STUDY OF THE STATUS AND TRENDS OF IN-SITU CONSERVATION OF BIOLOGICAL DIVERSITY WORLDWIDE

A paper prepared for the

Office of Technology Assessment,
Congress of the United States

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ABSTRACT

The principal aims of this paper are to illustrate the status and trends of <u>in situ</u> conservation of biological diversity; to look at the information available and some of the methods of managing it; and to review what is needed to both improve information availability and information management. The paper begins with a brief description of the database used for the analysis of status and trends, that of the IUCN Conservation Monitoring Centre (CMC). The work of CMC on protected areas is carried out in cooperation with IUCN's Commission on National Parks and Protected Areas. Data collection methods are also described, as is the requirement for information at all levels.

Some classification of the information is necessary. It is relatively straightforward to provide lists of protected areas within a country, arranged by definition (national park, nature reserve, etc.), but this fails to show three vital things, coverage of natural features, management objectives, and how well those objectives are being met. It is therefore important to arrange the information to make it more comparable, and so that it can be used to assess coverage of the world's natural features. IUCN uses global biogeographic maps in making an initial assessment of biogeographical coverage. These are available for both terrestrial and marine areas, though CMC has yet to apply the marine biogeographic classification. Some of the problems of using such maps are discussed. Classification of protection is also necessary to indicate actual protection of a site (rather than the protection implied by a site's name). IUCN have developed a classification of management categories which is employed here.

The analysis begins with a general description of the rates of growth of the world's protected areas network. These figures are then split to illustrate differences between developed and developing countries, between different biogeographical realms, and between different biome types (e.g. mountains and tropical humid forest). This illustrates some large differences, though its value is probably historic rather than predictive. The value of an international database in presenting the opportunity for international comparison is also introduced. Data derived from various sources is used here to illustrate differences in protected area network between countries in South America. However there are problems in making even this type of analysis, and these are discussed.

The terrestrial biogeographical map adopted by IUCN is then used to study world coverage of protected areas more closely. In this way a number of gaps

within the system are highlighted. Lists of biogeographic provinces either without protected areas, or with few areas or a small area protected are given. Problems with this approach are touched on, and some of the anomalies thrown up by such analysis illustrated. The method does however indicate the patchy nature of current protection and indicate areas that may warrant further attention. Clearly application of biogeographical approaches at a lower level can be correspondingly more sensitive, and a number of differing methods are briefly described. This is followed by a discussion of the problems and approaches used with ecosystems which are azonal.

It is one thing having the information available, but it is quite another to actually ensure good use of it. Various conservation groups that make use of this type of data at the international level are briefly described, as well as the use made by agencies such as the World Bank. The need for availability and use of the information at all levels is also discussed, along with the need for accessibility. A number of recommendations are made.

The final topic dealt with is the potential for improving the database. Discussion first deals with collection, verification and compilation of data, and makes a number of recommendations applicable to database efforts at all levels. This is followed by discussion relating to database management, and in particular methods of data handling which would greatly improve the value of current databases (particularly those at the international level, and CMC specifically). Topics covered include geographical information systems, habitat classification, ecosystem inventories, species inventories and surveys of the effectiveness of protected area management. Recommendations made here cover not only further development of the IUCN database, but also national and local databases, and the necessary basic research.

Recommendations are drawn together and rearranged/rewritten in a summary under five headings: availability of information; national and local conservation databases; improvement of information exchange; IUCN's international database; and use of the information. Perhaps the most important point to make in conclusion, however, is that if U.S. agencies, institutions etc. encourage and support the use of environmental data in decision making, and use such data in their own decision making processes, this should in itself encourage the development of the information base at all levels. This will then provide improved tools both for making new planning decisions, and reviewing the effects of previous decisions. Further use of such information within the U.S. will hopefully also lead to further use of environmental information within planning and management elsewhere.

INTRODUCTION

> "In situ conservation (natural ecosystem or habitat conservation) entails the management or conservation of genetic resources within their natural or original habitat". (Oldfield, 1984)

Clearly any review of the in-situ conservation of biological diversity needs to be prefaced by three key questions:

a) What do we mean by biological diversity in this context;

b) Why must it be conserved; and

C) Why should it be conserved in situ?

As this is one of a number of papers being prepared for an assessment of Technologies to Maintain Biological Diversity it is assumed that the first two questions need not be addressed further here. The questions are, of course, also addressed by a number of key texts on genetics, conservation and evolution (e.g. IUCN, 1980; Soulé and Wilcox, 1980; Frankel and Soulé, 1981; Schonewald-Cox et al, 1983; Oldfield, 1984), and by innumerable papers and reports. It is, therefore, taken as read that conservation of biological diversity is important. The third question, however, is rather more pertinent to this paper.

In essence the reasons for needing to conserve biological diversity (or genetic resources) in situ are as follows:

1. It is not usually possible or practical (or indeed desirable) to protect ex situ the entire gene pool of a population or species. It therefore follows that not all of the useful genetic material will be available.
2. Genetic traits, and specific adaptations exhibited by 'resource' populations are acquired through dynamic evolutionary processes within natural environments - by definition a continuous (and continuing) process. Removal of members of a population from their natural environment will lead to a total change in the dynamic interactions a population undergoes. This not only results in a reduction in the gene pool available for adaptive evolution (limiting the possiblitites), but also removes the natural influences on the genetic character of the population, thereby altering the rates and directions of genotypic development.
3. Finally there are numerous problems with both effective sampling of the available genetic material, and its