's technical work is carried out through Technical Committees (TCs). Currently, it has Tcs working in the following fields: air quality; water quality and soil quality.

Many standards have been written for air pollution, including work-place air, ambient air and stationary source emissions. In addition, technical reports have been compiled on the monitoring of ambient air quality. To promote and develop Certified Reference Materials ISO initiated the Committee on Reference Materials (REMCO).

ISO is active in many fields related to the environment. It has developed International Standards for such environmentally related topics as: acoustics; air quality; building construction; chemistry; fertilisers; fire protection; mining, nuclear energy; pesticides; petroleum products; natural gas; soil and water quality.

Name **International Plant Genetic Resources Institute (IPGRI)**

Description Established in 1991, the International Plant Genetic Resources Institute (IPGRI) is an autonomous international scientific organisation operating under the aegis of the Consultative Group on International Agricultural Research (CGIAR). IPRGI's mandate is to advance the conservation and use of plant genetic resources for the benefit of present and future generations.

IPGRI intends to expand its information service to better meet the needs of the plant genetic resources community. Existing services and databases held by other institutions already cater to many of these needs. Wherever appropriate, IPGRI will refer users to such sources.

IPGRI maintains a database on the known Directories of Germplasm Collections. These directories list the germplasm holdings of specific crops and food plants in institutes around the world. The information aids scientists in making contact with other workers involved in the same crop.

Name **IUCN - The World Conservation Union**

Description The World Conservation Union was founded in 1948 at an international conference at Fontainebleau, France, under the sponsorship of the Government of France, the Swiss League for the Protection of Nature, and the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

IUCN's mission is to provide knowledge and leadership for the sustainable use of the planets natural resources. It provides leadership that can guide governments, aid agencies, nongovernmental organisations an local communities. It helps governments to develop international Conventions and national laws on conservation. IUCN initiative helped to create many well-known international measures like the Convention Concerning the Protection of The World Cultural and Natural Heritage, Convention on International Trade in Endangered Species, and the Convention on Wetlands of International Importance.

There are 636 members representing 120 countries. The IUCN has two global information centres: the World Conservation Monitoring Centre and the Environmental Law Centre. See profiles on WCMC and ELC.

The IUCN monitors the global environment and collects scientifically-based data about species and ecosystems. It investigates the causes of environmental change and degradation in different places, assesses the problems and determines options for solutions. Drawing on information and analysis, specialists consider how to reverse destructive trends and make development sustainable. The Union designs actions, provides advice and helps to carry both through to conclusion working with governments, aid agencies, NGOs and local groups and communities.

The IUCN publishes authoritative reviews on conservation policy and the Red Data Books on the status and urgent conservation needs of flora and fauna. It also publishes directories, handbooks, guides, reports, and guideline documents on biodiversity conservation.

Name **IUCN Commission on National Parks and Protected Areas (CNPPA)**

Description The IUCN Commission on National Parks and Protected Areas (CNPPA) is the leading international scientific and technical body concerned with the selection, establishment and management of national parks and other protected areas. Its membership includes more than 500 protected areas professionals from about 120 countries. CNPPA is served by IUCN's Protected Areas

Programme in order to promote the establishment of a world-wide network of effectively managed terrestrial and marine protected areas.

Name **IUCN Environmental Law Centre (ELC)**

Description The ELC, the "legal arm" of the IUCN Secretariat, monitors and maintains databases on legal trends and developments in the environmental field, including international agreements, binding instruments of international organisations, national legislation, and legal literature. It also develops specific databases (eg, on species protection); contributes to the work of other organisations working in the field; supports activities of other IUCN components (eg, organising an international symposium on legal aspects of wetlands protection); and develops and carries out specifically legal activities (eg, drafting international treaties).

Name **IUCN Species Survival Commission (SSC)**

Description The Species Survival Commission (SSC) is one of the six volunteer Commissions of IUCN - The World Conservation Union. It was founded in 1949 to provide global leadership for plant and animal conservation efforts. Within IUCN, the mission of SSC is to conserve biological diversity by developing and executing programmes to study, save, restore and manage wisely species and their habitats. SSC volunteers (5000 in 169 countries) assess the status of biodiversity at the species level, determine the conservation status of individual species, identify the detrimental factors that may be operating, and devise strategies to mitigate these negative factors.

Name **Missouri Botanical Gardens (MOBOT)**

Description The Missouri Botanical Gardens operates an active research programme in tropical botany. Scientific research at the Garden focuses on the exploration of the tropics, which encompasses the earths least known, most diverse, and most rapidly vanishing ecosystems. Because of the speed with which irreversible changes are occurring in tropical regions, the Garden has made a long-term commitment to the study and conservation of these threatened habitats.

MOBOT was founded in 1857 when Henry Shaw purchased a comprehensive herbarium collection of 62,000 specimens which became the basis for the present collection of 4.3 million specimen collection. There are 56 research botanists who work in the tropics worldwide. MOBOT is under contract with the National Cancer Institute to collect plants to screen for anti-cancer and anti-AIDS agents.

The Garden also coordinates the Flora of North America, the Flora of China and the Flora of Mesoamericana projects. In conjunction with the Missouri Department of Conservation, the Garden sponsors the Flora of Missouri project. Images and data are now available for the Conspectus of the Vascular Plants of Madagascar project.

Name **National Museums of Kenya (NMK)**

Description The National Museums of Kenya was founded in 1911. The National Museums of Kenya are comprised of: National Museum of Nairobi; Fort Jesus Museum; Kisumu Museum; Kitale Museum; Lamu Museum and Meru Museum. They are involved in research, training, monitoring and education activities aimed at conserving Kenya's biological resources.

At the National Museum in Nairobi there are ten departments: Molecular Genetics; Herbarium; Phytochemistry; Palynology and Palaebotany; Plant Propagation and Conservation Unit; Zoology; Herpetology; Ornithology; Mammalogy; and Osteology. The Museum also has two programmes one in Wetlands and one in Marine Science. It has established the Kenya Resource Centre for Indigenous Knowledge (KENRIK) and is involved in the MPALA Research Centre; Elangata WUAS Ecosystem Management Programme; Zoo Atlanta's African Biodiversity Conservation Programme.

Collections record diversity in many taxa, while research projects on a wide range of biodiversity-related topics are run by various departments. Research findings are exchanged through publications, regular seminars, workshops and conferences with national and international scientists, resource managers and policy-makers.

The Centre for Biodiversity has been initiated as a means by which the efforts of departments are directed to a specific common goal. In order to fulfil its national obligation to provide technical information to allow "protection, exploitation and management of the country's indigenous biological resources", the Centre for Biodiversity mission includes a country-wide inventory; development of a standard sampling protocol; establishment of a Biodiversity database; documentation of traditional uses of biological diversity and development of biological training programmes.

Name **Royal Botanic Gardens Kew (RBGK)**

Description The Royal Botanic Gardens at Kew were established in as a royal garden in 1721 and opened as a public body in 1850. The mission of the Royal Botanic Gardens is to ensure better management of the Earth's environment by increasing knowledge and understanding of the plant kingdom. The Kew Herbarium is one of the world's largest, and houses an encyclopedic collection of over six million specimens of vascular plants and fungi from every country in the world. The Jodrell Laboratory carries out fundamental research in plant biochemistry, physiology, anatomy, cytology, and molecular systematics. The library with its collection of over 750,000 books and journals is a resource for all Kew's research work. the living collections are the world's largest with 79,600 accessions representing 35,900 species; one in ten of all vascular plants. In addition, Kew has the largest seed bank of wild plants containing over 4,000 species.

Kew in involved in major biodiversity research programmes in many parts of the world including tropical and West Asia, Africa, South America, and the Pacific and Indian Oceanic Islands. Kew staff carry out systematic programmes in many major plant families, such as the grasses, legumes, palms, daisies, orchids and fungi. Kew also through its Herbarium services, makes about 10,000 identifications a year and provides specialist advice on taxonomy and nomenclature in difficult cases.

Name **The Nature Conservancy (TNC)**

Description The Nature Conservancy was founded in 1951, and presently has 588,000 members. It is the leading private sector organisation working to preserve biological diversity in the United States by protecting lands and the life they harbour. TNC operates a system of over 1,000 nature sanctuaries, "*the largest private system of nature sanctuaries in the world*".

The Latin American Programme works with national agencies and NGOs, as well as international organisations, to protect critical natural areas. This is done by strengthening like-minded organisations, assisting to found national conservation organisations, supporting development of national conservation data centres, and helping to design national parks.

Publications include: *The Nature Conservancy Magazine*, bimonthly and *International News*.

Name **UNEP Global Resource Information Database (GRID)**

Description GRID was established as part of the Global Environment Monitoring System (GEMS) network after the 1972 UN Stockholm Conference on the Human Environment. GRID aims to collect an disseminate the most advanced information available on the state of natural resources worldwide. In order to better collect, manage and disseminate datasets and other information, GRID has established a series of *nodes*. At the moment there are four nodes: Nairobi, Geneva, Bangkok, and Arendal, Norway. GRID Arendal was the first national node in 1989. The Arendal centre is responsible for a number of different tasks including collecting and collating data; assisting in the establishment of national GIS in developing countries, and exploring the possibilities of expanding into regional a node for the Nordic Countries and polar regions. Additional GRID nodes are to be established in such regions as West Africa, Latin America and the South Pacific.

The information GRID holds consists of processes geo-referenced data sets drawn from various sources, including the GEMS network (UNEP HEM, 1994).

Name **UNEP International Environmental Information System (INFOTERRA)**

Description INFOTERRA was established by UNEP in 1974 in order to identify and aid in the exchange sources of environmental information and expertise. It was established as a decentralised world-wide network of information storage and dissemination facilities. These are primarily independent National Focal Centres (NFCs) whose activities are coordinated by the INFOTERRA Programme Activity Centre. Currently, approximately 135 countries have designated NFCs within their borders. In addition, INFOTERRA has contracted 20 institutions, including the IUCN Environmental Law Centre (ELC), to act as special sectoral sources. These would respond to queries related to their areas of expertise. In order to facilitate regular demands for information Regional Service Centres have been established in Australia, India, Morocco and Chile.

The type of data being managed by INFOTERRA is extremely broad, including scientific as well as literary data. Consequently, management procedures and quality considerations will vary from data set to set, and from storage centre to centre. Information, however, is made readily available through a variety of means. These include regular publications such as *International Directory of Sources* and the *World Directory of Environmental Expertise*.

INFOTERRA co-operates extensively with other institutions in the area of information exchange. This is seen in its extensive network of NFCs and Regional Service Centres. It also co-operates with the UN Advisory Committee for the Coordination of Information Systems (ACCIS) (UNEP HEM, 1994).

Name **United Nations Educational, Scientific and Cultural Organization (UNESCO)**

Description UNESCO was established in 1946 "for the purpose of advancing, through the educational, scientific and cultural relations of the peoples of the world, the objectives of international peace and the common welfare of mankind". UNESCO's activities are funded through a regular budget provided by member states and also through other sources, particularly the UNDP. UNESCO is involved in International Intellectual Cooperation; Operational Assistance; and the Promotion of Peace.

UNESCO's Executive Board consists of 51 members. In accordance with its constitution, national commissions have been set up in most member states. UNESCO's activities can be divided into three levels: international; regional and sub-regional; and national. At the international level UNESCO has over the years set up various forms of inter-governmental cooperation concerned with the environmental sciences and research on natural resources.

Key programmes in biodiversity include:

- **Man and the Biosphere Programme (MAB)**
  The UNESCO Man and the Biosphere Programme (MAB) was launched in 1971 to provide the knowledge, skills, and human values to support harmonious relationships between people and their environment throughout

the world. Biosphere reserves act a keystone of MAB by providing a global network of sites for cooperative research toward this goal. The programme is overseen by the *MAB Secretariat*, based at UNESCO.

- **World Heritage Programme (WH)**
  In order to apply the principles of the 1972 *Convention Concerning the Protection of the World Cultural and Natural Heritage*, UNESCO set up a committee of 21 state parties to the Convention. This is the *World Heritage Committee*, which, acting on proposals from all the state parties, is responsible for establishing the list of natural and cultural sites of exceptional and universal value. The Committee meets once a year to decide on nominations, financial and technical help to state parties for the preservation of sites.

Name **United Nations Statistical Division (UNSTAT)**

Description The United Nations Statistical Division UNSTAT (formerly the United Nations Statistical Office) concentrates on developing economic methodologies. Two current projects involve the development of indicators for sustainable development and environmental accounting.

UNSTAT has developed *The Framework for the Development of Environment Statistics (FDES)* as a basis for developing and organising environmental statistics. The United Nations Economic and Social Commission for Western Asia, Statistical Division (UN ESCWA) and the State Ministry for Environment in Indonesia are testing and using the UNSTAT Framework.

The United Nations also has developed the United Nations Statistical Information System (UNSIS). A major feature of the system is the specialised output facility for photo and xerographic typesetting via user definitions written in a unique publication definition language. Supporting on-line facilities include a register of all codes with their interpretation in English, French and Spanish; individual libraries of user definitions and an extensive collection of variable conversion factors.

UNSTAT contributes to the United Nations Statistical Yearbook.

Name **World Bank Group**

Description The World Bank Group comprises the International Bank for Reconstruction and Development (IBRD), the International Development Association (IDA), the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA). IBRD is the main lending arm of the World Bank. IDA is the World Bank affiliate that lends on concessionary terms to the poorest countries. IFC finances private sector projects and advises businesses and governments on investment issues. MIGA promotes foreign direct investment through guarantees, policy advice, and promotional services.

IBRD, typically referred to as the World Bank, was established in 1945. Its objective is to help raise the standard of living in developing countries, and to finance investments that contribute to economic growth by channelling financial resources from developed countries.

The World Bank operates under the authority of a Board of Governors. Each of the World Banks 167 member countries is represented by one governor. The Board of Governors delegates its authority to a smaller group of representatives, the Board of Executive Directors, who are responsible for decisions on policies affecting the Banks operations and approval of all loans.

IDA has 144 member countries of which 58 are borrowers. It was established in 1960 to assist poorer developing countries by providing interest free loans. IDA's assistance is therefore concentrated on countries whose annual per capita gross national product is US$610 or less (in 1990 dollars). Although legally separate from the World Bank, IDA shares the World Banks staff and facilities.

IFC was established in 1956 and has 147 member countries. Its function is to assist the economic development of less-developed countries by promoting economic growth in the private sector and helping mobilise domestic and foreign capital for this purpose. Membership of the IBRD is a prerequisite to become a member of IFC.

MIGA was established in 1988 and has 86 member countries and its role is to promote private investments in developing countries. It provides guarantees on investments, protecting investors from non-commercial risks such as war or nationalisation. It also provides advisory services to governments helping them find ways of attracting private investment to their countries.

Although not affiliated to the World Bank, the International Monetary Fund (IMF), is a complementary institution to the World Bank. The IMF acts as a monitor of the worlds currencies by helping maintain a system of payments between countries. It also lends money to those members who face deficits in their balance of payments.

While the World Bank has traditionally financed a variety of capital infrastructure projects, the focus of its stated development strategy emphasises investments that directly affects the well-being of poor people in developing countries by making them active partners in the development process. In an effort to reduce poverty, the Banks investments projects include improving education, ensuring environmental sustainability, expanding economic opportunities for women, strengthening family-planning, health and nutrition services, and developing the private sector.

In keeping with the World Bank's policy to be open about its activities and to welcome and seek out opportunities to explain its work to the widest possible audience, a new policy on disclosure of operational information was approved in 1993. As part of the new policy, the Public Information Center (PIC) has been established to make available to the public a range of operational documents that were previously restricted. The policy became effective on January 1, 1994 and is not retroactive.

Name **World Conservation Monitoring Centre (WCMC)**

Description WCMC is recognised as a centre of excellence in the handling and management of information on the conservation of biodiversity. The Centre has more than 12 years' experience in this field, providing advice and information services not only to its three founder organisations, IUCN - The World Conservation Union, the World Wide Fund for Nature (WWF) and the United Nations Environment Programme (UNEP), but also to development aid agencies, UN agencies, international convention secretariats, government and non-governmental organisations, the media, commerce and industry.

WCMC is a non-profit organisation, independent of government funding and public membership. Occupying a new, purpose-built, building in Cambridge, WCMC is a highly professional organisation with full project development and management capabilities. WCMC employs some 60 professional staff, with a wide range of international experience.

Annually WCMC delivers upwards of 30 projects, as well as providing regular information services for a wide range of clients. WCMC's project portfolio of over 100 projects, in execution or development, builds on the Centre's resources and staff experience and is centred upon the main aims of the Centre, which are to provide:

WCMC has experience in the development of information services required by the users of biodiversity data. For example, WCMC provides information services to:

- the *Convention on International Trade in Endangered Species* Secretariat and several Contracting Parties including the EU
- IUCN and UNESCO on *World Heritage*
- IUCN's expert networks on species and protected areas.
- UNEP and the *Convention on Biological Diversity*

In addition, WCMC has been collaborating with British Petroleum Company plc to develop an advanced map-based information management system - the *Biodiversity Map Library*. This system aims to facilitate access to computer maps and the databases linked to them, providing non-expert users much of the power of a computer GIS, without requiring them to be familiar with GIS software and technology. This database offers an advanced take-off point for further projects in this area.

WCMC has been very active in supporting development of in-country information management, and is the hub of a network of organisations preparing guidelines and materials for capacity building. These activities build on an earlier collaboration between WCMC and UNEP on the development of *Guidelines for Country Studies on Biological Diversity*. They are to provide the support necessary for developing and implementing the national biodiversity strategies and action plans called for by the *Convention on Biological Diversity*. WCMC activity in this area is likely to increase significantly over the next few years.

WCMC works to a three-year programme, reviewed annually by its international management board. The programme identifies the wide range of activities being undertaken by the Centre, most of them in collaboration with a wide range of national and international organisations. The programme also charts the general direction in which the Centre is moving, while providing sufficient flexibility to encompass new services which fall within the Centre's mission. WCMC actively seeks new opportunities.

Name **World Resources Institute (WRI)**

Description The World Resources Institute (WRI) was founded in 1982. It is a major policy research "created to help governments, international organisations, and private business address a fundamental question: how can societies meet basic human needs and nurture economic growth without undermining the natural resources and environmental integrity on which life, economic vitality, and international security depend?"

Current areas of policy research include tropical forests; biological diversity; sustainable agriculture; energy; climate change; atmospheric pollution; economic incentives for sustainable development; and resource and environmental information.

Name **World Wide Fund for Nature (WWF) International**

Description The World Wide Fund for Nature (WWF) was founded in 1961. It was formerly known World Wildlife Fund, and is still know by that name in Australia, Canada and the USA. It is the largest private international nature conservation organisation in the world, with more than 4.7 million supporters and 28 national and associate organisations on all continents. WWF promotes public awareness of conservation problems and raises funds for the protection of threatened species and environments. WWF works through fieldwork, policy development and lobbying, education and training, public awareness campaigns and support for other organisations. Since its founding, WWF has channelled more than US $335 million into 10,500 projects in over 130 countries. Grants support work undertaken by educators, scientists, other NGOs and government bodies.

WWF's missions are protection of biodiversity; pollution control; and promoting sustainable use of natural resources. Priority is given to conservation of forests, woodland, wetlands and coasts. Following are some of WWF Internationals major activities: TRAFFIC, WWF's international network of wildlife trade monitoring centres in 15 countries, works to prevent illegal exports and imports of wildlife. With IUCN and UNEP, WWF sponsored *Caring for the Earth: A Strategy for Sustainable Living*, the second World Conservation Strategy (IUCN *et al*, 1991).

8.2 Address List

The address list presented below contains details of a very wide range of organisations relevant to biodiversity information management. Specifically, every effort has been made to include all those organisations cited within Documents 1-4 of the current "Biodiversity Data Management" series. Nevertheless, it is inevitable that some organisations may have been overlooked. It is also likely that the address details of some organisations may be incorrect, due to the rapidly changing nature of the information.

A full address consists of the following components:

Address
This comprises the name of the organisation, its acronym (where known), and full postal address.

Type
The type of organisation as follows:

AC = Academic
CO = Commercial
GO = Governmental
IG = Inter-governmental
NG = Non-governmental
UN = United Nations

Telephone
The full international telephone number of the organisation.

Fax
The full international fax number of the organisation.

Email
The electronic mail (e-mail) address of the organisation (or key contact).

Address	Type	Telephone	Fax
AIDAB Centre for Pacific Development and Training (ACPAC)			
ANZUS Council (formerly ALIC) (ANZUS)	IG		
ASEAN Experts Group on the Environment (AEGE)			
ASEAN Senior Officials on the Environment (ASOE)			
ASEAN Standing Committee (ASC)			
Aart Systems Limited, Unit D Isaac Newton Building, Highfields Science Park, Nottingham NG7 2RH, UK	CO		
Academie Internationale de l'Environment (AIA)			
Administrative Committee on Coordination (ACC)	UN		
Advanced Earth Observing Satellite (ADEOS)			
Advantage Publications, PO Box 7678, Riverton NJ 08077 7678, USA	CO		
Advisory Committee for the Coordination of Information Systems (ACCIS)	UN		
Advisory Committee on Administrative and Budgetary Questions (ACABQ)	UN		
Advisory Committee on Chemicals in the Environment (ACCE)			
Advisory Committee on Conservation of Biological Diversity (ACCBD)			
Advisory Committee on Environmental Resources (ACER)			
Advisory Committee on Pollution of the Sea (ACOPS)			
African Biodiversity Institute (ABI), KENYA	NG		
African Centre for Technology Studies (AACTS)			
African Centre of Meteorological Applications for Development (ACMAD)			
African Development Bank (ADB), Abidjan 01 BP 1387, CôTE D'IVOIRE			
African Elephant Conservation Coordination Group (AECCG)			
African Environmental Research and Consulting Group (AERGC)			
African NGOs Environment Network (ANEN), PO Box 53844, Nairobi , KENYA			
African Technical Regional Environment Group (ATREG)			
African Training and Research Centre for Women (ATRCW)			
African Wildlife Foundation (AWF)			
Agricultural Council of Australia and New Zealand (ACANZ)			
Agricultural Development Planning Centre (ADPC)			
Agricultural and Food Research Council (AFRC)			
Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ)			
Air Service of the CNRS, PO Box 3, Verrires Le Buisson F-91371, FRANCE	GO	+33 1 69 20 01 83	+33 1 69 20 2999
Alice Software Partnership, Royal Botanic Gardens, Kew, London TW9 3AB, UK	CO	+44 181 940 1171	+44 181 948 1197
Amazon Commission on development and Environment (ACDE)			
American Association of Zoological Parks and Aquariums (AAZPA)			
American Committee for International Conservation (ACIS)			
American Museum of Natural History, Central Park West at 79th, New York NY 10024, USA			
American National Standards Institute (ANSI)			
American Society of Icthyologists and Herpetologists (ASIH)			
Antarctic Treaty Consultative Party (ATCP)			
Antarctic Treaty System (ATS)			
Antarctic and Southern Ocean Coalition (ASOC), 717 D Street, Washington DC 20013, USA	NG	+1 202 544 0236	+1 202 544 8483
Applications in CAD Ltd, 21 Britannia Street, Shepshed LE12 9AE, UK	CO		
Arab Centre for the Studies of Arid Zones and Dry Lands (ASCAD), Damascus , SYRIAN ARAB REPUBLIC	IG	+963 11 755 713	

Arab Gulf Programme for UN Development Organisations (AGFUND)	UN		
Arab League Educational, Scientific and Cultural Organization (ALESCO)			
Argentine Institute of Research on Arid Zones (IADIZA)			
Arid Lands Environment Centre (ALEC)			
Arnold Arboretum, 125 Arborway, Jamaica Plain MA 02130-3519, USA	AC		
Asia Pacific Economic Cooperation (APEC)			
Asia-Pacific Peoples Environment Network (APPREN)			
Asian & Pacific Regional Agricultural Credit Association (APRACA)			
Asian Bureau for Conservation, 18E Capitol Building, 175-191 Lockhart Road, Wanchai , HONG KONG		+852 598 6960	
Asian Development Bank (ADB), PO Box 789, Manilla 2800, PHILIPPINES	NG		
Asian Development Fund (ADF)			
Asian Elephant Specialist Group (AESG)			
Asian Fisheries Social Science Research Network (AFSSRN)			
Asian Institute for Rural Development (AIRD)			
Asian Institute of Technology (AIT), THAILAND	AC		
Asian NGO Coalition for Agraian Reform and Rural Development (ANGOLO)			
Asian Society for Environmental Protection (ASEP), C/o Cdg-south East Asia Program Office, Asian Institute of Technology, Bangkok 10501, THAILAND	NG	+66 66 2 524 5363	+66 66 2 524 5390
Asian Wetlands Bureau (AWB), Institute of Advanced Studies, University of Malaya, Lembah Pantai, Kuala Lumpur 59100, MALAYSIA	NG	+60 3 7572176	+60 3 7571225
Asian and Pacific Council (ASPAC)			
Association for Better Land Husbandry (ABLH), Parklands PO, Nairobi , KENYA	NG	+254 2 521 090	+254 2 521 482
Association for Cooperation in Banana Research in the Caribbean and Tropical Ame (ACORBAT)			
Association for Research, Exploration and Environmental Aid (AREA)			
Association of Mining and Exploration Companies (AMEC)			
Association of Natural Rubber Producing Countries (ANRPC)			
Association of South East Asian Nations (ASEAN)			
Association of the South Pacific Environmental Institutions (ASPEI)			
Atlantic Centre for the Environment (ACE)	IG		
Australia New Zealand Land Information Council (ANZLIC)			
Australia/France Joint Working Group (AFJWG)			
Australian & New Zealand Minerals & Energy Council (ANZMEC)			
Australian Centre for International Agricultural Research (ACIAR)			
Australian Council for Overseas Aid (ACFOA)			
Australian Environment Council (AEC)			
Australian International Development Assistance Bureau (AIDAB)			
Australian Nature Conservation Agency (formerly ANPWS) (ANCA)	GO		
Australian Pacific Science Foundation (APSF)			
Australian Plant Specialists Group (APSG)	NG		
Australian and New Zealand Environment & Conservation Council (ANZECC)			
Autodesk Ltd, Cross Lanes, Guildford Surrey GU1 1UJ, UK	CO		
BG-BASE Inc, C/o the Royal Botanic Garden, Inverleith Row, Edinburgh EH3 5LR, UK	CO	+44 31 5527171	+44 31 5520382
BIDS Bath University Computer Service, University of Bath, Claverton Down, Bath , UK		+44 1225 826 345	+44 1225 826 176
Bat Conservation Trust (BCT), C/o the Conservation Foundation,1 Kensington Gore, London SW7 2AR, UK			
Berkshire and Avon Computing Ltd, Rowan House, 8 Pine Drive, Finchampstead RG11 3LE, UK	CO		
BioNET-International, Technical Secretariat (TECSEC), CAB International, 56 Queen's Gate, London SW7 5JR, UK	NG	+44 171 584 0067	+44 171 581 1676
Biodiversity Coalition, AUSTRALIA	NG	+61 2 951745	+61 2 951964

Biodiversity Foundation for Africa (BFA), BFA - Savskill, Famona, Bulawayo PO Box FM730, ZIMBABWE	NG	+263 9 61226	+263 9 74839
Biodiversity Information Network 21 Secretariat (BIN21), Fundacao Tropical, Rua Latino Coelho 1301, Parque Taquaral, Campinas SP 13087-010, BRAZIL	NG	+55 192 42 7827	+55 192 42 7827
Biological Records Centre (BRC)			
Biological Software, 23 Darwin Close, Farnborough, Orpington BR6 7EP, UK	CO		
Biosciences (BIOSIS), 2100 Arch Street, Philadelphia PA 19103-1399, USA		+1 800 523 4806	+1 215 587 2016
Biospheric Apsects of the Hydrological Society (BAHC)			
Birdlife International (BLI), 32 Cambridge Road, Girton, Cambridge CB3 0PJ, UK			+44 1223 277 200
Bombay Natural History Society (BNHS)			
Borland International Incorporated, 100 Borland Way, Scotts Valley CA 95066 - 3249, USA	CO	+1 408 431 1000	
Botanic Gardens of Adelaide and State Herbarium, C/o Botanic Garden, North Terrace, Adelaide S.A 5000, AUSTRALIA	GO	+61 8 228 2320	+61 8 223 1809
Botanical Gardens Conservation International (BGCI)			
Brazilian Foundation for Nature Conservation (FBCN)			
Brazilian Institute for Environment and Renewable Natural Resources (IBAMA)			
Brazilian Landscape Association (SBP)			
Brehm Fund for the international Conservation of Birds (BFIV)			
British Antarctic Survey (BAS), High Cross, Madingley Road, Cambridge CB3 0ET, UK	GO	+44 1223 61188	+44 1223 62616
British Arachnological Society (BAS), Burnsfarm, Cornhill AB45 2DL, UK			
British Association for the Advancement of Science (BAAS)			
British Bryological Society (BBS), Botanydepartment, Liverpool Museum, William Brown Street, Liverpool L3 8EN, UK			
British Council (BC), 10 Spring Gardens, London SW1A 2BN, UK	GO	+44 171 930 8466	+44 171 839 6347
British Ecological Society, Burlington House,piccadilly, London W1V 0LQ, UK			
British Geological Survey (BGS)			
British Lichen Society, Department of Botany, Natural History Museum, Cromwell Road, London SW7 5BD, UK			
British Society of Plant Breeders (BSPB)			
British Technology Group (BTG)			
Bunyip Information Systems Inc, 310 St-catherine St. West, Suite 202, Montreal H2X 2A1, CANADA	CO	+1 514 875 8611	+1 514 875 8134
Bureau of International Expositions (BIE)			
Business Council for Sustainable Development (BCSD), World Trade Centre, 10, Route de l'Aeroport, Geneva 15 CH-1215, SWITZERLAND	CO	+41 22 788 3202	+41 22 788 3211
Business Industry Advisory Committee (BIAC)	IG		
CAB International, Malaysia (CABI), PO Box 11872, Kuala Lumpur 50760, MALAYSIA	IG	+60 3 255 2922	+60 3 255 1888
CAB International, UK (CABI), Wallingford, Oxfordshire, Wallingford OX10 8DE, UK	IG	+44 1491 832111	+44 1491 833508
CAB International, USA (CABI), 845 North Park Avenue, Tucson AZ 85719, USA	IG	+1 602 621 7897	+1 602 621 3816
CGNET Services International, 1024 Hamilton Court, Menlo Park CA 94025, USA		+1 415 325 3061	+1 415 325 2313
CSI (Sales and Service), 7 Meadowbank Park South, Stocksfield NE43 7QA, UK		+44 1661 842741	+44 1661 842288
Caibbean Natural Resources Institute (CNRI)			
CalComp Ltd, Vector House, 3-5 Ruscombe Park, Ruscombe, Reading RG10 9NU, UK	CO	+44 1734 320032	+44 1734 341215
California Academy of Sciences, Golden Gate Park, San Francisco CA 94118, USA		+1 415 221 5100	+1 415 750 7346
Caliper Corporation, 1172 Beacon Street, Newton MA 02161, USA	CO	+1 617 527 4700	+1 617 527 5113
Canada Centre for Inland Waters (CCIW)			
Canada Institute for Scientific and Technical Information (CAN/OLE), Montreal Road, Ottawa Ontario K1A 0S2, CANADA		+1 613 993 1210	+1 613 952 8244
Canadian Centre for Remote Sensing (CCRS)			
Canadian Forestry Association (CFA), 185 Somerset Street, West, Suite 203, Ottowa Ontario K2P 0J2, CANADA	NG	+1 613 232 1815	+1 613 232 4210
Canadian International Development Agency (CIDA), 200 Promenadedu Portage, Hull K1A OG4, CANADA			
Canadian Nature Federation (CNF)			

Canadian Standards Association, Secretary, Iso/tc 207 178 Rexdale Blvd, Rexdale Ontario M9W 1R3, CANADA		+1 416 747 2473	
Canadian Wildlife Federation, 2740 Queensview Drive, Ottawa K2B1A2, CANADA			
Caribbean Conservation Association (CCA)			
Caribbean Conservation Corporation (CCC)			
Caribbean Natural Resources Institute (CANARI)			
Carl Zeiss Inc, 61 Inverness Dr E, Suite 102, Englewood CO 80122, USA	CO	+1 303 799 3532	+1 303 799 8159
Carnegie Foundation, USA	NG		
Cartograph Ltd, The Eden Centre, 47 City Road, Cambridge CB1 1DP, UK	CO		
Cat Survival Trust (CST), The Centre, Codicote Road, Welwyn AL69TU, UK			
Center for Marine Conservation (CMC), 1725 Desales Street, Nw, Suite500, Washington DC 20036, USA			
Central American Commission for Environment and Development (CCAD)			
Central Arid Zones Research Institute (CAZRI)			
Centre Canadian d'Etude et de Cooperation Internationale (CECI)			
Centre Scientifique de Monaco Observatoire European (CSMOOE)			
Centre de Cooperation Internationale en Recherche Agronomique Developpement (CIRAD), Avenue du Val Montferrand BP 5035, Montpelier 34032, FRANCE		+33 67 61 58 00	+33 67 61 58 20
Centre for Earth Observation (CEO)			
Centre for Economic and Environmental Development (CEED)			
Centre for Environmental Legal Studies (CELS)	AC		
Centre for Environmental Management and Planning, Auris Ltd (CEMP), Cemp, Auris Business Centre, 23 St. Machar Drive, Aberdeen AB2 1RY, UK	NG	+44 1224 272483	+44 1224 487658
Centre for Environmental Study (CES)			
Centre for Environmental and Nature Protection (ZUN), Gregor-mendal-strasse 33, Vienna A-1180, AUSTRIA	AC	+43 222 47 654	+43 222 47 654
Centre for Field Research (CFR)	UN		
Centre for Global Environmental Research (CGER)			
Centre for International Environmental Cooperation (of Russia) (INENCO)			
Centre for International Forestry Research (CIFOR), C/oworld Bank (environmental Department), 1818 H Street NW, Washington DC 20433, USA			
Centre for Marine Conservation (CMC)			
Centre for Our Common Future, Palais Wilson, 52, Rue des Paquis, Geneva CH-1201, SWITZERLAND	NG	+41 22 732 71 17	+41 22 738 50 46
Centre for conservation Studies (CECON)	AC		
Centre for plant Conservation (CPC)	NG		
Centro Agronómico Tropical de Investigatión y Enseñanza (CATIE)			
Centro Internacional de Agricultura Tropical (CIAT), CIAT Apartado Aereo, Cali 6713, COLOMBIA	NG	+57 23 675 050	+57 22 647 243
Centro Panamericano de Ingeneria y Ciencias del Ambiente (CEPIS)			
Charles Darwin Foundation for the Galapogos Islands (FCDIG)			
Clark University Graduate School of Geography, 950 Main Street, Worcester MA 01610, USA	AC	+1 508 793 7201	+1 508 793 8820
Clough Engineering, 627 Chapel Street, Melbourne 3141, AUSTRALIA	CO	+61 3 825 5555	+61 3 826 6463
Coastal Zone Mangement Subgroup (CZMS)			
College of Geographic Sciences (COGS), PO Box 10, Lawrencetown BOS 1MO, CANADA	AC		
Commission For Our Common Future (CFOCF)			
Commission of Atmospheric Chemistry and Global Pollution (CACGP)			
Commission of the European Community (CEC), Rue de la Loi 200, Brussels B-1049, BELGIUM	IG		
Commission on Agriculture (COAC)	UN		
Commission on Ecology (COE)	NG		
Commission on Education & Training (CET)	NG		
Commission on Education and Communication (CEC)	NG		

Commission on Environment Policy, Law and Administration (CEPLA)	NG		
Commission on Environmental Law (CEL)			
Commission on Environmental Strategy and Planning (CESP)			
Commission on Fisheries (COFI)	UN		
Commission on Plant Genetic Resources (CPGR)	UN		
Commission on Sustainable Development (CSD)	NG		
Committe on the Human Environment (CHEK)			
Committee for Environmental Protection (CEP)			
Committee of International Development Institutions on the Environment (CIDIE)			
Committee on Climate Change and the Oceans (CCCO)			
Committee on Data for Science and Technology (CODATA)			
Committee on Earth Observation Satellites (CEOS)			
Committee on Food Aid Policies and Programmes (CFA)			
Committee on Water Research (COWAR)			
Committee on the Participation of Developing Countries (CPDC)			
Commonwealth Development Bank (CDB)			
Commonwealth Development Corporation (CDC)	GO		
Commonwealth Environment Protection Agency (CEPA)			
Commonwealth Science Council (CSC), Commonwealth Science Council, Malborough House, Pall Mall, London SW1Y 5HX, UK	NG	+44 171 747 6219	+44 171 839 6174
Commonwealth Scientific and Industrial Research Organisation (CSIRO), 407 Royal Parade, Parkville Parkville 3052, AUSTRALIA	GO	+61 03 662 7111	+61 03 662 7196
Commonwealth Secretariat Publications, Marlborough House, Pall Mall, London SW1Y 5HX, UK	IG		
Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y5HX, UK	IG		
Competition Law and Policy Committee (CLP)	IG		
Compuserve Incorporated, 5000 Arlington Centre Blvd., Columbus OH 43220, USA	CO	+1 614 529 1340	
Computer Associates (CA), 1 Computing Associates Plaza, Islandia NY 11788-7000, USA	CO	+1 516 342 5367	+1 516 342 5329
Computing Resource Center (CRC), 1640 Fifth Street, Santa Monica CA 90401, USA		+1 310 3939893	+1 310 3937551
Confederation of Central American Universities (CSUCA)			
Conservation Data Centre - Mahidol University, THAILAND	AC		
Conservation International (CI), 1015 18th St. N.W. Suite 1000, Washington DC 20036, USA	NG	+1 202 429 5660	+1 202 887 5188
Conservation Monitoring Centre (CMC)	NG		
Conservation for Development Centre (CDC)	NG		
Consortium for International Earth Science Information Network (CIESIN), 2250 Pierce Road, University Center, Saginaw MI 48710, USA	NG	+1 517 797 2700	+1 517 797 26221
Consortium on Plant resources of the Americas (COPRA)			
Consultative Group on International Agricultural Research (CGIAR), C/o World Bank, Room 11 5053, 1818 H Street NW, Washington DC 20433, USA		+1 202 473 8934	+1 202 334 8750
Convention of International Trade in Endangered Species (CITES), Case Postale 456 Chatelaine, Geneva CH-1219, SWITZERLAND	IG	+41 22 9799139	+41 22 797 3417
Convention on Biological Diversity Secretariat (CBD), 15, Chemin des Anemones, Cp 356 Chatelaine, Geneva CH-1219, SWITZERLAND	IG		+41 22 797 2512
Coolidge Centre for Environmental Leadership (CCEL)			
Cooperative Research Centre for the Antarctic and Southern Ocean Environment (ANTARCTIC CRC), Hobart 7001, AUSTRALIA	NG	+61 02 202 380	+61 02 202 973
Coordinating Body on the Seas of East Asia (COBSEA)			
Coordinating Committee on the Ozone Layer (CCOL)	UN		
Council for Scientific and Industrial Research (CSIR), Division of Information Services, Pretoria PO Box 395, SOUTH AFRICA	NG	+27 12 841 2106	+27 12 841 3037
Council of Conservation Ministers (CONCOM)			
Council of Europe (COE)	IG		
Council of Europe, Centre Natropa, Strasbourg Cedex F-67075, FRANCE	IG	+33 88 41 22 56	+33 88 42 27 51/84
Danish Development Agency, Ministry of Foreign Affairs, Asiatisk Plads 2, Copenhagen DK-1448, DENMARK	GO		

Danish Ornithological Society (DOF)			
David Lubin Memorial Library, C/o Food and Agriculture Organization	UN		
Decision Images Inc, 9 Charlton Street, Princeton NJ 08540, USA	CO	+1 609 683 0234	+1 609 683 4068
Defense Mapping Agency (DMA), Fort Belvoir VA 22060-5546, USA	GO	+1 703 355 2800	+1 703 355 3176
Department for Policy Coordination and Sustainable Development (DPCSD)	UN		
Department of Agriculture (USDA), 14th Street and Independence Avenue, Sw, Washington DC 20250, USA	GO	+1 202 447 2791	
Department of Foreign Affairs and Trade (DFAT)			
Department of International Development (DANIDA)	GO		
Department of International Economic and Social Affairs (DIESA)	UN		
Department of Scientific and Industrial Research (DSIR)	GO		
Department of Technical Cooperation for Development (DTCD)	UN		
Department of the Environment (DOE), 2 Marsham Street, London SW1P 3EB, UK			
Desertification Information System (DESIS), Unep-desertification Programme Centre, Po Box 30552, Nairobi , KENYA	UN		+254 2 5207 11
Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), Dag-hammarskjold Weg 1, Eschborn D-6236, GERMANY	NG		
Deutsches Institut fuer Medizinishce Dokumentation und Information (DIMDI), Postfach 42 05 80, Koln 50899, GERMANY		+49 221 4824 1	+49 221 411429
Development Assistance Committee (DAC)	IG		
Development Data Bases Service Centre Library (IDRC), PO Box 8500, 250 Albert Street, Ottawa K1G 3H9, CANADA			
Directorate General Forest Protection and Nature Conservation (DJPHPA)	GO		
Division Observation de la Terre (CNES), Programmes Directorate, 2 Place Maurice-quentin, Paris F-75039, FRANCE			
Duke University, The Centre for Tropical Conservation (CTC), The Centre for Tropical Conservation, Po Box 90381, Duke University, Durham NC 27708, UK	AC	+44 1919 490 9081	+44 1919 419 1433
Durrell Institute of Conservation and Ecology (DICE), Dice, University of Kent at Canterbury, Canterbury CT2 7PD, UK	AC	+44 1227 475480	+44 1227 475481
Dutch Society for the Preservation of the Waddensea (LVBW)			
ERDAS Inc, 2801 Buford Hwy, Suite 300, Atlanta GA 30329, USA	CO	+1 404 248 9000	+1 404 248 9400
EROS Data Centre, Sioux Falls SD 57198, USA			
ESA-IRS, Esrin, Via Galileo Galilei, Frascati 00044, ITALY		+39 6 941801	+39 6 94180361
ESCAP Pacific Operations Centre (EPOC)			
Earth Resources Data Analysis Centre (ERSDAC)			
Earthnet Programme Office (EPO), European Space Agency, Via Galileo Galilei, Frascati I-00044, ITALY			
Earthwatch Europe (EE)	UN		
Earthwatch Headquarters, 680 Mount Auburn Street, Po Box 403, Watertown MA 02272 9104, USA	NG	+1 617 926 8200	+1 617 926 8532
East Africa Natural History Society (EANHS), Nairobi , KENYA	NG	+254 2 742131	
East African Herbarium (EAH)			
East African Wildlife Society (EAWLS)			
East-West Environment and Policy Institute (EAPI), 1777 East-west Road, Honolulu Hawaii 96848, USA	AC	+1 808 944 7111	+1 808 944 7970
Eastern Africa Environmental Network (EAEN), C/o East African Wildlife Society, Po Box 20110, Nairobi , KENYA			
Eastern Africa Regional Office (EARO)			
Ecological Society of America (ESA), 9650 Rockville Pike, Suite 2503, Bethesda MD 20814, USA			
Economic & Social Commission for Western Asia (ESCWA)	UN		
Economic Commission for Africa (ECA)	UN		
Economic Commission for Asia and the Far East (ECAFE)	UN		
Economic Commission for Latin America and the Caribbean (ECLAC)	UN		
Economic Commission for Western Asia (ECWA)	UN		
Economic Commission of West African States (ECOWAS)	UN		
Economic Development Insitute (EDI)			

Economic and Social Commission for Asia & the Pacific (ESCAP)	UN		
Ecosystem Conservation Group (ECG)			
Elsa Nature Conservancy (ENC)			
Elsevier, Regency House, 34 Duke Street, Norwich NR3 3AP, UK		+44 1603 626327	+44 1603 667934
Emergency Centre for Locust Operations (ECLO)	UN		
Endangered Species Unit (ESU)			
Endangered Wildlife Trust (EWT)			
English Nature, Northminster House, Peterborough PE1 1UA, UK			
Environment Canada, Department of the Environment, Ottawa Ontario K1A0H3, CANADA			
Environment Coordination Board (ECB)	UN		
Environment Liason Centre International (ELCI), PO Box 72461, Nairobi , KENYA			
Environment Programme (UNIDO), Environment Co-ordination Unit, Vienna International Centre, Po Box 300, Vienna A-1400, AUSTRIA			+43 222 23 21 56
Environment Programme of the International Institute for Applied Systems Analysi, Laxenburg A-2361, AUSTRIA		+43 2236 71521	+43 2236 73147
Environmental Change Network (ECN), Merlewood Research Station, Windermere Road, Cumbria, Grange-over-sands LA11 6JU, UK	GO	+44 15395 32264	+44 15395 34705
Environmental Data Centre (EDC)			
Environmental Defense Fund (EDF), 1616 P St.nw, Washington DC 20010, USA			
Environmental Information Management Unit (EIMU)			
Environmental Information System (ENVIS), Environmental Department, The World Bank, 1818 H Street, N.w., Washington D.C. 20433, USA	IG	+1 202 477 1234	
Environmental Law Information System (ELIS), Adenauer Allee 214, Bonn D-5300, GERMANY			+49 228 2692 250
Environmental Management Committee (CMA)			
Environmental Protection Agency (EPA), 401 M Street, Sw, Washington DC 20460, USA	GO		
Environmental Protection Foundation (FEN COLOMBIA)			
Environmental Research Centre (UFZ), Permoser Strasse 15, Leipzig D-04318, GERMANY	GO	+49 341 235 2242	+49 341 235 2791
Environmental Resources Information Network (ERIN), DEST, GPO Box 787, Canberra ACT 2601, AUSTRALIA	GO		+61 6 274 1333
Environmental Studies Association of Canada (ESAC)			
Environmental Systems Research Institute Inc (ESRI), Redlands CA, USA	CO	+1 909 793 2853	+1 909 307 3070
Era-Maptec Ltd, 5 South Leinster Street, Dublin 2, IRELAND	CO	+353 1 676 6266	+353 1 661 9785
European Association of Environmental and Resource Economists (EAERE)			
European Bureau for Conservation and Development (EBCD)			
European Centre for Nature Conservation (ECNC), Warandelaan 2, PO Box 1352, Tilburg 5004 BJ, NETHERLANDS	NG	+31 13 663240	+31 13 663250
European Centre for Nuclear Research (CERN), Geneva 23 CH-1211, SWITZERLAND	IG	+41 22 767 3755	+41 22 767 7155
European Communities Host Organisation (ECHO), BP 2373, LUXEMBOURG		+352 34981 200	+352 34980 234
European Communities Statistical Office (EUROSTAT), Cec, Rue de la Loi 200, Brussels B-1049, BELGIUM	IG		
European Development Fund (EDF)			
European Economic Community (EEC)	IG		
European Environment Agency (EEA), DGXI- EEA Task Force, 200 Rue de la Loi, Bruxelles B-1049, BELGIUM	IG	+32 2 296 88 13	+32 2 296 95 62
European Environment Bureau (EEB)			
European Environmental Research Organisation (EERO), Ab Wageningen NL-6700, NETHERLANDS	NG	+31 8370 84817	+31 8370 84818
European Ozone Research Coordinating Unit (EORCU), C/o British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK	NG	+44 1223 61188	+44 1223 62616
European Science Foundation (ESF)			
European Space Agency (ESA)			
European Tropical Forest Research Network, Universite Catholique Delouvain, Unite Agro-efor, Place Croix du Sud 2, Louvain-la-neuve , BELGIUM			
European Union (EU), Rue de la Loi 200, Brussels B-1049, BELGIUM	IG		
European Union for Bird Ringing (EURING)			
European Union for Coastal Conservation (EUCC)			

European Youth Science Network (EURYSN)			
Expert Centre for Taxonomic Identification (ETI), Mauritskade 61, Amsterdam 1091 AD, NETHERLANDS	NG	+31 20 5257239	+31 20 5257238
FAO Regional Office for Africa, PO Box 1628, Accra , GHANA			
Faculty of Natural Sciences, University of Tirana, Tirana , ALBANIA	GO	+355 42 276 69	
Fatscad GIS Ltd, 26 Greenhill Crescent, Watford Business Park, Watford WD1 8XG, UK	CO	+44 1904 240272	
Fauna and Flora Preservation Society (FFPS), 1 Kensington Gore, London SW72AR, UK			
Federación Conservacionista Mexicana (FECOMEX)			
Federal Agency for Nature Conservation (BFN), Konstantinstrasse 110, Bonn D-53179, GERMANY	GO	+49 228 8491 180	+49 228 8491 200
Federation of Nature and National Parks of Europe (FNNPE)			
Federation of Zoological Gardens of Great Britain and Ireland (FZGGBI)			
Federation of groups for the Defense of Nature (CODA)			
Field Operations Division (FOD)	NG		
Finnish Association for Nature Conservation (FANC)			
Finnish Development Agency, Helsinki , FINLAND	GO		
Finnish International Development Agency (FINNIDA), Ministry of Foreign Affairs, Mannerheimintie 15C, Helsinki SF-00260, FINLAND	GO		
Food and Agriculture Organisation of the United Nations (FAO), Forestry Department, Via Delle Terme de Caracalla, Rome 1-00100, ITALY	UN		
Forest Resource Information System (FORIS), 431 Pine Street, Burlington VT 05401, USA			
Forest Stewardship Council (FSC), Avenida Hidalgo 502, Oaxaca 68000, MEXICO	NG		
Forestry Association of Botswana, Gaborone , BOTSWANA	NG	+267 351660	+267 300316
Forests and Pastures Research Institute (IKPK), Rruga niko Avrimi, Tirana , ALBANIA	GO	+355 42 33343	+335 42 27665
Foundation for Environment and Natural Resources (FARN)			
Foundation for Ethnobiology (FEB), North Parade Chambers, 75 Banbury Road, Oxford OX2 6PE, UK	NG	+44 1865 516333	+44 1865 59743
Foundation for Nature (FUNATURA)			
Foundation for a Better Environment (FMA)			
Foundation for the Management of Tropical Areas (FUNDAMAT)			
Frankfurt Zoological Society (FZS)			
Friends of the Earth (UK) (FOE), 26-28 Underwood Street, London N1 7JQ, UK			
Friends of the Earth (USA) (FOE), 218 D Street, Se, Washington DC 20003, USA			
Friends of the Earth International (FOE)			
Fulbright Scholarships, United States Embassy In Home Country	GO		
Funación Neotrópica (NEOTROPICA)			
GEMS Monitoring and Assessment Research Centre (MARC), The Old Coach House, Campden Hill, London W8 7AD, UK	UN	+44 171 376 1577	+44 171 937 5396
GIMMS (GIS) Ltd, 30 Keir Street, Edinburgh EH3 9E4, UK	CO		
GIS World, 155 e Boardwalk Dr, Suite 250, Fort Collins CO 80525, USA	CO		+1 303 223 5700
GK Hall, 866 Third Avenue, 17th Floor, New York NY 10022, USA		+1 212 702 6789	+1 212 605 9350
GTI Veterinary Systems Ltd, Ashfield Road, Salisbury SP2 7HL, UK		+44 1722 338484	
Garmin International, 9875 Widmer Road, Lenexa KS 66215, USA		+1 913 599 1515	+1 913 599 2103
Genasys II Ltd, Ist Floor, Parkway One, Parkway Business Centre, 300 Princess Road, Manchester M14 7LU, UK	CO		
General Fisheries Council of the Mediterranean (GFCM)	UN		
General Forest Directorate (DGF)			
George Wright Society (GWS)			
German Agency for International Development (GTZ)	GO		
German Foundation for International Development (DSE)			
Gibraltar Ornithological and Natural History Society (GONHS)			
Global Atmospheric Watch (GAW)			

Global Change and Terrestrial Ecosystems (GCTE), PO Box84, Lyneham ACT 2602, AUSTRALIA			
Global Climate Observing System (GCOS), World Meteorological Organisation, Geneva , SWITZERLAND			
Global Environment Facility (GEF)			
Global Environment Monitoring System (GEMS), UNEP, PO Box 30552, Nairobi , KENYA	UN		+254 2 520 281
Global Environment Monitoring System, Monitoring and Assessment Research Centre (MARC), Kings College London, The Old Coach House, Campden Hill, London W8 7AD, UK	UN	+44 171 376 1577	+44 171 937 5396
Global Environmental Problems Unit, Bd. du Triomphe,174, Brussels 1160, BELGIUM			
Global Land Information System (GLIS), US Geological Survey, Eros Data Center, Sioux Falls SD 57198, USA	GO	+1 605 594 6099	
Global Legislators Organisation for a Balanced Environment (GLOBE), Rue du Taciturne 50, Brussels B-1040, BELGIUM	NG	+32 2 230 6589	+32 2 230 9530
Global Precipitation and Climatology Centre (GPCC), Offenbach D-63004, GERMANY	GO	+49 69 8062 2981	+49 69 8062 2880
Global Resource Information Database (GRID), PO Box 30552, Nairobi , KENYA	UN		+254 2 52 02 81
Global Run-off Data Centre (GRDC)			
Goldin-Rudahl Systems, 6 University Drive No 213, Amherst MA 01002, USA	CO	+1 413 253 7340	+1 413 549 6401
Great Barrier Reef Marine Park Authority (GBRMPA)			
GreenNet, 23 Bevenden Street, London N1 6BH, UK		+44 171 608 3040	+44 171 253 0801
Greenpeace, UK (GP), Canonbury Villas, London N1 2PN, UK	NG	+44 171 354 5100	
Group of Economic Experts (GEE)	IG		
Hellenic Society for the Protection of Nature (HSPN), 24, Nikis Street, Athens GR-10557, GREECE	NG	+30 1 322 49 44	
Hull University, Hull , UK	AC		
INDPE-National Institute for Space Research, PO Box 515, Sao Jose Dos Compos 12201-70, BRAZIL		+55 123 41 8977	+55 123 21 8743
IOC Committee for Global Ocean Observing System (I-GOOS)			
IOC Regional Subcommission for the Caribbean and Adjacent Regions (IOCARIBE)			
ISO 3166 Maintenance Agency, DIN Burggrafenstrasse 6, Berlin D 10787, GERMANY			
IUCN Commission on National Parks and Protected Areas (CNPPA), Rue de Mauverney 28, Gland CH-1196, SWITZERLAND	NG		+41 22 999 0002
IUCN Environmental Law Centre (ELC), Adenauer Allee 214, Bonn D-5300 1, GERMANY	NG		+49 228 2692 250
IUCN Publications Services Unit, 219 Huntingdon Road, Cambridge CB3 ODL, UK	NG	+44 1223 277894	+44 1223 277175
IUCN Species Survival Commission (IUCN/SSC), Rue Mauverney 28, Gland CH-1196, SWITZERLAND	NG	+41 22 999 0157	+41 22 999 0015
Indira Gandhi Conservation Monitoring Centre (IGCMC), Wwf-india, 172-b Lodi Estate, New Delhi 110 003, INDIA	NG	+91 11 4616532	+91 11 4626837
Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan) (LIPI), Jl. Jendral Gatot Subroto No. 10, PO Box 250, Jakarta , INDONESIA	GO	+62 511542	+62 520 7226
Indonesian MAB National Committee and the Indonesian Institute of Sciences (LIPI), Jl. Jendral Gatot Subroto No. 10, PO Box 250, Jakarta , INDONESIA	GO	+62 511542	+62 520 7226
Industry and Environment Office (IEP)	NG		
Industry and Environment Programme Activity Centre (IE/PAC)	UN		
InfoPro Technologies, 18 Parkshot, Richmond TW9 2RG, UK		+44 181 332 7888	+44 181 332 7449
Institut de Botanique, 163, Rue Auguste Broussonet, Montpellier 34000, FRANCE			
Institut francais de Recherche Scientifique pour le Developpment en Cooperation (ORSTOM), 213 Rue Lafayette, Paris 75480, FRANCE	GO	+33 48 03 7777	
Institute for Environmental Communication (SME)			
Institute for European Environmental Policy (IEUP), Roonstrasse 7, Bonn D-53175, GERMANY	NG	+49 228 95 73 50	+49 228 95 522
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Institute of Earth Studies, University College of Wales, Aberystwyth S23 3DB, UK	AC		
Institute of Evolutionary Animal Morphology and Ecology (IEAME)			
Institute of Foresters of Australia (IFA)			
Institute of Geography, University of Copenhagen, Oster Boldgade 10, Copenhagen DK 1350, DENMARK	AC	+45 35 32 2524	+45 35 32 2501
Institute of Terrestial Ecology, Merlewood Research Station (ITE), Windermere Road, Grange-over-sands LA11 6JU, UK	GO	+44 153 953 2264	+44 153 953 4705
Institute of Terrestrial Ecology, Edinburgh Research Station (ITE), Bush Estate,penicuik, Midlothian EH26 0QB, UK			
Institute of Tropical Forest Conservation (ITFC)			

Instituto Nacional de Biodversidad (National Biodiversity Institute) (INBIO), 3100 Santo Domingo, Heredia , COSTA RICA	GO	+506 36 4269	
Integrated Resource Mapping Centre (IRMC)			
Inter-American Development Bank (IADB), 1300 New York Avenue, N.w., Washington DC 20577, USA	NG		
Inter-American Indian Institute (III), Nubes 232, Col. Pedregal de San Angel, Mexico City D.F 01900, MEXICO	IG	+52 5 568 0819	+52 5 652 1274
Inter-American Institute for Cooperation on Agriculture (IICA)			
Inter-Governmental Maritime Consultative Organisation (IMCO)			
Inter-Parliamentary Commission for Environment and Development (CICAD)			
Inter-governmental Panel on Climate Change (IPCC), The World Meteorological Organisation, Case Postale 2300, Geneva 20 CH-1211, SWITZERLAND	UN	+41 22 7308 215	+41 22 7331 270
Interamerican Foundation for Tropical Research (FIIT)			
Intergovernment Committee on Ecologically Sustainable Development (ICESD)			
Intergovernmental Authority on Drought and Development (IGADD)			
Intergovernmental Committee on the Conventionn on Biological Diversity (ICCBD)			
Intergraph Corporation, IW 17 D2, Huntsville AL 35894, USA	CO	+1 205 730 2000	+1 205 730 8300
Intergraph Europe, PO Box 333, Hoofddorp 2130 AH, NETHERLANDS	CO	+31 2503 66333	+31 2503 66414
International Academy of the Environment, 4 Chemin de Conched, Conches-geneve CH-1231, SWITZERLAND	AC	+41 22 7891311	+41 22 789 2538
International Agency for Research on Cancer (IARC)			
International Arctic Science Commission (IASC)			
International Association of Botanic Gardens (IABG), C/o Botanic Garden, North Terrace, Adelaide S.A. 5000, AUSTRALIA			
International Association of Hydrological Sciences (IAHS)			
International Association of Plant Taxonomists (IAPT)			
International Association of Theoretical and Applied Limnology (SIL), Department of Biology, University of Alabama, Tuscaloose Alabama 35487, USA			
International Association of Zoo Educators (IZE)			
International Atomic Energy Agency (IAEA)			
International Bee Research Association (IBRA), 18 North Road, Cardiff CF1 3DY, UK			
International Business Machines Inc (IBM), Old Orchard Road, Armonk NY 10504, USA	CO	+1 914 765 1900	+1 914 765 4190
International Center for Living Aquatic Resources Management (ICLARM), PO Box 2631, Manila 0718, PHILIPPINES		+63 2 817 5163	+63 2 816 3183
International Centre for Agricultural Investment and Cooperation (CIPREDA), 6a Calle 1-36, Zona 10, Oficinas 601 y 904, Guatemala 01010, GUATEMALA	NG	+502 31 94 13	
International Centre for Agricultural Research in Dry Areas (ICARDA)			
International Centre for Alpine Environment (ICALPE), Technolac, Le Bourget Du Lac F-73374, FRANCE	NG	+33 79 25 20 04	+33 79 25 28 48
International Centre for Antarctic Information and Research (ICAIR)			
International Centre for Arid and Semi-Arid Land Studies (ICASALS)			
International Centre for Conservation Education (ICCE), Greenfield House, Guiting Power, Gloucester GL54 5TZ, UK			
International Centre for Genetic Engineering and Biotechnology (ICGEB)			
International Centre for Integrated Mountain Development (ICIMOD), 4/80 Jawalakhel, Gpo Box 3226, Kathmandu , NEPAL		+977 1 525313	+977 1 524509
International Centre for Ocean Development (ICOD)			
International Centre for Protected Landscapes (ICPL)			
International Centre for Research in Agroforestry (ICRAF), United Nations Avenue, Gigin, Po Box 30677, Nairobi , KENYA			+254 2 521 001
International Centre of Tropical Agriculture (CIAT), Apartado Aereo, Cali , COLOMBIA	NG	+57 23 675050	+57 23 647243
International Coastal and Ocean Organization (ICO), C/o Urban Harborsinstitute, University of Massachusetts, Boston MA 02125, USA			
International Commission for the Conservation of Atlantic Tuna (ICCAT), Principe de Vergara 17-7, Madrid E-28001, SPAIN	IG	+34 1 431 03 29	+34 1 576 19 68
International Commission for the Protection of the Alps (CIPRA)			
International Commission on Irrigation and Drainage (ICID)			
International Committee on Coral Reefs, PO Box 2200, Canberra ACT 2601, AUSTRALIA			
International Congress of Ecology (ICE)			

International Council for Environmental Law (ICEL)			
International Council for Game and Wildlife Conservation, 30, Rue de Miromesnil, Paris 75008, FRANCE	NG	+33 1 47 42 13 48	+33 1 47 42 13 60
International Council for Local Environmental Initiatives (ICLEI)			
International Council for Monuments and Sites (ICOMOS)			
International Council for Research in Agroforestry, Box 4000, Macdonald College, 21111 Lakeshore Road, Ste Anne de Bellevue, Quebec H9X 1C0, CANADA			
International Council for the Exploration of the Seas (ICES)			
International Council of Scientific Unions (ICSU), 51, Boulevard de Montmorency, Paris F-75016, FRANCE	NG	+33 1 4525 0329	+33 1 4288 9431
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru PO, Andhra Pradesh 502324, INDIA	NG	+91 842 224016	+91 842 241239
International Development Association (IDA)			
International Development Bank (IDB)			
International Development Research Centre (IDRC), 250 Albert Street, Po Box 8500, Ottawa K1G 3H9, CANADA		+1 613 236 6163	+1 613 238 7230
International Dolphin Watch (IDW), Parklands, North Ferriby, Humberside HU14 3ET, UK			
International Energy Agency (IEA)			
International Environment Assistance (IEA)			
International Environment Bureau (IEB)			
International Environment Facility (IEF)			
International Environment Technology Centre (IETC)			
International Environmental Bureau (IEB), PO Box 301, Lysaker 1324, NORWAY			
International Environmental and Natural Resource Assessment Information Service (INTERAISE), IIED, 3 Endsleigh Street, London , UK			+44 171 388 2826
International Federation of University Women, 37 Quai Wilson, Geneva CH 1201, SWITZERLAND	NG		
International Foundation for the Conservation of Game (FISG)			
International Fund for Agricultural Development (IFAD)	UN		
International Fur Trade Federation (IFTF)			
International Group of National Associations of Agrochemical Manufacturers (GIFAP)			
International Imaging Systems, 1500 Buckeye Drive, Milpitas CA 95035, USA		+1 408 432 3400	+1 408 433 0965
International Institute for Aerospace Survey and Earth Sciences (ITC), 350 Boulevard 1945, PO Box 6, Enschede 7500 AA, NETHERLANDS	NG	+31 53 874444	+31 53 874400
International Institute for Applied Systems Analysis (IIASA), Laxenburg A-2361, AUSTRIA	NG	+43 2236 71521	+43 2236 73147
International Institute for Environment and Development (IIED), 3 Endsleigh Street, London WC1H 0DD, UK	NG		+44 171 388 2826
International Institute for Tropical Agriculture (IITA)			
International Institute for Tropical Forestry (IITF)			
International Institute of Tropical Agriculture (ITTA), PMB 5320, Ibadan , NIGERIA			
International Lake Environment Committee (ILEC)			
International League for the Protection of Cetaceans (ILPC)			
International Legume Database and Information Service (ILDIS), Biology Dept., University of Southampton, Southampton SO9 3TU, UK		+44 1703 592 444	+44 1703 594 269
International Maize and Wheat Improvement Centre (CIMMYT), Lisboa 27, Apartado 6-641, Mexico City CP 00660, MEXICO			
International Marine Biodiversity Development Corporation (IMBDC)			
International Maritime Organisation (IMO)			
International Microbial Strain Data Network (MSDN)			
International Monetary Fund (IMF)			
International Oceanographic Commission (IOC)	UN		
International Oceanographic Data Exchange System (IODE), IOC Secretariat, Unesco, 7, Place Defontenoy, Paris F-75700, FRANCE	UN		+33 1 40 56 93 16
International Organisation for Ecology (INTECOL)			
International Organization for Standardization (ISO), Case Postale 56, Geneva CH-1211 20, SWITZERLAND	NG		+41 22 733 3430

International Organization of Plant Information (IOPI), Conservatoire et Jardin Botaniques, Chemin de l'Imperative 1, CP 60, Geneva CH-1292, SWITZERLAND		+41 22 732 69 69	+41 22 732 45 97
International Park Documentation Centre (CEDIP)	GO		
International Petroleum Industry Environmental Conservation Association (IPIECA)			
International Plant Genetic Resources Institute (IPGRI), Via Delle Sette Chiese 142, Rome 00145, ITALY	NG		+39 6 5750309
International Potato Center (CIP), SSD-CIP, PO Box 5969, Lima , PERU	NG		
International Primate Protection League (IPPL), 116 Judd Street, London WC1H 9NS, UK			
International Primatological Society (IPS)			
International Rivers Network (IRN), 1847 Berkeley Way, Berkeley CA 94703, USA			
International Rural Development Centre (IRDC)			
International School of Nairobi, Medias-France, Nairobi , KENYA	AC		
International Seabed Resource Authority (ISRA)			
International Service for the Aquisition of Agro-biotech Applications (ISAAA)			
International Snow Leopard Trust (ISLT)			
International Society for Endangered Cats (ISEC)			
International Society for Tropical Ecology (ISTE), C/o Dept. of Botany, Banaras Hindu University, Varanasi UP 221005, INDIA	NG	+91 542 312989	+91 542 312059
International Society of Naturalists (INSONA)			
International Task Force on Forestry Research (ITFFR)			
International Trade Centre (ITC)			
International Tree Project Clearinghouse, Non-governmental Liaisonservice, Room Dc2-1103, United Nations, New York NY 10017, USA			
International Tropical Timber Organisation (ITTO), International Organisations Centre, Pacifico Yokohama, 5f1-1-1 Minato-mirai, Nishi-ku Yokohama 220, JAPAN	IG	+81 45 223 1110	+81 45 223 1111
International Trust for Zoological Taxonomy, C/o Natural History Museum, Cromwell Road, London SW7 5BD, UK	GO		
International Union for the Protection of Nature (IUPN)			
International Union of Biological Sciences (IUBS), IUBS Secractariat, 51 Boulevard de Montmorency, Paris 75016, FRANCE	NG	+33 1 45 25 00 09	+33 2 45 25 20 29
International Union of Directors of Zoological Gardens (IUDZG), Copenhagen Zoo, Sdr. Fasanvej 79, Frederiksberg DK-2000, DENMARK			
International Union of Forestry Research Organisations (IUFRO), Seckendorff-gudent-weg 8, Vienna A-1131, AUSTRIA	NG	+43 1 87 70 151	+43 1 87 79 355
International Waterfowl and Wetlands Research Bureau (IWRB), Slimbridge, Gloucester GL2 7BX, UK	NG	+44 1453 890 624	+44 1453 890 697
International Whaling Commission (IWC)			
International Wilderness Leadership Foundation (WILD)			
International Working Group on Data Management for Global Change (IWGDMGC)			
International Working Group on Taxonomic Databases for Plant Sciences (TDWG), Royal Botanic Gardens Kew, Richmond TW9 3AE, UK	NG	+44 181 940 1171	+44 181 332 5197
International Youth Federation for Environmental Studies and Conservation (IYF)			
Islamic Educational, Scientific and Cultural Organisation (ISESCO)			
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Japan Ocean Data Centre (JODC)			
Japan Tropical Forest Action Network (JATAN)			
Japan Wildlife Research Centre (JWRC)			
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José Maria Blanc Foundation (FJMB)			
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Latin America Centre for Economic and Social Affairs (CLADES)	UN		
Latin American and Caribbean Commission on Development & Environment (LACCDE)			
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Lotus Development Corporation, 55 Cambridge Parkway, Cambridge MA 82142-1295, USA	CO		
MPA Communications Pty Ltd, 37-51 Lusher Road, Croydon VI 3136, AUSTRALIA	CO	+61 3 724 4488	+61 3 724 4455
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Marine Parks Centre of Japan (KKC)			
Mesoamerican Plant Genetic Resources Institute (REMERFI)			
Mexican Commission on Conservation and Use of Biodiversity (CONABIO)			
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Microcomputer and Workstation Networks Center, 152 Shepherd Labs, 100 Union Street Se, University of Minesota, Minneapolis MN 55455	CO	+1 612 625 1300	+1 612 625 6817
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Minitab Inc, 3081 Enterprise Drive, State College PA 16801, USA	CO	+1 814 238 3280	+1 814 238 4383
Missouri Botanical Garden (MOBOT), PO Box 299, St. Louis MS 63166-0299, USA			
Monitoring and Assessment Research Centre (MARC)	UN		
Motorola Inc, 8201 e Mcdowell Road, Po Box 1417, Scottsdale AZ 85252-1417, USA	CO	+1 800 424 0052	
Multilateral Development Bank (MDB)			
NASA World Data Center (NASA-WDC), 7601 Ora Glen Drive, Suite 300, Greenbelt MD 20770, USA	GO	+1 301 513 1687	
NASA/GSFC and the University of Maryland, Code 923, Greenbelt MD 20771, USA			
National Aeronautics and Space Administration (NASA)	GO		
National Audubon Society (NAS)			
National Board of Waters and the Enviornment, Environmental Data Centre (EDC), Helsinki SF-00101, FINLAND	GO	+358 0 731 44208	+358 0 731 44280
National Centre for Scientific Research (CNRS), 46,rue d'Ulm, Paris Cedex05 F-75230, FRANCE	AC	+33 1 44323708	+33 1 44321885
National Commission for Wildlife Conservation and Development (NCWCD)			
National Committee on Nature Conservation (NCNC)	GO		
National Environment Information Centre (NEIC)	GO		
National Environment Management Council (NEMC)			
National Environment Secretariat (NES)			

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National Geographic Society, 1145 - 17th Street NW, Washington DC 20036, USA			
National Information Services Corporation (NISC), Suite 6, Wyman Towers, 3100 St. Paul Street, Baltimore MD 21218, USA		+1 410 243 0797	+1 410 243 0982
National Institute for the Conservation of Nature (ICONA)			
National Museums of Kenya (NMK), PO Box 40658, Nairobi , KENYA	GO		+254 274 1424
National Nature Protection Society (SNPN)			
National Oceanic and Atmospheric Administration (NOAA), 3300 Whitehaven Street, Nw, Washington DC 20235, USA			
National Park Service, Department of the Interior, 1849 C Street NW, Washington DC 20240, USA			
National Parks Board of South Africa, PO Box 787, Pretoria 0001, SOUTH AFRICA			
National Remote Sensing Agency, Balanagar, Hyderabad 500 037, INDIA	CO		
National Water Resources Institute (NWRI)			
National Wildlife Federation (NWF), 1400 16thst NW, Washington DC 20036, USA			
Natural Environment Research Council (NERC), Polaris House, North Star Avenue, Swindon SW2 1EU, UK	GO		
Natural History Museum (NHM), Cromwell Road, London SW7 5BD, UK	GO	+44 171 938 9123	+44 171 938 8937
Natural Resources Defense Council, 1350 New York Ave, Nw, Washington DC 20005, USA			
Natural Resources Institute (NRI), Central Ave, Chatham Maritime ME4 4TB, UK			
Netherlands Society for the Protection of Birds (NSPB)			
Network Solutions Inc, Attn: Internic Registration Services, 505 Huntmar Park Drive, Herndon VA 22070, CANADA	CO	+1 703 742 4777	
New York Botanical Gardens, 200 St. and Southern Blvd., Bronx NY 10458, USA			
New York Zoological Society (NYZS)			
North Atlantic Treaty Organisation (NATO)			
Norwegian Centre for International Agricultural Development (NORAGRIC)			
Norwegian Institute for Nature Research (NINA), Tungasletta 2, Trondheim N-7005, NORWAY	NG	+47 7 580500	+47 7 915433
Norwegian Society for Conservation of Nature (NSCN)			
Office of Ocean Affairs and the Law of the Sea, Office of the Secretary General, United Nations, New York NY 10017, USA			
Organisation for Economic Cooperation and Development (OECD), BELGIUM	IG		
Organisation for Tropical Studies (OTS)			
Organisation for the Phyto-Taxonomic Investigation of the Mediterranean Area (OPTIMA)			
Organisation of African Unity (OAU)			
Organisation of American States (OAS)			
Organization for Tropical Studies (OTS), Durham NC 27708-0630, USA	AC	+1 919 684 5774	+1 919 684 5661
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Oxfam United Kingdom, 274 Banbury Road, Oxford OX2 7DZ, UK			
Oxford Forestry Institute (OFI), South Parks Road, Oxford OX1 3RB, UK	NG		
Oxford University Press (OUP), Electronic Publishing Division, Walton Street, Oxford OX2 6DP, UK	CO	+44 1865 267979	+44 1865 56646
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PEO International Peace Scholarships Fund, 3700 Grand Avenue, Des Moines IA 50321, USA			
Pacific Information Service, University of the South Pacific, Po Box 1168, Suva , FIJI	GO	+679 313900	+679 301305
Pan-American Centre for Human Ecology and Health (ECO/OPS)			
Pan-American Health Organisation (PAHO)			
Peoples Trust for Endangered Species (PTES)			
Permanent Centre for Nature Conservation (CPECN)			
Permanent Interstate Committee for Drought Control in the Sahelian Zone (CILSS)			

Permanent South Pacific Commission (CPPS), Teatinos 20, Oficina 93, Santiago 9, CHILE	IG	+56 2 6726652	+56 2 6951100
Planning and Development Collaborative International (PADCO)			
Plant Advisory Group (PAG)	NG		
Probe International, 225 Brunswick Ave., Toronto On M5S 2M6, CANADA			
Procis Software Ltd, Alexander House, 19 Fleming Way, Swindon SN1 2NG, UK	CO	+44 1793 541200	+44 1793 541025
Programme on Biological Diversity (DIVERSITAS)	NG		
Protected Areas Data Unit (PADU)			
Protected Areas Wildlife Bureau (PAWB)			
Quanta Press Inc, Suite 223A, 1313 Fifth Street, Minneapolis MN 55414, USA	CO	+1 612 379 3956	+1 612 623 4570
Quebec Labrador Foundation (QLF)			
Rainforest Action Network, Suite A, 301 Broadway, - CA 94133, USA			
Rainforest Alliance, 65 Bleecker Street,6th Floor, New York NY 10012, USA			
Rainforest Conservation Society, 15 Colorado Avenue, Bardon 4065, AUSTRALIA			
Rainforest Information Centre, PO Box 368, Lismore NSW 2480, AUSTRALIA			
Ramsar Convention Bureau (RAMSAR), Rue Mauverney 28, Gland CH-1196, SWITZERLAND	IG	+41 22 999 01 70	+41 22 999 01 69
Ramsar Wetland Bureau, Rue Mauverney 28, Gland CH-1196, SWITZERLAND			
Regional Environmental Training Network for Latin America and the Caribbean, Asi (ETN)			
Regional Network on the Production, Marketing and Control of Pesticides for Asia (RENPAP)			
Regional Office for Asia and the Pacific (RAPA)	UN		
Regional Office for Central Ammerican Programme (ROCAP)			
Regional Office for Science and Technology for South East Asia (ROSTSEA)			
Regional Office for South America (SUR)	NG		
Regional Office for Southern Africa (ROSA)	NG		
Regional Organisation for the Protection of the Marine Environment (ROPME)			
Research and Training Centres on Desertification Control in Asia & the Pacific (DESCONAP)			
Rijksherbarium/Hortus Botanicus (RHHB), 2300 RA, Leiden PO Box 9514, NETHERLANDS	NG	+31 71 273500	+31 71 273511
Rockefeller Brothers Fund, Suite 3450, 1290 Avenue of the Americas, New York NY 10104, USA	NG		
Royal Botanic Gardens (RBG)			
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Royal Geographical Society (RGS), London SW7 2AR, UK			
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Royal Swedish Academy of Sciences (RSAS)			
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Scientific Advisory Committee on Biological Diversity (SACBP)			
Scientific Committee for Antarctic Research Secretariat (SCAR), Scott Polar Research Institute, Lensfield Road, Cambridge CB2 1ER, UK		+44 1223 62061	+44 1223 336549
Scientific Committee on Antarctic Research (SCAR)			
Scientific Committee on Oceanic Research (SCOR)			
Scientific Committee on Problems of the Environment (SCOPE)			

Scientific Event Alert Network (SEAN)			
Scientific Research Institute for Cooperation in Development (ORSTOM)			
Scott Polar Research Institute (SPRI)			
Scripps Institution of Oceanography, University of California, La Jolla CA 92093, USA			
Sea Turtle Protection Society, PO Box 51154, Kifissia 14510, GREECE			
Sierra Club, 330 Pennsylvania Avenue, Se, Washington DC 20003, USA			
SilverPlatter Information BV, NL, PC Hooftstraat 116, Amsterdam 1071 CD, NETHERLANDS	CO	+31 20 675 41 99	+31 20 675 50 03
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Smithsonian Tropical Research Institute (STRI)			
Societas Europaea Herpetologica (SEH)			
Societas Europaea Lepidopterologica (SEL)			
Societe Francaise pour le Droit de l'Environnement (SFDE)			
Society for Conservation Biology (SCB)			
Society for Environmental Conservation (SNM)			
Sociiete Marocaine pour le Droit de l'Environnement (SFDE)	GO		
Software Toolworks, 60 Leveroni Court, Novato CA 94949, USA	CO	+1 415 883 3000	+1 415 883 3303
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South East Asia Association for Regional Cooperation (SAARC)			
South Pacific Commission (SPC)			
Southern African Development Community (SADC)			
Spanish Agency for International Cooperation (AECI)	GO		
Spanish Association for Ecodevelopment and Environmental Defence (AEMA)			
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Species Conservation Monitoring Unit (SCMU)			
StatSci Division, Mathsoft Inc, 1700 Westlake Avenue, N. Suite 500, Seattle WA 98109, USA	CO	+1 206 283 8802	+1 206 283 8691
Statistics Package for the Social Sciences Inc (SPSS), SPSS House, 5 London Street, Chertsey KT16 8AP, UK	CO	+44 1932 566262	+44 1932 567020
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Survival International, 310 Edgware Road, London W2 1DY, UK	NG		
Swedish Agency Research Cooperation with Developing Countries (SARD)			
Swedish Agency for International Technical and Economic Cooperation (BITS)	GO		
Swedish International Development Agency (SIDA), Birger Jarlsgatan 61, Stockholm 105 25, SWEDEN	GO		
Swedish Ornithological Society (SOF)			
Swiss Academy of Natural Sciences (SAS)	GO		
Swiss Development Agency, SWITZERLAND	GO		
Systat Inc, 1800 Sherman Avenue, Evanston IL 60201, USA	CO	+1 708 8645670	+1 708 4923567
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Television Trust for the Environment (TVE)			
Terrestrial Ecosystems Branch (TEB)	UN		

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The Ford Foundation, 55 Lodi Estate, New Delhi 110003, INDIA	NG		
The Global Climate Observing System (GCOS), C/o WMO, PO Box 2300, Geneva CH-1211, SWITZERLAND			+41 22 7401439
The MathWorks Inc, Cochituate Place, 24 Prime Park Way, Natick MA 01760, USA	CO	+1 508 653 1415	+1 508 653 2997
The National University of Hanoi, Department of Environmental Sciences, Hanoi , VIET NAM	AC		
The Nature Conservancy (TNC), 1815 N. Lynn Street, Arlington VA 22209, USA			
The Nature Conservancy of Canada, 110 Eglinton Ave. West, 4th Floor, Toronto M4R 2G5, CANADA			
The Royal Society (RS)			
The Swedish Forest Service, Falun 5-791 81, SWEDEN			
The Tropical Agronomic Centre for Research and Education (CATIE), Turrialba 7170, COSTA RICA	IG	+506 56 64 31	+506 56 15 33
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Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC)	NG		
Trade and Development Board (TDB)	UN		
Trimble Navigation Ltd, 645 N Mary Ave, Sunnyvale CA 94088-3642, USA	CO	+1 800 827 8000	+1 408 481 7781
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Tropical Agricultural Research and Training Centre (CATIE), Programa de Manejo Integrado de Recursus Naturales, Apartado 7170, Turrialba, COSTA RICA	NG	+506 56 64 31	+506 56 15 33
Tropical Biology Association, University of Bristol, Bristol , UK	AC		
Tropical Ecosystem Environment Observation by Satellites (TREES)			
Tropical Forest Action Plan (FAO-TFAP), Via Delle Terme di Caracalla, Rome 00100, ITALY			
Tropical Forest Foundation, C/o Smithsonian Institution, Suite 3123, 1100 Jefferson Drive SW, Washington DC 20560, USA			
Tropical Marine Research Unit (TMRU)	AC		
Tropical Rainforest Campaign/Greenpeace, 1436 U St. NW, Washington DC 20009, USA			
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UN Economic Commission for Asia and the Pacific, United Nations Building, Rajdamnern Avenue, Bangkok 10200, THAILAND	UN		
UN Economic Commission for Latin America, Casilla 179-D, Santiago , CHILE	UN		
UNEP (Mexico), Boulevard de los Virreyes No. 155, Col. Lomas Virreyes, Mexico DF 11000, MEXICO	UN	+52 5 202 4841	+52 5 202 0950
UNEP Global Resource Information Database (UNEP GRID), PO Box 30552, Nairobi , KENYA	UN	+254 2 624202	+254 2 226491
UNEP Harmonization of Environmental Measurement (UNEP HEM), GSF Research Centre, Neuherberg, Ingolstaedter Landstrasse 1, Oberschleissheim 85764, GERMANY	UN	+49 89 3187 5488	+49 89 3187 3325
UNEP International Environmental Information System (INFOTERRA), INFOTERRA Programme Activity Centre, Unep, Po Box 30552, Nairobi, KENYA	UN	+254 2 623274	+254 2 52 07 11
UNESCO Man and the Biosphere Programme (MAB), Division of Ecological Sciences, Unesco, 7 Place de Fontenoy, Paris F-75700, FRANCE	UN		+33 140 65 9897
UNESCO World Heritage Committee (WH), World Heritage Centre, Unesco, 7 Place de Fontenoy, Paris F-75700, FRANCE	UN		
UNU Institute for Natural Resources in Africa (UNU/INRA), PO Box 30592, Nairobi , KENYA			
US Army Construction Engineering Research Laboratory, PO Box 9005, Champaign IL 61826-9005, USA	IG	+1 217 352 6511	+1 217 352 7222
US Department of Agriculture (USDA)	GO		
US Fish and Wildlife Service, 1201 Oak Ridge Drive, Suite 200, Fort Collins CO 80525-5589, USA	GO	+1 303 226 9401/223 9	
US National Committee for Man and the Biosphere (MAB), Sa37, Room 608, Department of State, Washington DC 20522, USA			
US National Oceanic and Atmospheric Administration (NOAA)	GO		

USACO Corporation, 13-12 Shinbashi 1-chome, Minatoku, Tokyo 105, JAPAN		+81 3 3502 6471	+81 3 3593 2709
USGC Master Directory, National Space Science Data Center, Nasa, Greenbelt MD 20771, USA			
Umweltbundesamt (Federal Environmental Agency), Bismarckplatz 1, Berlin D-14193, GERMANY	GO		
Unistat Ltd, Unistat House, 4 Shirland Mews, London W9 3DY, UK	CO	+44 181 9641130	+44 181 9640531
Unisys Ltd, PO Box 500, Blue Bell PA 19424, USA	CO	+1 215 986 3683	+1 416 747 2473
United Nations (UN)			
United Nations Capital Development Fund (UNCDF)	UN		
United Nations Caribbean Environment Programme (UNCEP)	UN		
United Nations Centre for Regional Development (UNCRD)	UN		
United Nations Centre for Science and Technology for Development (UNCSTD)	UN		
United Nations Childrens Fund (UNICEF)	UN		
United Nations Commission of the USSR (UNEPCOM)	UN		
United Nations Development Programme (UNDP), 1 United Nations Plaza, New York NY 10017, USA	UN		
United Nations Economic Commission for Europe (UN-ECE)	UN		
United Nations Economic Commission for Latin America and the Caribbean (UN/ECLAC)	UN		
United Nations Educational, Scientific and Cultural Organisation (UNESCO), 7 Place de Fontenoy, Paris F-75700, FRANCE	UN		
United Nations Environment Programme (UNEP), PO Box 30552, Nairobi , KENYA	IG		
United Nations Industrial Developement Organisation (UNIDO)	UN		
United Nations Industry and Environment Office (IEO)	UN		
United Nations Institute for Training and Research (UNITAR)	UN		
United Nations Library, Palais des Nations, Geneva CH 1211 10, SWITZERLAND	UN	+41 22 734 6011	+41 22 733 0800
United Nations Saharan Office (UNSO)	UN		
United Nations Secretariat (UN), 1 United Nations Plaza, New York NY 10017, USA	UN		
United Nations Statistical Office (UNSTAT)	UN		
United Nations Statistical Office Environment Statistics Section, DC 2-1652, 2 United Nations Plaza, New York NY 10017, USA	UN	+1 212 963 4581	+1 212 963 4116
United Nations Training Institute for Training and Research (UNITAR), SWITZERLAND	IG		
United States Agency for International Development (USAID), 1500 Wilson Boulevard, Suite 1010, Arlington VA 22209 2404, USA	GO	+1 703 351 4006	+1 703 351 4039
United States Environmental Protection Agency (USEPA). .			
United States Environmental Training Institute (USETI), USA	AC		
University of Adelaide, Adelaide , AUSTRALIA	AC		
University of Amsterdam, Research School of Biodiversity, PO Box 94766, Amsterdam 1090 GT, NETHERLANDS	AC	+31 20 525 6499	+31 20 525 5402
University of Birmingham, School of Biological Sciences, University of Birmingham, Birmingham , UK	AC		
University of Botswana, BOTSWANA	AC		
University of Edinburgh, Institute of Ecology and Resource Management, University Research and Teaching Department, King's Buildings, West Mains Road, Edinburgh EH9 3JG, UK	AC	+44 131 667 1041	+44 131 667 2601
University of Nairobi, PO Box 30197, Nairobi , KENYA	AC	+254 2 334244	
University of Toronto Press, 1280-1011 Sheppard Ave, Toronto M3H 5V4, CANADA	CO		+1 416 667 7832
University of Wisconsin Press, 900 2nd St. Ne, Suite 304, Washington DC 20002, USA	CO		
Whale and Dolphin Conservation Society (WDCS), 19A James Street, Bath BA1 2BT, UK			
Wide Area Information Servers Inc (WAIS), 1040 Noel Drive, Suite 102, Menlo Park CA 94025, USA	CO	+1 415 617 0444	+1 415 327 6513
Wild Bird Society of Japan (WBSJ)			
Wildfowl and Wetlands Trust (WWT)			
Wildlife Conservation International, NY Zoological Society, The Bronx Zoo, New York NY 10460, USA			
Wildlife Information Network, The Royal Veterinary College, Royal College Street, Camden Town, London NW1 0TU, UK		+44 171 388 7003	+44 171 388 7110
Wildlife Management Institute (WMI)			

Wildlife Preservation Trust International (WPTI)			
Wildlife Society (WS)			
Wildlife Trade monitoring unit (WTMU)			
Wolfram Research Inc, 100 Trade Center Drive, Champaign IL 61820 7237, USA	CO	+1 217 398 0700	+1 217 398 0747
Woods Hole Oceanographic Institution, Woodshole MA 0, USA			
Working Group on Climate Change Detection (WGCCD)			
World Association of Soil and Water Conservation, 317 Marvin Avenue, Volga SD 57, USA			
World Bank (IBRD), 1818 H Street, Nw, Washington DC 20433, USA	IG	+1 202 676 0483	+1 202 477 1234
World Bank Publications Distribution Office, 1818 H Street, Nw, Washington DC 20433, USA	IG	+1 202 473 2941	
World Conservation Monitoring Centre (WCMC), 219 Huntingdon Road, Cambridge CB1 3NA, UK	NG	+44 1223 277314	+44 1223 277136
World Conservation Union (IUCN), Rue Mauverney 28, Gland CH-1196, SWITZERLAND	NG	+41 22 999 00 01	+41 22 999 00 02
World Council for the Biosphere-International Society for Environmental Educatio (WCB-ISEE)			
World Data Centre (WDC)			
World Environment Centre (WEC)			
World Food Council (WFC)	UN		
World Forestry Center, 4033 S.W. Canyon Road, Portland OR 97221, USA			
World Health Organization (WHO), 20, Ave. Appia, Geneva CH-1211, SWITZERLAND	UN	+41 22 791 2111	+41 22 791 0746
World Intellectual Property Organisation (WIPO)	UN		
World Meteorological Organisation (WMO), Case Postale 2300, Geneva 20 CH-1211, SWITZERLAND	UN	+41 22 730 84 01	+41 22 734 23 26
World Ozone Data Centre (WODC)			
World Rainforest Movement, 8 Chapel Row, Chadlington OX7 3NA, UK			
World Resources Institute (WRI), 1709 New York Avenue NW, Washington DC 20006, USA	NG	+1 202 662 2583	+1 202 638 0036
World Society for Preservation of Animals (WSPA)			
World Tourism Organisation (WTO), Capitan Haya 42, Madrid 28020, SPAIN	IG	+34 1 571 06 28	+34 1 571 37 33
World Underwater Federation (CMAS)			
World Wide Fund for Nature (WWF-UK), Panda House, Weyside Park, Catteshall Lane, Godalming, Surrey GU7 1XR, UK	NG	+44 1483 426444	
World Wide Fund for Nature International (WWF), Gland CH-1196, SWITZERLAND			
World Wildlife Fund (WWF-US), 1250 24th Street NW, Washington DC 20037, USA			
World Working Group on Birds of Prey and Owls, Wangenheimstr 32, Berlin 1000-33, GERMANY			
Wye College, University of London, Ashford TN25 5AH, UK	AC	+44 1233 812401	+44 1233 812138
Xinjiang Centre Station of Environmental Monitoring, Arid Environmental Monitoring Editorial Office, 38 Beijing South Road, Urumqi, Xinjiang, CHINA	GO	+86 991 338972	
Zoological Society of London, Regents Park, London NW1 4RY, UK		+44 171 722 3333	+44 171 483 4436

8.3 Acronyms & Abbreviations

The acronyms presented below are those that are in international usage in the field of biodiversity information management; that is they may be international or national organisations, projects, programmes, systems, technological terms, and so on (see **TYPE** below). For example, the acronym "ECN" stands for "Environmental Change Network" in the UK.

Acronym
The acronym itself; either a recognised abbreviation of its full name (expansion), or a word formed from the initial letters of its full name.

Expansion
The fully expanded name or meaning of the acronym.

Type
The type of acronym as follows:

I	= Institution/agency/committee/association/sub-organisation/unit
P	= Programme/activity/project
C	= Convention/treaty/protocol
T	= Technological or scientific term
CT	= Commercial technology
M	= Miscellaneous

Region
Depending on the acronym type, this may refer to:

- the region in which an organisation, project or convention operates (not the location of the organisation itself)
- the geographic extent over which an acronym is used.

Parent (where applicable)
Depending on the acronym type, this may refer to:

- the administrator of a programme, project, or system
- the parent organisation of an institution or agency
- the vendor of commercial product.

Acronym	Expansion	Type	Region	Parent
AAECP	ASEAN-Australian Economic Cooperation Programme	P	International	ASEAN/Australian Government
AAICLS	Afro-Asian Insitute for Cooperation and Labour Studies	I	International	Israeli Government
AAZPA	American Association of Zoological Parks and Aquariums	I	International	
ABC	Asian Bureau for Conservation	I	International	
ACABQ	Advisory Committee on Administrative and Budgetary Questions	I	International	UN
ACANZ	Agricultural Council of Australia and New Zealand	I	International	
ACC	Administrative Committee on Coordination	I	International	UN
ACCBD	Advisory Committee on Conservation of Biological Diversity	I	International	
ACCE	Advisory Committee on Chemicals in the Environment	I	International	ANZEC
ACCIS	Advisory Committee for the Coordination of Information Systems	I	International	UN
ACCT	Sciences et Technique pour le Developpement	I	International	
ACDE	Amazon Commission on Development and Environment	I	South America	
ACDI	(See CIDA)			
ACE	Atlantic Centre for the Environment	I	USA/ Canada	QLF
ACER	Advisory Committee on Environmental Resources	I	International	
ACFOA	Australian Council for Overseas Aid	I	Australia	
ACIAR	Australian Centre for International Agricultural Research	I	Australia	
ACIS	American Committee for International Conservation	I	International	
ACMAD	African Centre of Meteorological Applications for Development	I	Africa	
ACOPS	Advisory Committee on Pollution of the Sea	I	International	
ACORBAT	Association for Cooperation in Banana Research in the Caribbean and Tropical America	I	International	
ACPAC	AIDAB Centre for Pacific Development and Training	I	Australia	
ACS	Antarctic Conservation Strategy	C	International	IUCN
ACSAD	Arab Centre for the Studies of Arid Zones and Dry Lands	I	Syria	
ACT	Amazonian Cooperation Treaty	C	Amazonia	
ACTS	African Centre for Technology Studies	I	Africa	
ADDB	Antarctic Digital Database	CT	International	ESRI/WCMC/BAS/SPRI
ADEOS	Advanced Earth Observing Satellite	I	Japan	
ADF	Asian Development Fund	I	Asia	ADB
ADPC	Agricultural Development Planning Centre	I	International	ASEAN
ADS	Acid Deposition System Database	T	USA	EPA
AEC	Australian Environment Council (ANZEC)	I	Australia	
AECCG	African Elephant Conservation Coordination Group	I	International	
AECI	Agencia Espanola de Cooperacion Internacional (Spanish Agency for International Cooperation)	I	International	Government of Spain
AEGE	ASEAN Experts Group on the Environment	I	International	
AEMA	Spanish Association for Ecodevelopment and Environmental Defence	I	International	
AERGC	African Environmental Research and Consulting Group	I	International	
AERP	Aquatic Effects Research Programme	P	International	
AESG	Asian Elephant Specialist Group	I	International	
AETFAT	Association pour l'Etude de la Flore d'Afrique Tropicale	I	Tropical Africa	
AFJWG	Australia/France Joint Working Group	I	International	
AFRC	Agricultural and Food Research Council	I	UK	
AFRENA	Agroforestry Research Networks for Africa	P	Africa	ICRAF

AFSSRN	Asian Fisheries Social Science Research Network	I	International	
AGFUND	Arab Gulf Programme for United Nations Development Organisations	I	International	UN
AGREP	Agricultural Research Projects in the European Communities	P	International	CEC
AIA	Academie Internationale de l'environment	I		
AIDAB	Australian International Development Assistance Bureau	I	Australia	DFAT
AIRD	Asian Institute for Rural Development	I	International	
AIT	Asian Institute of Technology	I	Asia	
ALE	Atmospheric Lifetime Experiment	P	USA	Chemical Manufacturers' Association
ALEC	Arid Lands Environment Centre	I	International	
ALESCO	Arab League Educational, Scientific and Cultural Organization			
	(Organization de la Lique Arabe pour l'Éducation, la Culture et la Science	I	International	
AMAP	Arctic Monitoring and Assessment Programme	P	International	
AMC	Antarctic Minerals Convention	C	International	
AMEC	Association of Mining and Exploration Companies	I	International	
AML	ARC Macro Language	CT	USA	ESRI
AMNH	American Museum of Natural History	I	USA	SI
ANCA	Australian Nature Conservation Agency (formerly ANPWS)	I	Australia	Government
ANGOLO	Asian NGO Coalition for Agraian Reform and Rural Development	I	International	
ANRPC	Association of Natural Rubber Producing Countries	I	International	
ANSI	American National Standards Institute	I	USA	
ANZECC	Australian and New Zealand Environment and Conservation Council	I	International	
ANZLIC	Australia New Zealand Land Information Council	I	International	
ANZMEC	Australian and New Zealand Minerals and Energy Council	I	Interational	
ANZUS	ANZUS Council	I	Australia/New Zealand/USA	
APEC	Asia Pacific Economic Cooperation	I	International	
APELL	Awareness and Preparedness for Emergencies at Local Level	P	International	UNEP Industry and Environment Office
APN	Amelioration des Peuplements Naturels	I	International	
APO	Asian Productivity Organisation	I	Asia	Inter-Governmental
APPREN	Asia-Pacific Peoples Environment Network	I	International	
APRACA	Asian and Pacific Regional Agricultural Credit Association	I	International	
APSF	Australian Pacific Science Foundation	I	International	
APSG	Australian Plant Specialists Group	I	Australia	IUCN
ARC/INFO	GIS package	CT	International	ESRI
AREA	Association for Research, Exploration and Environmental Aid	I	International	
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand	I	International	
ARSAP	Agriculture Requisites Scheme for Asia and the Pacific	P	International	
ASB	Alternatives to Slash and Burn Global Project	P	International	ICRAF
ASC	ASEAN Standing Committee	I	International	
ASCII	American Standard Code for Information Interchange	T	International	
ASDB	Asian Development Bank (Banque Asiatique de Développement)	I	International	
ASDI	(See SIDA)			
ASEAN	Association of South East Asian Nations (Association des Nations de L'Asie du Sud-Est)	I	South East Asia	
ASEP	ASEAN Subregion Environment Programme	P	International	
ASFIS	Aquatic Sciences and Fisheries Information System	T		
ASIH	American Society of Icthyologists and Herpetologists	I	International	

ASOC	Antarctic and Southern Ocean Coalition	I	International	
ASOE	ASEAN Senior Officials on the Evironment	I	International	
ASPAC	Asian and Pacific Council	I	International	
ASPEI	Association of the South Pacific Environmental Institutions	I	International	
ASSN	(See SAS)			
AT	AntarticTreaty	C	Antarctic	
ATCP	Antarctic Treaty Consultative Party	I	International	
ATRCW	African Training and Research Centre for Women	I	International	
ATREG	African Technical Regional Environment Group	I	International	
ATS	Antarctic Treaty System	I	International	
AVHRR	Advanced Very High Resolution Radiometry	T		
AVRDC	Asian Vegetable Research and Development Centre	I	Asia	Inter-Governmental
AWB	Asian Wetlands Bureau	I	International	
AWF	African Wildlife Foundation	I	International	
AfDB	African Development Bank (Banque Africaine de Développement)	I	International	
Apia Convention	Convention on the conservation of Nature in the South Pacific	C	South Pacific	
AsDB	See ADB			
BAA	Biodiversity Analysis for Africa	P	International	
BAAS	British Association for the Advancement of Science	I	International	
BADC	Belgian Administration for Development Cooperation	I	International	Government
BAHC	Biospheric Apsects of the Hydrological Society	I	International	
BAP	Biodiversity Action Plan	M		
BAPMoN	Background Air Pollution Monitoring Network	P	International	UNEP
BAS	British Antarctic Survey	I	Antarctic	NERC
BCSD	Business Council for Sustainable Development	I	International	
BDD	British Development Division	I	International	Government
BELUNIV	Belgian Universities	I	International	Government
BES	British Ecological Society	I	UK	
BESO	British Executive Service Overseas	I	International	Government
BFIV	Brehm Fund for the International Conservation of Birds	I	Germany	
BGCI	Botanical Gardens Conservation International	I	UK	RBGK
BGS	British Geological Survey	I	UK	
BIAC	Business Industry Advisory Committee	I	International	OECD
BIBLIO	Bibliography Documentation Programme	P	International	
BIDR	Bleaustein Institute for Desert Research	I	International	Israeli Government
BIE	Bureau of International Expositions	I	International	
BIM	Belgian Investing Maatshappij	I	International	Government
BIOMASS	Biological Investigation of Marine Antarctic Species and Stocks	P	International	BAS
BIOTROP	Southeast Asian Regional Centre for Tropical Biology	I	South East Asia	
BIS	Biodiversity Information System	T	International	
BITNET	International Communications Network	T	International	
BITS	Swedish Agency for International Technical and Economic Cooperation	I	Sweden	Government
BLI	Birdlife International	I	International	
BM	Brontosaurus Movement	P	Czech Socialist Republic	
BM (NH)	British Museum	I	UK	

BNHS	Bombay Natural History Society	I	India	
BOD	Biological Oxygen Demand (Demande Biologique en Oxygène)	T	International	
BP/RAC	Blue Plan/Regional Activity Centre	P	Europe	Council of Europe
BPT	Best Practice Technology	T	International	
BRC	Biological Records Centre	I	UK	
BRU	Basic (or Biological) Recording Unit	T		
BSPB	British Society of Plant Breeders	I	UK	
BTG	British Technology Group	I	UK	
BUN	Biomass Users' Network	P	International	
CABI	CAB International	I	UK	
CACGP	Commission of Atmospheric Chemistry and Global Pollution	I	International	
CAMBA	China-Australia Migratory Birds Agreement	C	International	
CAMP	Conservation Assessment and Management Plan (Plan de Gestion et D'Évaluation de la Conservation)	P	International	
CAMPFIRE	Communal Area Management Plan for Indigenous Resources	I	International	
CANARI	Caribbean Natural Resources Institute	I	Caribbean	
CANRIS	Coastal and Marine Resources Information System	T	International	
CAP	Common Agricultural Policy (Politique Agricole Commune)	I	International	EU
CAPMoN	Canadian Air and Precipitation Monitoring Network	P	Canada	Government
CAR	Central African Republic	M		
CARE	Care and Relief Everywhere (Care International)	I	International	
CARIPOL	Caribbean Pollution Research and Monitoring Programme	P	International	
CASE	Computer Aided Systems Engineering	T	International	
CATIE	Centro Agronómico Tropical de Investigatión y Enseñanza (Centre de Recherche et de Formation en Agriculture Tropicale)	I	International	
CAZRI	Central Arid Zones Research Institute	I	International	
CBD	Convention on Biological Diversity	C	International	
CCA	Caribbean Conservation Association (Association pour la Conservation des Caraibes)	I	International	
CCAD	Central American Commission for Environment and Development	I	Central America	
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources	C	International	
CCAS	Convention for the Conservation of Antarctic Seals	C	International	
CCC	Caribbean Conservation Corporation	I	International	
CCCO	Committee on Climate Change and the Oceans	I	International	
CCEL	Coolidge Centre for Environmental Leadership	I	USA	
CCFI	Collaborative Community Forestry Initiative	I	Africa	
CCIW	Canada Centre for Inland Waters	I	Canada	
CCOL	Coordinating Committee on the Ozone Layer	I	International	UNEP
CCRS	Canadian Centre for Remote Sensing	I	Canada	
CD-ROM	Compact Disk Read Only Memory	T	International	
CDB	Commonwealth Development Bank	I	International	
CDC	Commonwealth Development Corporation	I	UK	Government
CDC	Conservation for Development Centre	I	International	IUCN
CDD	Control of Diarrhoeal Diseases Programme	P	International	WHO
CDS	Catalog of Data Sources	M	International	EEA
CEC	Commission of the European Communities	I	International	EU

CEC	Commission on Education and Communication (Commission de L'Éducation et de la Communication)	I	International	IUCN
CEC-JRC	Environment Research Programme	P	International	
CECI	Centre Canadien d'Etude et de la Coopération Internationale	I	Canada	
CECON	Centre for conservation Studies	I	Guatemala	USAC - San Carlos University
CEDAR	Central European Environmental Data Request Facility	P	Central European	
CEED	Centre for Economic and Environmental Development	I	International	
CEHANET	Centre for Environmental Health Activites	P	International	
CEL	Commission on Environmental Law (Commission du Droit de L'Environnement	I	International	IUCN
CELS	Centre for Environmental Legal Studies	I	USA	Pace University, School of Law
CEMAA	Special Commission for the Amozonian Environment	I	International	ACT
CEMP	Ecosystem Monitoring Programme	P	International	CCAMLR
CENAREST	Centre National de la Recherche Scientifique et Technique	I	International	
CEO	Centre for Earth Observation	I		
CEOS	Committee on Earth Observing Satellites	I	International	IOC
CEP	Caribbean Environment Programme	P	Caribbean	
CEP	Committee for Environmental Protection	I	International	
CEPA	Commonwealth Environment Protection Agency	I	Commonwealth	
CEPIS	Centro Panamericano de Ingeneria y Ciencias del Ambiente	I	South America	
CEPLA	Commission on Environment Policy, Law and Administration	I	International	IUCN
CEPNET	Caribbean Environmental Programme Network	P	Caribbean	CEP
CERN	Chinese Ecological Research Network	P	China	
CERN	European Centre for Nuclear Research	I	Europe	
CES	Center for Environmental Study	I	International/USA	
CESP	Commission on Environmental Strategy and Planning (Commission des Stratégies et de la Planification de L'Environnement)	I	International	IUCN
CET	Commission on Education and Training	I	International	IUCN
CFA	Committee on Food Aid Policies and Programmes	I	International	
CFDT	Committee for Forest Development in the Tropics	I	Tropics	FAO
CFOCF	Commission For Our Common Future	I	International	
CFR	Centre for Field Research	I	International	Earthwatch/UNEP
CGER	Centre for Global Environmental Research	I	International	
CGIAR	Consultative Group on International Agricultural Research	I	International	
CGIS	Canada Geographic Information System	T	Canada	Government
CHEK	Committe on the Human Environment	I	International	
CI	Conservation International	I	International	
CIAT	International Centre for Tropical Agriculture	I	International	Inter-Governmental
CICAD	Inter-Parliamentary Commission for Environment and Development	I	Central America	
CIDA	Canadian International Development Agency (Agence Canadienne pour le Développement International)	I	International	
CIDIE	Committee of International Development Institutions on the Environment	I	International	
CIEO	Centre International pour l'Exploitation des Oceans	I	International	
CIESIN	Consortium for International Earth Science Information Network	I	International	
CIFOR	Center for International Forestry Research	I	International	
CIID	(See IDRC)			

CILSS	Permanent Interstate Committee for Drought Control in the Sahelian Zone (Comité Inter-Etats de Lutte Contre la Sécheresse dans le Sahel)	I	International	
CIMMYT	International Maize and Wheat Improvement Centre	I	Inernational	
CIPRA	International Commission for the Protection of Alpine Regions (Commission Internationale pour la Protection des Régions Alpines)	I	International	
CIPREDA	International Centre for Agricultural Investment and Cooperation	I	International	
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora (Convention sur le Commerce International des Espèces de Faune et de Flore Sauvages Manacèes d'Extinction)	C	International	
CLADES	Latin America Centre for Economic and Social Affairs	I	Latin America	UN
CLIMEX	Information Exchange System on Country Activities on Climate Change	T	International	UNFCCC
CLP	Competition Law and Policy Committee	I	International	OECD
CMA	Environmental Management Committee	I	International	IADB
CMAS	Confederation Mondaile des Activites Subaquatiques (World Underwater Federation)	I	International	
CMC	Center for Marine Conservation (formerly Center for Environmental Education)	I	USA	
CMC	See WCMC (formerly Conservation Monitoring Centre of IUCN)			
CMS	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	C	International	
CNF	Canadian Nature Federation	I	Canada	
CNPPA	Commission on National Parks and Protected Areas (Commission des Parcs Nationaux et des Aires Protégées)	I	International	IUCN
CNR	Istituto Technologie Biomediche	I	Italy	
COAC	Commission on Agriculture	I	International	FAO
COADS	Comprehensive Ocean Atmosphere Data Set	T	USA	NOAA
COBSEA	Coordinating Body on the Seas of East Asia	I	International	
CODA	Federation of groups for the Defense of Nature	I	International	
CODATA	Committee on Data for Science and Technology	I	International	ICSU
COE	Commission on Ecology	I	International	IUCN
COFI	Commission on Fisheries	I	International	FAO
COMARIS	Coastal Marine Information System	T	International	
COMSERV	Community Service	I	Internationa	NGO Germany
CONABIO	Mexican Commission on Conservation and Use of Biodiversity	I	Mexico	
CONCOM	Council of Conservation Ministers	I	Australia/New Zealand	
CONPACSE	Coordinated Programme on Marine Pollution Monitoring and Control in the South-East Pacific	P	International	
COPRA	Consortium on Plant resources of the Americas	I	USA	
CORINE	Coordination of Information on the Environment (Coordination des Informations sur L'Environnement)	P	European	EU
COWAR	Committee on Water Research	I	International	ICSU/UITA
CPC	Centre for Plant Conservation	I	International	IUCN
CPDC	Committee on the Participation of Developing Countries	I	International	
CPECN	Permenant Centre for Nature Conservation	I	Belgium	
CPGR	Commission on Plant Genetic Resources	I	International	FAO
CPPS	Comision Permanente del Pacifo Sur (Permanent South Pacific Commission)	I	International	
CPU	Central Processing Unit	T	International	
CRDI	(See IDRC)			
CRMN	Coral Reef Monitoring Network	P	International	CONPACSE
CRMP	Coastal Resources Management Project	P	International	ASEAN

CSD	Commission on Sustainable Development	I	International	IUCN
CSIRO	Commonwealth Science and Industry Research Organisation	I	International	Commonwealth Bureau
CSM	Climate System Monitoring Project	P	International	WMO/WCP
CSMOOE	Centre Scientifique de Monaco Observatoire Européen	I	Monaco	
CSPODP	Canada South Pacific Ocean Development Project	P	International	
CSS	Country Socio-economic Studies	P	International	IADB
CSTD	Centre for Science and Technology for Development	I	International	UN
CSUCA	Confederation of Central American Universities	I	International	
CTFT	Centre Technique Forestier Tropical	I	Tropics	French Government
CUSO	Canadian University Service Overseas	I	International	
CZMS	Coastal Zone Mangement Subgroup	I	International	IPCC
CoE	Council of Europe	I	European	EU
DAC	Development Assistance Committee	I	International	OECD
DAD	Development Assistance Division	I	International	New Zealand Government
DANIDA	Danish International Development Agency (Agence Danoise par le Développement International)	I	Denmark	Government (Dept. International Development)
DB	Database	T	International	
DBMS	Database Management System	T	International	
DC/PAC	Desertification Control, Programme Activity Centre	P	International	UNEP
DDA	Direction de la Cooperation au Developpement et a l'Aide Humanitaire	P		
DDC-AUS	Department for Development Cooperation	I	International	Australian Government
DDE	Dynamic Data Exchange	T	International	
DDL	Data Description Language	T	International	
DELTA	Descriptive Language for Taxonomy	CT	International	
DESCONAP	Research and Training Centres on Desertification Control in Asia and the Pacific	I	International	
DESIS	Desertification Information System	T	International	
DGCS	Direzzione Generale Di Coperazione Allo Svilluppo	I	International	Italian Government
DGF	General Forest Directorate	I	Central America	
DGIS	Directorate General for International Cooperation	I	International	Netherlands Government
DICE	Durrell Institute of Conservation and Ecology	I	International	University of Kent UK
DIESA	Department of International Economic and Social Affairs	I	International	UN
DIF	Data Interchange Format	T	International	
DIVERSITAS	Programme on Biological Diversity	I	International	IUBS/SCOPE/UNESCO
DJPHPA	Directorate General Forest Protection and Nature Conservation	I	Indonesia	Government
DMA	Defense Mapping Agency	I	USA	Government
DOF	Danish Ornithological Society	I	Denmark	
DOS	Disk Operating System	CT	International	
DPCSD	Department for Policy Coordination and Sustainable Development	I	International	UN
DSA	Daily Subsistence Allowance	M	International	
DSE	German Foundation for International Development	I	International	
DSIR	Department of Scientific and Industrial Research	I	New Zealand	Government
DTCD	Department of Technical Cooperation for Development	I	International	UN
E-R	Entity-Relationship	T	International	
E-mail	Electronic Mail	T	International	
EAERE	European Association of Environmental and Resource Economists	I	International	
EAH	East African Herbarium	I	Kenya/East Africa	

EANHS	East Africa Natural History Society	I	Kenya/East Africa	
EAP	Environmental Action Plan	M		
EARO	Eastern Africa Regional Office Délégation Régionale pour L'Afrique de L'Est)	I	East Africa	IUCN
EAWLS	East African Wildlife Society	I	East Africa	
EBA	Endemic Bird Area	T	International	BLI
EBCD	European Bureau for Conservation and Development	I	International	
ECA	Economic Commission for Africa (Commission Économique pour L'Afrique)	I	Africa	UN
ECAFE	Economic Commission for Asia and the Far East	I	International	UN
ECB	Environment Coordination Board	I	International	UN
ECDIN	Environmental Chemicals Data and Information Network	P		EU
ECE	Economic Commission for Europe (Commission Économique pour L'Europe)	I	International	
ECG	Ecosystem Conservation Group	I		
ECLAC	Economic Commission for Latin America and the Caribbean (Commission Économique pour L'Amérique Latine et les Caraibes)	I	International	UN
ECLO	Emergency Centre for Locust Operations	I	International	FAO
ECN	Environmental Change Network	P	UK	NERC
ECNC	European Centre for Nature Conservation	I	International	
ECO/OPS	Pan-American Centre for Human Ecology and Health	I	USA	
ECOWAS	Economic Commission of West African States	I	International	UN
ECR	Edge/core Ratio	T		
EDC	Environmental Data Centre	I	International	
EDF	Environmental Defense Fund	I	USA	
EDF	European Development Fund (Fonds Européen de Développement)	I	International	
EDI	Economic Development Insitute	I	International	
EDWIN	Environment and Development Wetland Information Network	I	International	
EE	Earthwatch Europe	I	International	UNEP
EEA	European Environment Agency	I	International	EU
EEB	European Environmental Bureau (Bureau Européen de L'Environnement)	I	International	
EEC	European Economic Community (Now EU)	I	Europe	
EEP	East European Programme	P	East European	IUCN
EEP	Environmental Education Programme	P	International	
EETU	Environmental Education and Training Unit	P	International	UNEP
EFZ	Ecofloristic Zone	T		
EIA	Environmental Impact Assessment (Etude D'Impact Sur L'Environnement)	T	International	
EIMU	Environmental Information Management Unit	I	International	
EIS	Environmental Information System	T	International	
EIS	Environmental Information System Network for Sub-Saharan Africa	I	Sub-Saharan Africa	
ELADA 21	Electronic Atlas of Agenda 21	CT	International	IDRC, CCRS
ELAN	Environment in Latin-America Network	P	International	
ELC	Environmental Law Centre (Centre du Droit de L'Environnement)	I	International	IUCN
ELCI	Environment Liason Centre International	I	International	
ELIPAC	Environmental Law and Institutions Programme Activity Centre	P	International	UNEP
ELIS	Environmntal Law Information System (Système D'Information sur le Droit de L'Environnement)	T	International	
EMEP	Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe	P	European	UN ECE

EMP	Environmental Management Plan	M		
EN	English Nature	I	UK	Government
ENC	Elsa Nature Conservancy	I	Japan	
ENCORE	Environmental Coastal Resources	P	Caribbean	OECS
ENVIS	Environmental Information System	T	International	IBRD
EOP	Earth Observation Programmes	P	International	CEC/ESA
EORCU	European Ozone Research Coordinating Unit	I	Europe	
EOSDIS	Earth Observing System Data and Information System	T	USA	NASA
EPA	Environmental Protection Agency	I	USA	Government
EPA	Environmental Protection Agency	I	USA	Government
EPOC	ESCAP Pacific Operations Centre	I	International	ESCAP
EPOC	Environment Protection Policy	P	International	OECD
ERDAS	GIS software package	CT	International	
ERIN	Environmental Resource Information Network	I	Austrailia	Government
ERIS	Environmental Resources Information System	T	International	ERIN
EROS	Earth Resources Observation System	T	USA	USGS
ERP	Economic Recovery Programme	M		
ERSDAC	Earth Resources Data Analysis Centre	I	Japan	
ESA	European Space Agency	I	Europe	
ESAC	Environmental Studies Association of Canada	I	Canada	
ESCAP	Economic and Social Commission for Asia and the Pacific	I	International	UN
ESCWA	Economic and Social Commission for Western Asia	I	International	UN
ESCWA	Economic and Social Commission for Western Asia	I	International	UN
ESDD	Earth Science Data Dictionary	T	International	USGS
ESF	European Science Foundation	I	European	
ESP	Endangered Species Programme	P	International	ANCA
ESRI	Environmental Systems Research Institute Inc.	I	USA	
ESU	Endangered Species Unit	I	International	ANCA
ETFRN	European Tropical Forest Research Network	P	International	
ETI	Expert Centre for Taxonomic Identification	I	International	
ETN	Regional Environmental Training Network for Latin America and the Caribbean, Asia, the Pacific and Africa	I	International	
EU	European Union (Union Européenne)	I	International	
EUREKA	Eureka Environmental Projects	P	International	EU
EURING	European Union for Bird Ringing	I	International	
EUROTRAC	European Experiment on Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere over Europe	P	International	
EURYSN	European Youth Science Network	I	International	
FAO	Food and Agriculture Organization (Organisation des Nations unies pour L'Alimentation et L'Agriculture)	I	International	UN
FAQ	Frequently Asked Questions	M		
FARN	Environment and Natural Resources Foundation	I	Argentina	
FBCN	Brazilian Foundation for the Conservation of Nature	I	Brazil	
FDA	Forest Development Authority	M		
FDES	Framework for the Development of Environmental Statistics	P		

FEC	Federal Economic Chamber	I	International	Australian Government
FECOMEX	Mexican Conservation Federation (Federación Conservacionista Mexicana)	I	Mexico	
FEDCHAN	Federal Chancellery	I	International	Australian Government
FEN Colombia	José Celestino Mutis Foundation for Protection of the Environment in Colombia	I	Colombia	
FES	Friedrich Ebert Foundation	I	International	NGO Germany
FFPS	Fauna and Flora Preservation Society	I	International	
FFTC	Food and Fertilizer Technology Centre for Asia & the Pacific	I	International	Inter-Governmental
FIIT	Interamerican Foundation for Tropical Research	I	Americas	
FINNIDA	Finnish International Development Agency (Agence Finlandaise pour le Developpement International)	I	Finland	Government
FMA	Foundation for a Better Environment	I	Colombia	
FNF	Friedrich Naumann Foundation	I	International	NGO Germany
FNNPE	Federation of Nature and National Parks of Europe (Fédération Européenne des Parcs Naturels et Nationaux)	I	International	
FOD	Field Operations Division	I	International	IUCN
FORIS	Forest Resources Information System 1990	T	International	FAO
FOWCIS	Forest and Wildlands Conservation Information System	T	International	FAO
FRA	Forest Resource Accounting	T	International	
FRA	Forest Resources Assessment 1990 Project	P	International	
FRIEND	Flow Regimes from International Experimental and Network Data	T	International	IHP/UNESCO
FRP	Forest Response Programme	P	USA	
FSC	Forest Stewardship Council	I	Mexico	
FTPP	Forest, Trees and People Programme	P	International	FAO/RDC
FUNATURA	Fundacao Pro Natureza	I	Brazil	
FUNDAMAT	Chiapas Foundation for the Management of Tropical Areas	I	Mexico	
FZGGBI	Federation of Zoological Gardens of Great Britain and Ireland	I	UK	
FZS	Frankfurt Zoological Society	I	Germany	
FoEI	Friends of the Earth International	I	International	
GAIM	Global Analysis, Interpretation and Modelling	T	International	IGBP
GAW	Global Atmosphere Watch	I	International	WMO
GAW-GO3OS	Global Atmosphere Watch Global Ozone Observing System	T	International	
GBS	Global Biodiversity Strategy	P	International	
GCDIS	Global Change Data and Information System	T	USA	Government
GCDP	Global Change Database Project	P	International	
GCM	General Circulation Model	T	International	
GCMD	Global Change Master Directory	T	International	NASA
GCRP	Global Change Research Programme	P	International	
GCTE	Global Change and Terrestrial Ecosystems	T	International	IGBP
GDP	Gross Domestic Product	M		
GDPP	Global Database Planning Project	P	International	
GED	Global Ecosystems Database	T	International	EPA (USA)
GEE	Group of Economic Experts	I	International	OECD
GEENET	Global Environmental Epidemiology Network	P	International	WHO
GEF	Global Environment Facility (Fonds pour L'Environnement Mondial)	I	International	IBRD

GEMS	Global Environment Monitoring System (Système Mondial de Surveillance Continue de L'Environnement)	P	International	UNEP
GEMS/AIR	Global Environment Monitoring System Urban Air Quality Monitoring Project	P	International	UNEP
GEMS/Food	GEMS Food Contamination Monitoring Project	P	International	UNEP
GEMS/HEAL	GEMS Human Exposure Assessment Location Project	P	International	UNEP
GEMS/IBM	GEMS Integrated Background Monitoring	P	International	UNEP
GEMS/PAC	GEMS Programme Activity Centre	P	International	UNEP
GEMS/WATER	GEMS Assessment of Water Quality	P	International	UNEP
GENIE	Global Environmental Network Information Exchange	P	UK	MRRL
GER	Global Environmental Research	P	UK	
GERMON	Global Environmental Radiation Monitoring Network	P	International	UNEP/GEMS/WHO
GETF	Global Environment Trust Fund	P	International	GEF
GEWEX	Global Energy and Water Cycle Experiment	P	International	WCRP
GFCM	General Fisheries Council of the Mediterranean	I	International	FAO
GIAS	Global Integration and Synthesis	P	International	IGBP
GIFAP	International Group of National Associations of Agrochemical Manufacturers	I	International	
GIM	Global Integrated Monitoring	P	International	UNEP
GIM SITES	Global Integrated Monitoring Sites Database	T	International	
GIPME	Global Investigation of Pollution in the Marine Environment (Etude Mondiale de la Pollution dans le Milieu Marin)	P	International	IOC
GIS	Geographical Information System (Système D'Information Géographique)	T	International	
GLIS	Global Land Information System	T		
GLOSS	Global Sea Level Observing System	T	International	UNESCO/ IOC
GMCC	Geophysical Monitoring for Climatic Change	P	USA	US NOAA
GNIP	Global Network Isotopes in Precipitation	P	International	IAEA
GOES	Global Omnibus Environmental Survey	P	International	CIESIN
GONHS	Gibraltar Ornithological and Natural History Society	I	Gibraltar	
GOOS	Global Ocean Observing System	T	International	UNESCO/ IOC
GPCC	Global Precipitation Climatology Centre	I	International	WMO/German Weather Service
GPCP	Global Precipitation Climatology Project	P	International	
GPS	Global Positioning System	T	International	
GRDC	Global Run-off Data Centre	I	International	
GRID	Global Resource Information Database (Base de Données sur les Ressources Mondiales	I	International	UNEP/GEMS
GRID/PAC	Global Resource Information Database, Programme Activity Centre	P	International	UNEP
GTN	US Global Trends Network	P	USA	
GTOS	Global Terrestrial Observing System	T	International	UNESCO/UNEP/FAO/WMO/ICSU
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)	I	International	German Federal Government
GUI	Graphical User Interface	T	International	
GWS	George Wright Society	I	USA	
HDGECP	Human Dimensions of Global Environmental Change Programme	P	International	
HDP	Human Dimensions of Global Change	P	International	IGBP
HEALs	Human Exposure Assessment Locations	P	Interantional	WHO/UNEP
HELVETAS	Swiss Development Agency	I	International	Government
HEM	Harmonization of Environmental Measurement	P	International	UNEP
HIID	Harvard Institute for International Development	I	International	Harvard University

I-GOOS	IOC Committee for Global Ocean Observing System	I	International	
IABG	International Association of Botanic Gardens	I	International	
IAEA	International Atomic Energy Agency (Agence International de L'Énergie Atomique)	I	International	
IAHS	International Association of Hydrological Sciences	I	International	
IAPT	International Association of Plant Taxonomists	I	International	
IASC	International Arctic Science Commission	I	International	
IBA	Important Bird Area	T	International	BLI
IBAMA	Brazilian Institute for Environment and Renewable Natural Resources	I	International	
IBM	International Business Machines	CT	International	
IBN	Indigenous Biodiversity Network	P	International	
IBP	International Biological Programme	I	International	
IBPGR	(see IPGRI)	I	International	
IBRD	International Bank for Reconstruction and Development (World Bank) (Banque Internationale pour la Reconstruction et le Développement)	I	International	
ICAIR	International Centre for Antarctic Information and Research	I	International	
ICALPE	International Center for Alpine Environments (Centre International pour L'Environnement Alpin)	I	International	
ICARDA	International Center for Agricultural Research in Dry Areas	I	International	
ICASALS	International Center for Arid and Semi-Arid Land Studies	I	International	Texas Technical University USA
ICBN	International Code for Botanical Nomenclature	T	International	
ICC	International Chamber of Commerce	I	International	
ICCBD	Intergovernmental Committee on the Convention on Biological Diversity	I	International	
ICCC	International Convention on Climate Change	C	International	WMO
ICE	International Congress of Ecology	I	International	
ICEL	International Council of Environmental Law (Conseil International Du Droit de L'Environnement	I	International	
ICES	International Council for the Exploration of the Seas	I	International	
ICESD	Intergovernment Committee on Ecologically Sustainable Development	I	International	
ICFP	International Conservation Financing Project	P	International	WRI
ICGEB	International Centre for Genetic Engineering and Biotechnology	I	International	
ICGWC	International Council for Game and Wildlife Conservation	I	International	
ICID	International Commission on Irrigation and Drainage	I	International	
ICIMOD	International Centre for Integrated Mountain Development (Centre International de Mise en Valeur Intégrée des Montagnes)	I	International	
ICLARM	International Center for Living Aquatic Resources Management	I	International	
ICLEI	International Council for Local Environmental Initiatives	I	International	
ICNB	International Code of Nomenclature of Bacteriology			
ICOD	International Centre for Ocean Development (Now closed - 1992)	I	International	
ICOMOS	International Council for Monuments and Sites (Conseil International des Monuments et Sites)	I	International	
ICONA	National Institute for the Conservation of Nature	I	Spain	
ICPL	International Centre for Protected Landscapes	I	International	
ICRAF	International Centre for Research in Agroforestry	I	International	CGIAR
ICRISAT	International Crops Research Institute for Semi-Arid Tropics	I	International	CGIAR
ICRW	International Convention for the Regulation of Whaling	C	International	
ICSU	International Council of Scientific Unions (Conseil International des Unions Scientifiques)	I	International	
IDA	International Development Association	I	International	IBRD
IDB	Inter-American Development Bank (Banque Inter-Américaine de Développement)	I	International	

IDB	Inter-American Development Bank	I	Central/South America	
IDB	Islamic Development Bank	I	Middle East/North Africa	
IDRC	International Development Research Centre (Or CIID,CRDI)	I	International	
IDRISI	GIS package	CT	International	
IDRISI	International Development and Research Information System	T	International	IDRC
IE/PAC	Industry and Environment Programme Activity Centre	I	International	UNEP
IEA	International Energy Agency	I	International	OECD
IEA	International Environment Assistance	I	International	
IEAME	Institute of Evolutionary Animal Morphology and Ecology	I	Russia	Russian Academy of Sciences
IEB	International Environmental Bureau	I	International	ICC
IEC	(See SME)			
IEC	International Electro-technical Committee	I		
IEDS	International Environment and Development Service	P	International	USAID/WEC
IEEP	International Environmental Education Programme	P	International	UNEP/UNESCO
IEF	International Environment Facility	I	International	
IEP	Industry and Environment Office	I	International	IUCN
IETC	International Environment Technology Centre	I	International	
IFAD	International Fund for Agricultural Development	I	International	UN
IFC	International Finances Corporation	I	International	IBRD
IFTF	International Fur Trade Federation (Fédération Internationale du Commerce de la Fourrure)	I	International	
IGADD	Intergovernmental Authority on Drought and Development	I	International	
IGBP	International Geosphere-Biopshere Programme	P	International	ICSU
IGBP-DIS	International Geosphere-Biopshere Programme - Data and Information System	T	International	IGBP
IGF	International Foundation for the Conservation of Game	I	International	
IGOSS	Integrated Global Ocean Services System	T	International	
IHP	International Hydrological Programme	P	International	UNESCO
IIASA	International Institute for Applied Systems Analysis	I	International	
IICA	Inter-American Institute for Co-operation on Agriculture	I	International	
IIED	International Institute for Environment and Development			
	(Institut International de L'Environnement et du Développement)	I	International	
IITA	International Institute for Tropical Agriculture	I	International	CGIAR
IITF	International Institute of Tropical Forestry	I	International	USDA
ILDIS	International Legume Database and Information Service	T	UK	
ILEC	International Lake Environment Committee	I	International	
ILPC	International League for the Protection of Cetaceans	I	International	
ILWIS	Integrated Land and Watershed Management Information System	CT	International	
IMBDC	International Marine Biodiversity Development Corporation	I	International	
IMCO	Inter-Governmental Maritime Consultative Organisation	I	International	
IMF	International Monetary Fund	I	International	
IMO	International Maritime Organization (Organisation Maritime Internationale)	I	International	
IMP	International Pilot Programme on Integrated Monitoring	P	International	
INBio	National Biodiversity Institute of Costa Rica	I	Costa Rica	
INENCO	Centre for International Environmental Cooperation	I	Russia	
INFOCLIMA	Climate Data Referral System	T	International	WMO

INFOTERRA	International Environmental Information System of UNEP (Système International D'Information sur L'Environnement	T	International	UNEP
INSONA	International Society of Naturalists	I	International	
INSTAT	Institut National de Sciences Appliques Toulouse	I	International	French Government
INTECOL	International Association for Ecology (Association Internationale D'Écologie)	I	International	
INTERAISE	International Environmental and Natural Resources Assessment Information Service (Service International D'Information sur L'Évaluation de L'Environnement et des Ressources Naturelles)	T	International	
IOC	Intergovernmental Oceanographic Commission (Commission Océanographique Intergouvernmental)	I	International	UNESCO/FAO/IMO
IOCARIBE	IOC Regional Subcommission for the Caribbean and Adjacent Regions	I	International	IOC
IODE	International Oceanographic Data and Information Exchange	T	International	IOC
IOPI	International Organization for Plant Information	I	International	
IP	Internet Protocol	T	International	
IPCC	Intergovernmental Panel on Climate Change (Groupe D'Experts Intergouvernmental sur L'Évolution du Climat)	I	International	WMO/UNEP
IPCS	International Programme on Chemical Saftey	P	International	
IPF	Indigenous Peoples Fund	P	International	
IPGRI	International Plant Genetics Resources Institute (formerly IBPGR) (Conseil International pour les Ressources Phyogénétiques)	I	International	CGIAR
IPIECA	International Petroleum Industry Environmental Conservation Association	I		
IPPL	International Primate Protection League	I	International	
IPS	International Primatological Society	I	International	
IPT	Asian Wetland Bureau	I	Asia	
IRD	Information Network on Integrated Rural Development	P	International	
IRDC	International Rural Development Centre	I	International	
IRDS	Information Resources Dictionary System	T		
IRF	Island Resources Foundation	I	Caribbean	
IRMC	Integrated Resource Mapping Centre	I	International	
IRPTC	International Register on Potentially Toxic Chemicals	T	International	UNEP
IRPTC/PAC	International Register for Potentially Toxic Chemicals Programme	P	International	UNEP
IRTI	Islamic Research and Training Institute	I	International	
ISAAA	International Service for the Aquisition of Agro-biotech Applications	I	International	
ISBN	International Standard Book Number	T	International	
ISEC	International Society for Endangered Cats	I	International	
ISESCO	Islamic Educational, Scientific and Cultural Organisation	I	International	
ISIS	GIS package	CT	International	
ISIS	International Species Inventory System	T		
ISKO	International Society for Knowledge Organisation	I	International	
ISLSCP	International Satellite Land Surface Climatology Project	P	International	
ISLT	International Snow Leopard Trust	I	International	
ISO	International Standards Organisation	I	International	
ISRA	International Seabed Resource Authority	I	International	
ITC	International Trade Centre	I	International	
ITC	International Institute for Aerospace Survey and Earth Sciences	I	International	
ITE	Institute of Terrestrial Ecology	I	UK	
ITFC	Institute of Tropical Forest Conservation	I	Uganda	

ITFFR	International Task Force on Forestry Research	I	International	Rockefeller Foundation/UNDP/IBRD/FAO
ITTA	International Tropical Timber Agreement	C	International	
ITTC	International Tropical Timber Council	I	International	
ITTO	International Tropical Timber Organization (Organisation Internationale es Bios Tropicaux)	I	International	
IUBS	International Union of Biological Sciences	I	International	
IUCN	International Union for the Conservation of Nature - The World Conservation Union	I	International	
IUDZG	International Union of Directors of Zoological Gardens/World Zoo Organization (Internationale des Directeurs de Jardins Zoologiques)	I	International	
IUFRO	International Union of Forestry Research Organisations (Union Internationale des Instituts de Recherches Forestières)	I	International	
IUPN	International Union for the Protection of Nature	I	International	
IWC	International Whaling Commission (Commission Baleinière Internationale)	I	International	
IWGDMGC	International Working Group on Data Management for Global Change	I	International	
IWRB	International Waterfowl and Wetlands Research Bureau (Bureau Internationale de Recherches sur les Oiseaux D'Eau et les Zones Humides	I	International	
IYF	International Youth Federation (Fédération International de la Jeunesse)	I	International	
IZCN	Zaire Institute of Conservation and Nature	I	Zaire	
IZCN	Institut Zairos pour la Conservation de a Nature	I	Africa	
IZE	International Association of Zoo Educators	I	International	
JAMBA	Japan-Australia Migratory Birds Agreement	C	International	
JATAN	Japan Tropical Forest Action Network	I	Japan	
JCMCWY	Jeunesse Canada Monde/Canada World Youth	I	International	
JICA	Japanese International Cooperation Agency	I	International	Government
JNCC	Joint Nature Conservation Committee	I	UK	Government
JOCV	Japan Overseas Cooperation Volunteers	I	International	Government
JODA	Japanese Overseas Development Agency	I	International	Government
JODC	Japan Ocean Data Centre	I	Japan	
JWPT	Jersey Wildlife Preservation Trust	I	International	
JWRC	Japan Wildlife Research Centre	I	Japan	
KAF	Konrad Adenauer Foundation	I	International	NGO Germany
KENRIK	Kenya Resource Centre for Indigenous Knowledge	I	Kenya	NMK
KFW	Kreditanstallt fur Wiederaufbau	I	International	
KKC	Marine Parks Centre of Japan	I	Japan	
LAC	Local Area Coverage	M		
LACCDE	Latin American and Caribbean Commission on Development and Environment	I	International	
LAN	Local Area Network	T	International	
LANDSAT MSS/ TMLANDSAT	Satellite Multi-spectral Scanner/Thematic mapper	T		
LBRI	Lake Biwa Research Institute	I	International	
LIPI	Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia)	I	Indonesia	
LMU	Land Mapping Units	T	International	
LQ	Land Quality	T	International	
LTER	US Long-term Ecological Research	P	USA	
LUCID	Land Use Classification Information and Documentation	T		
LUR	Land Use Requirements	T	International	

LUT	Land Utilisation Types	T	International	
LVBW	Dutch Society for the Preservation of the Waddensea	I	The Netherlands	
MAB	Man and the Biosphere Programme (Programme pour L'Homme et la Biosphère)	P	International	UNESCO
MAP	Mediterranean Action Plan	P	International	UNEP Regional Seas
MARC	Monitoring and Assessment Research Centre	I	International	UNEP/GEMS
MARPOL	Convention for the Prevention of Pollution from Ships	C	International	
MBG	Missouri Botanic Garden	I	USA	
MDB	Multilateral Development Bank	I	International	
MED POL	Mediterranean Action Plan Pollution Monitoring and Research Programme	P	International	MAP
MEDIAS	Regional Research Network for the Mediterranean Basin and Sub-Tropical Africa	P	Mediterranean/Sub-Trop. Africa	
MEDU	Coordinating Unit for MAP	P	International	UNEP
MIGA	Multilateral Investment Guarantee Agency	I	International	IBRD
MIRENEM	Ministry of Natural Resources, Energ, and Mines	I	Cost Rica	
MPA	Marine Protected Area	T	International	
MRRL	Midlands Regional Research Laboratory	I	UK	
MSDN	Microbial Strain Data Network	I	International	
MUIENR	Makerere University Institute of Environment and Natural Resources	I	Uganda	
MVP	Minimum Viable Population	M		
NAS	National Audubon Society	I	USA	
NASA	National Aeronautics and Space Administration	I	USA	Government
NASA DIF	NASA Directory Interchange Format	T	International	NASA
NATO	North Atlantic Treaty Organization	I	International	
NBDB	National Biodiversity Data Bank	P	Uganda	MUIENR
NBU	National Biodiversity Unit	I	International	
NCA	Norwegian Church Aid	I	International	
NCDS	NASA Climate Data System	T	USA	Government
NCNC	National Committee on Nature Conservation	I	Japan	Science Council of Japan
NCS	National Conservation Strategy (Stratégie Nationale de Conservation)	C	International	IUCN
NCWCD	National Commission for Wildlife Conservation and Development	I	Saudia Arabia	
NEAP	National Environmental Action Plan/Programme	M		
NEIC	National Environment Information Centre	I	Uganda	Government
NEMC	National Environment Management Council	I	Tanzania	
NERC	Natural Environment Research Council	I	UK	Government
NES	National Environment Secretariat	I	Kenya	
NESDA	Network for Environment and Sustainable Development In Africa	I	Africa	
NESDD	NOAA Earth Science Data Directory	T	International	
NETT	Network for Environmental Technology Transfer	P	International	EU
NFC	National Focal Committee	I		INFOTERRA
NGO	Non-Governmental Organisation (Organisation Non-Gouvernmentale)	T	International	
NGS	National Geographic Society	I	USA	
NHM	Natural History Museum (formerly BMNH)	I	UK	
NMK	National Museums of Kenya	I	Kenya	
NOAA	National Oceanic and Atmospheric Administration	I	USA	Government
NODS	NASA Ocean Data System	T	USA	Government

NORAD	Norwegian International Development Agency (Agence Norvégienne pour le Développement International)	I	International	Government
NORAGRIC	Norwegian Center for International Agricultural Development	I	Norway	Agricultural University of Norway
NRDC	Natural Resources Defense Council	I	USA	
NRI	Natural Resources Institute (formerly ODNRI)	I	UK	
NRPTC	National Register for Potentially Toxic Chemicals	T	International	
NSCN	Norwegian Society for the Conservation of Nature (Noisk Natwiveinforbund)	I	Norway	
NSDS	National Sustainable Development Strategy	M		
NSPB	Netherlands Society for the Protection of Birds (Nederlandse Vereniging tot Bescheiming van Vogels)	I	The Netherlands	
NWF	National Wildlife Federation	I	International	
NWRI	National Water Resources Institute	I	International	
NYZS	New York Zoological Society	I	USA	
OAS	Organization of American States (Organisation des Etats Américains)	I	USA	
OAU	Organization of African Unity (Organisation de L'Unité Africaine)	I	Africa	
OCA	Ocean and Coastal Areas Programme	P	International	UNEP
OCR	Optical Character Recognition	T	International	
ODA	Overseas Development Administration	I	United Kingdom	Government
OECD	Organisation for Economic Co-operation and Development (Organisation de Coopération et de Développement Économiques)	I	International	
OECF	The Overseas Economic Cooperation Fund for Japan Government	I	International	Government
OFI	Oxford Forestry Institute	I	UK	
OLE	Object Linking or Embedding	T	International	
ONF	French National Forestry Office	I	France & Territories	Government
ONF	Office National Des Forets	I	France and Territories	Government
OO	Object Oriented	T	International	
OPTIMA	Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area	I	International	
ORSTOM	Institut Francais de Recherche Scientifique pour le Développement en Coopération (Scientific Research Institute for Cooperation in Development)	I	France	
OSME	Ornithological Society of the Middle East	I	Middle East	
OTP	Ozone Trends Panel	P		
OTS	Organisation for Tropical Studies	I	USA	
PA	Protected Area	T	International	
PADCO	Planning and Development Collaborative International	I	International	
PADU	Protected Areas Data Unit	I	International	WCMC
PAG	Plant Advisory Group	I	International	IUCN/WWF
PAHO	Pan American Health Organization	I	International	OAS
PAI	Perimeter Area Index	T	International	
PAP/RAC	Priority Activity Centre for Regional Actions Programmes	P	International	
PAWB	Protected Areas and Wildlife Bureau	I	Philippines	
PC	Personal Computer	T	International	
PFE	Permenant Forest Estate	M		
PHVA	Population and Habitat Viability Assessment (Evaluation de la Viabilité des Populations et des Habitats)	T	International	
PIPOR	Programme of International Polar Oceans Research	P	International	

PISP	Polar Ice Sheet Programme	P	International	
PNRP	Pollution and Natural Resources Programme	P	International	
PNUD	See UNDP			
PNUE	Programme des Nations Unies pour l'Environment	P	International	UN
PRA	Participatory Rural Appraisal	T	International	
PROSPECT	Programme Retrieval of Species by the Property and End-Use Classification of Their Timbers	T	UK	OFI
PSA	Pacific Science Association	I	International	
PTES	Peoples Trust for Endangered Species	I	International	
PVA	Population Viability Analysis	T	International	
QLF	Quebec Labrador Foundation	I	Canada	
RAISON	GIS package	CT	International	
RAM	Random Access Memory	T	International	
RAMSAR	Convention on Wetlands of International Importance Especially as a Waterfowl Habitat (Ramsar Convention)	C	International	RCB
RAPA	Regional Office for Asia and the Pacific	I	International	FAO
RBG#Kew	Royal Botanic Gardens, Kew	I	UK	
RBGE	Royal Botanic Garden of Edinburgh	I	UK	
RCB	Ramsar Convention Bureau	I	International	IWRB
RCS	Rainforest Conservation Society	I	Australia	
RDBMS	Relational Database Management System	T	International	
REDSUR	Sustainable Development Network	P	South America	UNDP
REED	Refferal Database on Energy and Environment	T	International	UNIDO
REMCO	Reference Materials Committee	I		ISO
REMERFI	Mesoamerican Plant Genetic Resources Institute	I	Central America	
RENPAP	Regional Network on the Production, Marketing and Control of Pesticides for Asia and the Pacific	I	International	
RESL	Royal Entomological Society of London	I	International	
RIJENT	Rijksuniversteit Institute	I	International	Belgian Government
ROA	Regional Office for Africa	P	Africa	UNEP
ROAP	Regional Office for Asia and the Pacific	P	Asia	UNEP
ROCAP	Regional Office for Central American Programme	I	Honduras	USAID
ROE	Regional Office for Europe	P	Europe	UNEP
ROLAC	Regional Office for Latin America and the Caribbean	P	Latin America	UNEP
ROM	Read Only Memory	T	International	
ROPME	Regional Organization for the Protection of the Marine Environment	I	Arabian Gulf	
ROSA	Regional Office for Southern Africa (Délégation Régionale pour L'Afrique Australe)	I	International	IUCN
ROSTSEA	Regional Office for Science and Technology for South East Asia	I	International	
ROWA	Regional Office for West Asia	P	West Asia	UNEP
RS	The Royal Society	I	UK	
RSAS	Royal Swedish Academy of Sciences	I	Sweden	
RSPB	Royal Scoiety for the Preservation of Birds	I	UK	
RSPB	Royal Society for the Protection of Birds	I	International	
SAARC	South East Asia Association for Regional Cooperation	I	South East Asia	
SACBP	Scientific Advisory Committee on Biological Diversity	I	International	
SACEP	South Asia Cooperative Environment Programme	P	South Asia	
SACTEMA	Scientific Advisory Committee for Terrestrial Ecosystems Monitoring and Assessment	I	International	UNEP

SADC	Southern Africa Development Community (Communité de L'Afrique Australe pour le Développement)	I	Southern Africa	
SANW	(See SAS)			
SARD	Swedish Agency Research Cooperation with Developing Countries	I	Sweden	
SAS	Swiss Academy of Natural Sciences	I	Switzerland	Government
SASIN	South African Sub-regional INFOTERRA Network	P	International	UNEP
SBP	Brazilian Landscape Association	I	Brazil	
SC	Sierra Club	I	International	
SCAR	Scientific Committee on Antarctic Research (Comité Scientifique pour la Recherche Antarctique	I	International	ICSU
SCB	Society for Conservation Biology	I	International	
SCI	Science Citation Index	T	International	
SCOPE	Scientific Committee on Problems of the Environment (Comité Scientifique pour les Problèmes de L'Environnement)	I	International	ICSU
SCOR	Scientific Committee on Oceanic Research	I	International	ICSU
SCP	Species Conservation Programme	P	International	SSC
SDC	Swiss Development Corporation	I	International	
SDC	Swiss Development Cooperation	I	International	Government
SEAMEO	South-East Asian Ministers of Education	I	South-East Asia	Inter-Governmental
SEAN	Scientific Event Alert Network	I	International	SI
SEC	(See SNM)			
SEH	Societas Europaea Herpetologica	I	International	
SEI	Stockholm Environment Institute	I	International	
SEL	Societas Europaea Lepidopterologica (European Lepidopterological Society)	I	International	
SFDE	Societe Francaise pour le Droit de l'Environnement (French Society for Environmental Law)	I	France	
SFU	(See CDS)			
SI	Smithsonian Institution	I	USA	
SIAP	Statistical Institute for Asia and the Pacific	I	International	UN
SIDA	Swedish International Development Authority (Styrelsen For Internationell Utveckling) (Autorité Suédoise pour le Développement International)	I	International	Government
SIL	Societas Internationalis Limnologiae Theoreticae et Applicatae (International Association of Theoretical and Applied Limnology)	I	International	
SL	(See FANC)			
SME	Stitching Milieu-Educatie (Institute for Environmental Education)	I	The Netherlands	
SNM	Stitching Natuur en Milieu (The Netherlands Society for Nature & Environment)	I	The Netherlands	
SOF	Svergies Ornitologiska Forening (Swedish Ornithological Society)	I	Sweden	
SOTER	Soil and Terrain Database	T		
SPC	South Pacific Commission	I	International	
SPOT	Systeme Probatoire d'Observation de la Terre	T	International	
SPREP	South Pacific Regional Environment Programme (Programme Régional Océanien de L'Environnement)	P	International	UNEP
SPRI	Scott Polar Research Institute	I	UK	
SQL	Structured Query Language	T	International	
SSC	Species Survival Commission (Commission de la Sauvegarde des Espèces)	I	International	IUCN
SSC	Settlement Study Centre	I	International	Israeli Government
STC	Save the Children - Norway	I	International	

STRI	Smithsonian Tropical Research Institute	I	International	SI
SUD	Sanitation and Urban Development Division	I	International	IADB
SUR	Regional Office for South America (Délégation Régionale pour L'Amerique du Sud)	I	South America	IUCN
SWMTEP	System Wide Medium Term Environment Programme	P	International	
TCDC	Technological Cooperation Among Developing Countries	P	International	
TCP	Tropical Conservation Programme	P	International	Wild Wings & Underhill Foundations
TCP	Transmission Control Protocol	T	International	
TDB	Trade and Development Board	I	International	UN
TDWG	Taxonomic Databases Working Group	I	International	
TEB	Terrestrial Ecosystems Branch	I	International	UNEP
TECCONILE	Technical Cooperation Committee for the Promotion, Development and Environmental Protection of the Nile Basin	P	International	
TEDIG	GIS package	CT	International	
TFAP	Tropical Forests Action Plan (Plan D'Action Forestier Tropical)	P	International	FAO
TFIS	Tropical Forest Information System	T	International	
TFRG	Tropical Forest Resource Group	I		
TMF	Tropical Moist Forest	M		
TMRU	Tropical Marine Research Unit	I	UK	York University
TNC	The Nature Conservancy	I	International	
TNCIP	The Nature Conservancy International Programme	P	USA	TNC
TOGA	Tropical Ocean Global Atmosphere Programme	P	International	WCRP
TPU	See WCMC (was Threatened Plants Unit of WCMC)			
TRAFFIC	Trade Records Analysis of Flora and Fauna in Commerce (Analyse des Registres du Commerce de la Faune et de la Flore)	I	International	IUCN & WWF
TRD	Tropical Research and Development	P	International	
TREES	Tropical Ecosystem Environment Observation by Satellites (Sometimes Monitoring by Satellite)	I	International	JRC/ISPRA
TRF	Tropical Forests Programme	P	International	IUCN
TTKD	(See TACN)			
TVE	Television Trust for the Environment	I	International	
UN	United Nations	I	International	
UNCDF	United Nations Capital Development Fund	I	International	UN
UNCED	United Nations Conference on Environment and Development (Conférence des Nations Unies sur L'Environnement et la Développement	P	International	UN
UNCEP	United Nations Caribbean Environment Programme	I	International	UN
UNCHS	United Nations Centre for Human Settlements	I	International	UN
UNCRD	United Nations Centre for Regional Development	I	International	UN
UNCSD	United Nations Committee on Sustainable Development	I	International	UN
UNDCP	United Nations International Drug Control Programme	P	International	
UNDP	United Nations Development Programme (Programme des Nations Unies pour le Développement)	P	International	UN
UNECE	United Nations Economic Commission for Europe	I	International	UN
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean	I	International	UN
UNEP	United Nations Environment Programme (Programme des Nations Unies pour L'Environnement)	I	International	UN
UNEP-GRID	See GRID			
UNEPCOM	United Nations Commission of the USSR	I	International	UN

UNESCO	United Nations Educational, Scientific and Cultural Organisation (Organisation des Nations Unies pour L'Education, la Science et la Culture)	I	International	UN
UNESCWA	United Nations Economic and Social Commission for Western Asia	I	International	UN
UNFPA	United Nations Children's Fund	I	International	UN
UNICEF	United Nations Children's Fund	I	International	UN
UNIDO	United Nations Industrial Developement Organisation	I	International	UN
UNIFEM	United Nations Development Fund for Women	I	International	UN
UNITAR	United Nations Institute for Training and Research	I	International	UN
UNPAAERD	United Nations Programme of Action of African Economic Recovery and Development	P	International	UN
UNSIS	United Nations Statistical Information System	T	International	UN
UNSO	United Nations Sundano-Sahelian Office (Bureau des Nations Unies par la Région Soudano Sahélienne)	I	International	UN
UNSTAT	United Nations Statistical Office	I	International	UN
UNV	United Nations Volunteers	I	International	UN
URL	Universal Resource Locator	T	International	
USAID	US Agency for International Development (Agence Américaine pour le Développement International)	I	USA	Government
USDA	US Department of Agriculture	I	USA	Government
USGS	United States Geological Survey	I	International	Government
UTM	Universal Transverse Mercator	T		
VN	(See NSPB)			
VOLCEN	Volcanic Centre	I	International	Israeli Government
VVOB	Viaamse Vereninging Voor opleidingsprogramma's in Buitendland	I	International	Belgian Government
WAIS	Wide Area Information Servers	T	International	
WB	(see IBRD)			
WBDB	World Bird Database	T	UK	BLI
WBSJ	Wild Bird Society of Japan	I	Japan	
WCAP	World Climate Applications Programme	P	International	
WCB-ISEE	World Council for the Biosphere-International Society for Environmental Education	I	International	
WCDP	World Climate Data Programme	P	International	WMO
WCED	World Commission on Environment and Development (Commission Mondiale pour L'Environnement et le Développement)	P	International	Brundtland Commission
WCI	Wildlife Conservation International	I	International	NYZS
WCISP	World Climate Impact Studies Programme	P	International	
WCMC	World Conservation Monitoring Center (Centre Mondial de Surveillance Continue de la Conservation de la Nature)	I	International	UNEP/IUCN/WWF
WCP	World Climate Programme	P	International	
WCRP	World Climate Research Programme	P	International	ICSU/WMO
WCS	World Conservation Strategy (Statégie Mondiale de la Conservation)	C	International	IUCN/WWF/UNEP
WDC	World Data Centre	I	International	ICSU
WDCGG	World Data Centre for Greenhouse Gases	T	International	ICSU
WDCM	World Data Centre for Collections of Microorganisms	T	International	ICSU
WDDES	World Digital Data for the Environmental Sciences	T	International	
WEAP	World Environment Action Plan	P	International	
WEC	World Environment Centers	I	International	
WFC	World Food Council	I	International	UN

WFCC	World Federation for Culture Collections	T	International	
WFP	World Food Programme	I	International	
WGCCD	Working Group on Climate Change Detection	I	International	WMO
WHC	World Heritage Convention	C	International	UNESCO
WHO	World Health Organization (Organisation Mondiale de la Santé)	I	International	UN
WILD	International Wilderness Leadership Foundation/ Wild Foundation	I	International	
WIPO	World Intellectual Property Organization	I	International	UN
WMI	Wildlife Management Institute	I	International	
WMO	World Meteorological Organization (Organisation Métérologique Mondiale)	I	International	UN
WODC	World Ozone Data Centre	I	International	ICSU
WORLDCON	World Concern	I	International	Netherlands Government
WPTI	Wildlife Preservation Trust International	I	International	Jersey Wildlife Preservation Trust
WRI	World Resources Institute (Institut Mondial des Ressources)	I	International	
WS	Wildlife Society	I	International	
WSPA	World Society for Protection of Animals	I	International	
WTMU	See WCMC (was Wildlife Trade Monitoring Unit)			
WTO	World Tourism Organisation (Organisation Mondiale du Tourisme)	I	International	
WWF	World Wide Fund for Nature/ World Wildlife Fund (in USA, Australia and Canada) (Fonds Mondial pour la Nature)	I	International	
WWW	World Weather Watch Programme	P	International	WMO
WWW	World Wide Web	T	International	
ZGF	(See FZS)			
ZOA-NET	Zoa Care-Netherlands	I	International	

8.4 Glossary

8.4.1 Biodiversity Terms

Accession. A sample of a crop variety collected at a specific location and time; may be of any size.

Alien species. A species occurring in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities. (Also known as an exotic or introduced species).

Artificial insemination. A breeding technique, commonly used in domestic animals, in which semen is introduced into the female reproductive tract by artificial means.

Assemblage. *See* "Community."

Biochemical analysis. The analysis of proteins or DNA using various techniques, including electrophoretic testing and restriction fragment length polymorphism analysis. These techniques are useful methods for assessing plant diversity and have also been used to identify many strains of micro-organisms.

Biodiversity. *See* "Biological diversity".

Biodiversity Information System (BIS). The computerised storage and manipulation of biodiversity data. *See* EIS.

Biogeography. A branch of geography that deals with the geographical distribution of animals and plants.

Biological diversity. Means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biological Oxygen Demand (BOD). The amount of dissolved oxygen consumed by microorganisms as they decompose organic material in polluted water. Measurement of the rate of oxygen take-up is used as a standard test to detect the polluting capacity of effluent; the greater the BOD value (g) (and hence the greater the presence of oxygen - consuming microorganisms) the greater the volume of pollutant present.

Biological resources. Includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

Biologically unique species. A species that is the only representative of an entire genus or family.

Biome. A major portion of the living environment of a particular region (such as a fir forest or grassland), characterised by its distinctive vegetation and maintained by local climatic conditions.

Bioregion (bioregional planning). A territory defined by a combination of biological, social, and geographic criteria, rather than geopolitical considerations; generally, a system of related, interconnected ecosystems.

Biosphere reserves. Established under UNESCO's Man in the Biosphere (MAB) Program, biosphere reserves are a series of protected areas linked through a global network, intended to demonstrate the relationship between conservation and development.

Biota. The living organisms of a region.

Biotechnology. Techniques that use living organisms or substances from organisms to make or modify a product. The most recent advances in biotechnology involve the use of recombinant DNA techniques and other sophisticated tools to harness and manipulate genetic materials.

Biotic. Pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.

Breed. A group of animals or plants related by descent from common ancestors and visibly similar in most characteristics. Taxonomically, a species can have numerous breeds.

Breeding line. Genetic lines of particular significance to plant or animal breeders that provide the basis for modern varieties.

Buffer zone. The region near the border of a protected area; a transition zone between areas managed for different objectives.

Buffer zones. Areas on the edge of protected areas that have land use controls and allow only activities compatible with protection of the core area, such as research, environmental education, recreation, and tourism.

Captive breeding. The propagation or preservation of animals outside their natural habitat, involving control by humans of the animals chosen to constitute a population and of mating choices within that population.

Carrying Capacity. The maximum number of people, or individuals of a particular species, that a given part of the environment can maintain indefinitely.

Centres of diversity. The regions where most of the major crop species were originally domesticated and developed. These regions may coincide with centres of origin.

Chromatography. A chemical analysis technique whereby an extract of compounds is separated by allowing it to migrate over or through an adsorbent (such as clay or paper) so that the compounds are distinguished as separate layers.

Climax community. The end of a successional sequence; a community that has reached stability under a particular set of environmental conditions.

Clonal propagation. The multiplication of an organism by asexual means such that all progeny are genetically identical. In plants, it is commonly achieved through use of cuttings or in vitro culture. For animals, embryo splitting is a method of clonal propagation.

Co-management. The sharing of authority, responsibility, and benefits between government and local communities in the management of natural resources.

Common property resource management. The management of a specific resource (such as a forest or pasture) by a well-defined group of resource users with the authority to regulate its use by members and outsiders.

Community. An integrated group of species inhabiting a given area; the organisms within a community influence one another's distribution, abundance, and evolution. (A Human Community is a social group of any size whose members reside in a specific locality.)

Community. A group of ecologically related populations of various species of organisms occurring in a particular place and time.

Comparative advantage. Relative superiority with which a region or state may produce a good or service.

Complementarity. The concept of achieving conservation efficiently by ensuring that a set of areas is assembled with due regard to the additional species that each brings into the network. This is the basis of a critical faunas analysis.

Conservation. The management of human use of the biosphere so that it may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations: Thus conservation is positive, embracing preservation, maintenance, sustainable utilisation, restoration, *and* enhancement of the natural environment.

Conservation of biodiversity. The management of human interactions with genes, species, and ecosystems so as to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity.

Country of origin of genetic resources. Means the country which possesses those genetic resources in *in-situ* conditions.

Country providing genetic resources. Means the country supplying genetic resources collected from *in-situ* sources, including populations of both wild and domesticated species, or taken from *ex-situ* sources, which may or may not have originated in that country.

Critical faunas analysis. Is a methodology to identify the minimum set of areas which would contain at least one viable population of every species in a given animal or plant group.

Critical habitat. A technical classification of areas in the United States that refers to habitats essential for the conservation of endangered or threatened species. The term may be used to designate portions of habitat areas, the entire area, or even areas outside the current range of the species.

Cryogenic storage. The preservation of seeds, semen, embryos, or micro-organisms at extremely low temperatures, below -130°C . At these temperatures, water is absent, molecular kinetic energy is low, diffusion is virtually nil, and storage potential is expected to be extremely long.

Cryopreservation. *See* "Cryogenic storage".

Cultivar. A cultivated variety (genetic strain) of a domesticated crop plant.

Cultivar. International term denoting certain cultivated plants that are clearly distinguishable from others by one or more characteristics and that when reproduced retain their distinguishing characteristics. In the United States, "variety" is considered to be synonymous with cultivar (derived from "cultivated variety").

Cultural diversity. Variety or multiformity of human social structures, belief systems, and strategies for adapting to situations in different parts of the world.

Cutting. Plant piece (stem, leaf, or root) removed from a parent plant that is capable of developing into a new plant.

Cycad. Any of an order of gymnosperms of the family cycadaceae. Cycads are tropical plants that resemble palms but reproduce by means of spermatozoids.

DNA. Deoxyribonucleic acid. The nucleic acid in chromosomes that codes for genetic information.

Domesticated or cultivated species. Means species in which the evolutionary process has been influenced by humans to meet their needs.

Domestication. The adaptation of an animal or plant to life in intimate association with and to the advantage of man.

Ecology. A branch of science concerned with the interrelationship of organisms and their environment.

Ecosystem. A dynamic complex of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an ecological unit.

Ecosystem diversity. The variety of ecosystems that occurs within a larger landscape, ranging from biome (the largest ecological unit) to microhabitat.

Ecotourism. Travel undertaken to witness sites or regions of unique natural or ecologic quality, or the provision of services to facilitate such travel.

Electrophoresis. Application of an electric field to a mixture of charged particles in a solution for the purpose of separating (eg mixture of proteins) as they migrate through a porous supporting medium of filter paper, cellulose acetate, or gel.

Embryo transfer. An animal breeding technique in which viable and healthy embryos are artificially transferred to recipient animals for normal gestation and delivery.

Endangered species. A technical definition used for classification in the United States referring to a species that is in danger of extinction throughout all or a significant portion of its range. The International Union for the Conservation of Nature and Natural Resources (IUCN) definition, used outside the United States, defines species as endangered if the factors causing their vulnerability or decline continue to operate.

Endemic. Restricted to a specified region or locality.

Endemic Bird Area (EBA). Is a term used by BirdLife International to describe areas with two or more restricted-range bird species entirely confined to them.

Endemism. The occurrence of a species in a particular locality or region.

Environmental Impact Assessment (EIA). A method of analysis which attempts to predict the likely repercussions of a proposed major development (usually industrial) upon the social and physical environment of the surrounding area.

Environmental Information System (EIS). The computerised storage and manipulation of environmental data. This data may include a large proportion of geographical (spatial) information along with data specific to the description of plants, animals and their habitats. EIS are frequently derivatives of GIS.

Equilibrium theory. A theory of island biogeography maintaining that greater numbers of species are found on larger islands because the populations on smaller islands are more vulnerable to extinction. This theory can also be applied to terrestrial analogues such as forest patches in agricultural or suburban areas or nature reserves where it has become known as "insular ecology."

Exotic species. An organism that exists in the free state in an area but is not native to that area. Also refers to animals from outside the country in which they are held in captive or free-ranging populations.

Ex-situ. Pertaining to study or maintenance of an organism or groups of organisms away from the place where they naturally occur. Commonly associated with collections of plants and animals in storage facilities, botanic gardens or zoos

***Ex-situ* conservation**. The conservation of components of biological diversity outside their natural habitats.

Extant. Species are those whose members are living at the present time.

Extinct. As defined by the IUCN, extinct taxa are species or other taxa that are no longer known to exist in the wild after repeated search of their type of locality and other locations where they were known or likely to have occurred.

Extinction. Disappearance of a taxonomic group of organisms from existence in all regions.

Fauna. Organisms of the animal kingdom.

Feral. A domesticated species that has adapted to existence in the wild state but remains distinct from other wild species. Examples are the wild horses and burros of the West and the wild goats and pigs of Hawaii.

Flora. Organisms of the plant kingdom

Forest Resource Accounting (FRA). Methodologies for forest resource accounting, aimed at encouraging improved forest information management systems for conservation and sustainable utilisation.

Gamete. The sperm or unfertilised egg of animals that transmit the parental genetic information to offspring. In plants, functionally equivalent structures are found in pollen and ovules.

Gene. A chemical unit of hereditary information that can be passed from one generation to another.

Gene bank. A facility established for the ex situ conservation of individuals (seeds), tissues, or reproductive cells of plants or animals.

General Circulation Model (GCM). Global-scale computer model that simulates physical and chemical processes in the atmosphere, both at the present time and in the future under conditions of elevated concentrations of radiatively active gases (enhanced greenhouse effect). In some instances integrated with comparable processes occurring at the surface and within oceans and at the land surface.

Genetic diversity. The variety of genes within a particular species, variety, or breed.

Genetic drift. A cumulative process involving the chance loss of some genes and the disproportion ate replication of others over successive generations in a small population, so that the frequencies of genes in the population is altered. The process can lead to a population that differs genetically and in appearance from the original population.

Genetic material. Means any material of plant, animal, microbial or other origin containing functional units of heredity.

Gene-pool. The collection of genes in an interbreeding population.

Genetic resources. Means genetic material of actual or potential value.

Genotype. The genetic constitution of an organism as distinguished from its physical appearance.

Genus. A category of biological classification ranking between the family and the species, comprising structurally or phylogenetically related species or an isolated species exhibiting unusual differentiation.

Germplasm. The genetic material, especially its specific molecular and chemical constitution, that compromises the inherited qualities of an organism.

Grassroots (organisations or movements). People or society at a local level, rather than at the centre of major political activity.

Grow-out (growing-out). The process of growing a plant for the purpose of producing fresh viable seed to evaluate its varietal characteristics.

Habitat. Is the environment in which an animal or plant lives, generally defined in terms of vegetation and physical features.

Hotspot. Is an area on earth with an unusual concentration of species, many of which are often endemic to the area.

Hybrid. An offspring of a cross between two genetically unlike individuals.

Hybridisation. Crossing of individuals from genetically different strains, populations, or species.

Important Bird Area (IBA). Sites of importance to birds, identified by Birdlife International and International Waterfowl and Wetlands Research Bureau. The sites are identified for four groups of birds: regularly occurring migratory species which concentrate at and are dependent on particular sites either when breeding, or migration, or during the winter; globally threatened species (ie species at risk of total extinction); species and sub-species threatened throughout all or parts of their range but not globally; species that have relatively small total world ranges with important populations in specific areas.

In-situ. Maintenance or study of organisms within an organism's native environment.

***In situ* conservation.** The conservation of biodiversity within the evolutionary dynamic ecosystems of the original habitat or natural environment.

Inbreeding. Mating of close relatives resulting in increased genetic uniformity in the offspring.

Indicator species. A species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem.

Indigenous peoples. People whose ancestors inhabited a place or country when persons from another culture or ethnic background arrived on the scene and dominated them through conquest, settlement, or other means and who today live more in conformity with their own social, economic, and cultural customs and traditions than with those of the country of which they now form a part. (also: "native peoples" or "tribal peoples")

Intellectual Property Rights (IPR). Rights enabling an inventor to exclude imitators from the market for a certain period of time.

Interspecies. Between different species.

Intrinsic value. The value of creatures and plants independent of human recognition and estimation of their worth.

Introduced species. *See* "Alien species".

Inventory. On-site collection of data on natural resources and their properties.

In vitro. (Literally "in glass"). The growing of cells, tissues, or organs in plastic vessels under sterile conditions on an artificially prepared medium.

Island biogeography. The study of the relationship between island area and species number. This idea has also been applied to isolated areas of habitat in continental areas which are effectively islands for many species. The extent to which habitat fragmentation may lead to extinction of species can be predicted from the relationship between number of species and island area.

Isoenzyme (Isozyne). The protein product of an individual gene and one of a group of such products with differing chemical structures but similar enzymatic function.

Keystone species. A species whose loss from an ecosystem would cause a greater than average change in other species populations or ecosystem processes.

Landrace. Primitive or antique variety usually associated with traditional agriculture. Often highly adapted to local conditions.

Land Mapping Unit (LMU). The smallest are of land that can be delineated on a map of a particular scale. Used in land evaluation as the basis of spatial variation.

Land Quality (LQ). A complex attribute of land, which acts in a manner distinct from the actions of other land qualities in its influence on the suitability of land for a specified kind of use.

Land Use Requirements (LUR). The requirements are related to growth and yield of crops and trees, animal husbandry, land management and conservation. The expression of the conditions for successful implementation are described for each LUT, eg growth requirements of certain tree species.

Land Utilisation Type (LUT). Described in terms of necessary inputs and expected results, based on a number of key attributes obtained from land use data; produce, capital input, labour input, farm size, land tenure, technical know-how, level of mechanism etc. LUTs relate to the physical social and economic conditions of the area and according to the development of objectives; description of the key attributes, reflecting biological, socio-economic and technical aspects of the production environment and which are relevant to the productive capacity of a LMU.

Living collections. A management system involving the use of off-site methods such as zoological parks, botanic gardens, arboretums, and captive breeding programs to protect and maintain biological diversity in plants, animals, and microorganisms.

Marine Protected Area (MPA). An area of sea (or coast) especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

Megadiversity countries. Are the small number of countries, located largely in the tropics, which account for a high percentage of the world's biodiversity by virtue of containing very large numbers of species.

Micro-organisms. In practice, a diverse classification of all those organisms not classed as plants or animals, usually minute microscopic or submicroscopic and found in nearly all environments. Examples are bacteria, cyanobacteria (blue-green algae), mycoplasma, protozoa, fungi (including yeasts), and viruses.

Minimum Viable Population (MVP). The smallest isolated population having a good chance of surviving for a given number of years despite the foreseeable effects of demographic, environmental, and genetic events and natural catastrophes.

Minor breed. A livestock breed not generally found in commercial production.

Modelling. The use of mathematical and computer based simulations as a planning technique.

Morphology. A branch of biology that deals with form and structure of organisms.

Multiple use. An on-site management strategy that encourages an optimum mix of several uses on a parcel of land or water or by creating a mosaic of land or water parcels, each with a designated use within a larger geographic area.

Mycorrhizal fungi. A fungus living in a mutualistic association with plants and facilitating nutrient and water uptake.

National income accounts. System of record by which the vigour of a nation's economy is measured, (results are often listed as Gross National Product, or Gross Domestic Product).

Native. A plant or animal indigenous to a particular locality.

Native species. Plants, animals, fungi, and microorganisms that occur naturally in a given area or region.

Nitrogen fixation. A process whereby *nitrogen fixing bacteria* living in mutualistic associations with plants convert atmospheric nitrogen to nitrogen compounds that plants can utilise directly.

Non-Governmental Organisation (NGO). A nonprofit group or association organised outside of institutionalised political structures to realise particular social objectives (such as environmental protection) or serve particular constituencies (such as indigenous peoples). NGO activities range from research, information distribution, training, local organisation, and community service to legal advocacy, lobbying for legislative change, and civil disobedience. NGOs range in size from small groups within a particular community to huge membership groups with a national or international scope.

Off-site. Propagation and preservation of plant, animal, and micro-organism species outside their natural habitat.

On-site. Preservation of species in their natural environment.

Open-pollinated. Plants that are pollinated by physical or biological agents (e-g-, wind, insects) and without human intervention or control

Orthodox seeds. Seeds that are able to withstand the reductions in moisture and temperature necessary for long-term storage and remain viable.

Parataxonomists. Field-trained biodiversity collection and inventory specialists recruited from local areas.

Participatory Rural Appraisal (PRA). Also known as Rapid Rural Appraisal, PRA is a relatively new and different approach for conducting action-oriented research in developing countries. PRAs are used to help involve villagers and local officials leaders in all stages of development work, from the identification of needs and decision making to the assessment of completed projects. The term can be used to describe any new methodology which makes use of a multidisciplinary team.

Patent. A government grant of temporary monopoly rights on innovative processes or products.

Pathogen. A disease-causing microorganism, bacterium or virus.

Phenotype. The observable appearance of an organism, as determined by environmental and genetic influences (in contrast to genotype).

Phytochemical. Chemicals found naturally in plants.

Phylogenetic. Pertaining to the evolutionary history of a particular group of organisms.

Phylum. In taxonomy, a high-level category just beneath the kingdom and above the class; a group of related, similar classes.

Population. A group of individuals with common ancestry that are much more likely to breed with one another than with individuals from another such group.

Population and Habitat Viability Assessment (PHVA). The theoretical modelling of minimum areas, habitat types and population sizes, to sustain any one or more species. Population size will be determined by the carrying capacity of the habitat.

Population Viability Analysis (PVA). The theoretical determination of the minimum viable (in terms of genetic make-up) breeding population for any one species to survive in a given range.

Predator. An animal that obtains its food primarily by killing and consuming other animals.

Primary (or natural) forest. A forest largely undisturbed by human activities.

Primary productivity. The transformation of chemical or solar energy to biomass. Most primary production occurs through photosynthesis, whereby green plants convert solar energy, carbon dioxide, and water to glucose and eventually to plant tissue. In addition, some bacteria in the deep sea can convert chemical energy to biomass through chemosynthesis.

Protected Area (PA). An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

Provinciality effect. Increased diversity of species because of geographical isolation.

Recalcitrant seeds. Seeds that cannot survive the reductions in moisture content or lowering of temperature necessary for long-term storage.

Recombinant DNA technology. Techniques involving modifications of an organism by incorporation of DNA fragments from other organisms using molecular biology techniques.

Rehabilitation. The recovery of specific ecosystem services in a degraded ecosystem or habitat.

Restoration. The return of an ecosystem or habitat to its original community structure, natural complement of species, and natural functions.

Riparian. Related to, living, or located on the bank of a natural watercourse, usually a river, sometimes a lake or tidewater.

Seedbank. A facility designed for the *ex situ* conservation of individual plant varieties through seed preservation and storage.

Selection. Natural selection is the differential contribution of offspring to the next generation by various genetic types belonging to the same populations. Artificial selection is the intentional manipulation by man of the fitness of individuals in a population to produce a desired evolutionary response.

Serological testing. Immunologic testing of blood serum for the presence of infectious foreign disease agents.

Somaclonal variations. Structural, physiological, or biochemical changes in a tissue, organ, or plant that arise during the process of in vitro culture.

Species. A group of organisms capable of interbreeding freely with each other but not with members of other species.

Species diversity. The number and variety of species found in a given area in a region.

Species richness. Is the number of species within a specified region or locality.

Spectroscopy. Any of several methods of chemical analysis that identify or classify compounds based on examination of their spectral properties.

Stochastic. Models, processes, or procedures that are based on elements of chance or probability.

Subspecies. A distinct form or race of a species.

Succession. The more or less predictable changes in the composition of communities following a natural or human disturbance.

Sustainable development. Development that meets the needs and aspirations of the current generation without compromising the ability to meet those of future generations.

Sustainable use. The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Systematics. The study of the historical evolutionary and genetic relationships among organisms and of their phenotypic similarities and differences.

Taxon (pl. taxa). The named classification unit (eg *Homo sapiens,* Hominidae, or Mammalia) to which individuals, or sets of species, are assigned. *Higher taxa* are those above the species level.

Taxonomy. Is the classification of animals and plants based upon natural relationships.

Threatened species. A U.S. technical classification referring to a species that is likely to become endangered within the foreseeable future, throughout all or a significant portion of its range. These species are defined as vulnerable taxa outside the United States by the IUCN.

Tissue culture. A technique in which portions of a plant or animal are grown on an artificial culture medium in an organised (eg as plantlets) or unorganised (eg as callus) state.

Trophic level. Position in the food chain, determined by the number of energy-transfer steps to that level.

Variety. *See* "Cultivar".

Wild relative. Plant species that are taxonomically related to crop species and serve as potential sources for genes in breeding of new varieties of those crops.

Wild species. Organisms captive or living in the wild that have not been subject to breeding to alter them from their native state.

Wildlife. Living, nondomesticated animals.

8.4.2 Information Management Terms

Application. A software application is a program that performs the functions for a user. Applications can be general-purpose (eg a word processor) or custom-built for a user's specific requirements.

American Standard Code for Information Interchange (ASCII). A standard character set that assigns a numeric code to each letter, number, and selected control characters.

Attribute. Characteristics that describe an entity (eg "IUCN Category" is one attribute that describes the entity "Protected Area").

Benchmark. A numerical value that gives a measure of the performance of a computer product in a specific test.

Best Practice Technology (BPT). The compromise whereby industrial premises are allowed to emit higher than normally acceptable pollution levels due to exceptional circumstances. these circumstances include the use of equipment which in itself is not life-expired, they are using in effect the *best practicable means* available to them.

Bulletin board. Also known as a newsgroup, is an "area" on a WAN where text messages can be posted by an author, so that they are available to be read by anyone accessing the bulletin board.

CD-ROM (Compact Disc-Read Only Memory). A relatively new technology that uses laser-read discs with their high data compression to store very large amounts of data. Data can only be read from the disk, it cannot be altered or re-written.

Central Processing Unit (CPU). The microchip that is the "computer within the computer", it logically coordinates the operations of all the other components of the computer.

Client-server. A computer architecture that is a hybrid of the traditional stand-alone and network options with computing tasks shared between the server and the user's workstations.

Computer Aided Design (CAD). Software used for designing in general. It facilitates geometrical drawing
on the computer.

Computer Aided Software Engineering (CASE). Software used for designing and developing information systems and databases.

Data. Facts that result from measurements or observations

Database. A logically structured and consistent set of data that can be used for analysis.

Database Management System (DBMS). Application software that stores, maintains, locates and retrieves data for a database.

Data Definition (or Description) Language (DDL). A programming language used to describe the structure and content of data files and the relationship between them (often referred to as schemas). A data description language is included as one component of many database management systems.

Data dictionary. A repository of information about the definition, structure, and use of data. This information is used for analysis, planning, control, and general documentation throughout the life of a system.

Data flow model. A representational tool that shows how information moves in an organisation or process. Special symbols represent different types of data flow.

Data model. A representational tool consisting of language and diagramming standards representing the structure and inter-relationships between a group of data entities.

Dataset. A collection of data and accompanying documentation which relate to a specific theme. (Usually consisting of one or more computer readable files on the same system).

Datastore. A logically related collection of data with no assumption on how and where the data is kept.

DBF format. The data file format originally used by the *dBASE* product and now the most common PC DBMS format.

Digitiser. A machine for converting analog information into digital form, so that it can be processed by a digital computer. For example, the digitising of feature outlines from a paper map into coordinates digitally stored in a GIS system.

Directory Interchange Format (DIF). A data structure originally defined by NASA used to exchange directory - level information about data sets among information systems.

Dynamic Data Exchange (DDE). A mechanism of "live link" which enables items of information in separate application programs to be inter-connected.

Electronic mail (e-mail). A computer network resource that allows messages and data to be sent and received by individuals or groups of individuals.

Entity. A thing of interest whose attributes (properties) are being measured or recorded.

Entity-Relationship diagram (E-R). An information modelling tool that breaks an information system up into a series of entities that have relationships to each other.

Field. In the context of databases, a field is a vertical column in a database table.

Flat-file. A matrix of columns (fields) of data, where each row represents one record. Equivalent to the term "Table" or "Relation" in a relational database.

Flat-file database. The simplest type of database that allows the user to work with only one table of data ("flat-file") at a time.

Geographic Information System (GIS). An information system that stores and manipulates data which is referenced to locations on the earth's surface, such as digital maps and sample locations.

Georeferenced data. Data which is connected to a specific location on the Earth's surface.

Global Positioning System (GPS). A data capture tool allowing mobile receivers to determine their position anywhere on the earths surface in latitude and longitude coordinates to an accuracy of fractions of a second of arc (1 second of arc latitude is approximately 30 metres).

Graphical User Interface (GUI). Computer software that is controlled by the user by the selection of options and symbols from a pictorial presentation on the computer screen (Microsoft's Windows is the most frequently seen example). The contrasting approach is a "command line" interface.

Hard-copy. Data or information that has been printed out from a computer onto paper.

Hardware. The physical components of a computer system such as the computers, disk drives and the screen.

Hyperlink. Hyperlinks are connections that have been programmed into a "hypertext" document. A reader browsing a hypertext document can select a hyperlink symbol to be presented with additional text on the subject of interest.

IBM compatible. Describes equipment, ranging from personal computers to large mainframes, that can run operating or applications software written for equivalent IBM computers without alteration.

Index. A direct access method to data in a database. An index has a key value and a pointer to the row of the table that contains data with the key.

Information. The product of the analysis and interpretation of the relationships among data, usually with the intent to aid the communication of understanding.

Information system. A structured set of processes, people and equipment for converting data into information.

Interface. The way that users communicate with a computer system.

Internet. The most widely used international communications computer network.

Listserver. An Internet facility similar in concept to a bulletin board. The main difference is that each time a message is posted by an author to a listserver, it is posted out by electronic mail to all the subscribers of that listserver.

Local Area Network (LAN). A computer network operating within a site or institution.

Logical database. The (conceptual) structure and design of a database as seen by a developer who is designing an application.

Mainframe. A multi-user computer designed to meet the needs of a large organisation; a mainframe has a greater capacity than that of a minicomputer or a microcomputer.

Menu. A list of options graphically presented for selection to the software application user.

Metadata. Information regarding the location, source, content, or other specifics in relation to the actual data (in general data which describes data).

Metadatabase. A database that has been designed and implemented to hold and manage specific metadata.

Modem. A piece of equipment used to link digital devices such as computers to an analog telephone line. The term is a contraction of *modulator-demodulator*.

Multimedia system. A computer system that provides information to the user in formats additional to basic text and static pictures - typically this means the ability to intermix sound and moving pictures with the text.

Multitasking. A computing environment that allows several software packages to be run concurrently.

Network. A collection of computers that can communicate with each other.

Normalisation. In the context of databases, the process of organising data into a structure of one or more tables, where each column has a specific unambiguous meaning. Normalisation is necessary to achieve the optimum structure for a relational database.

Object Linking and Embedding (OLE). A feature to transfer and share information between different software applications. For example, whilst within a word-processing document, a spreadsheet table can be directly worked upon using OLE.

Object Oriented (OO). A way of looking at processing problems and their solutions in terms of "objects". An object has a recognisable identity which includes information on its "behaviour" and function. In contrast with conventional software where program and data are separated, the object includes both the data and the procedures and functions that operate on it. Objects cooperate by sending messages to one another.

On-line database. An information retrieval service that can be accessed from computers dialling up over public networks.

Operating system. Controls access to all the resources of the computer and supervises the running of other programs. Examples of operating systems are MS-DOS, Windows and Unix.

Optical Character Recognition (OCR). Technique for rapid capture of text into a computer. First the text is scanned, then the image of each character in the text is analysed and converted into the computer code. Characters that cannot be matched may be displayed on a screen for an operator to enter manually. Modern OCR readers are capable of reading documents containing a mixture of fonts in differing sizes and styles.

Personal Computer (PC). Otherwise known as a microcomputer, is a single-user computer with a central processing unit based on a microprocessor chip.

Physical database. The actual physical structure of databases as implemented for a particular hardware or software configuration and database system.

Pixel. Abbreviation for picture element, meaning the smallest, discrete elements that are used to create an image on a visual display unit.

Process. To perform operations on data.

Process model. A representational tool consisting of language and diagramming standards representing the ordering and inter-relationships between a group of related processes.

Prototyping. A system development methodology which quickly develops a partial or preliminary version to determine its feasibility and user evaluation. Prototypes can then be refined into delivered applications.

Public domain. Intellectual property available to people without paying a fee. Most computer software developed at universities is in the public domain.

Query. A request to a database to select and extract data.

Random Access Memory (RAM). Dynamic memory provided by the computer's RAM microchips, sometimes known as central memory or core.

Raster graphics. Definition of an image to be produced on a computer screen is stored on a "pixel-by-pixel" basis.

Record. A collection of data about a specific case or subject. In the context of databases a record is a horizontal row in a database table.

Relational Database Management System (RDBMS). A database management system based on a relational database.

Relational database. A database in which the information is stored in tables. The information in a series of tables can be linked through common columns or "keys".

Relationship. Describes how two entities are related to one another (eg "species" may be related to "genera" by a "belongs to" relationship).

Server. Any program or computer that provides a service to other programs or users. A network server, for example, provides dedicated hardware and software for the purpose of giving terminals or computers access to a network.

Software. The programs that are run on a computer system.Includes custom programs as well as commercial, such as Microsoft Windows, Word Perfect and Novell Netware.

Spatial data. Data which contains reference to a location (which may be a specific location on the Earth's surface, or relative to an arbitrary point).

Spreadsheet. A software program that allows users to establish relationships between rows and columns of data in a tabular format.

Structured design. A methodology for the design of information systems that breaks the program down into a series of modules with carefully specified interfaces between the modules.

Structured Query Language (SQL). ANSI standard data manipulation language used in most relational database systems.

Table. An object in a relational database system composed of rows and columns.

Vector graphics. Definition of an object's image to be produced on a computer screen is stored by defining its geometry as a series of connected points - to be contrasted with *raster* graphics.

Wide Area Information Server (WAIS). A system designed for retrieving information from networks. It is a searching facility dependent on matching requests with a specific request.

Wide Area Network (WAN). A computer network where the constituent systems may be widely dispersed geographically and links are formed by the use of telephones, radio, satellite, etc.

Workstation. Powerful desktop computer equipped with a high-resolution display and designed for technical applications. Groups of these workstations are normally linked to a shared computer which holds common information.

World Wide Web (WWW). Based on a technology known as hypertext, another method for retrieving information from networks which is fast, powerful and intuitive.

Universal Resource Locator (URL). Address describing the location of information sources on the Internet global communications network.

xBASE. DBMS software products that are derivatives of the dBASE package.

8.5 References

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The World Conservation Monitoring Centre is a joint-venture between the three partners who developed the *World Conservation Strategy* and its successor *Caring for the Earth*: IUCN-The World Conservation Union, UNEP- United Nations Environment Programme, and WWF-World Wide Fund for Nature.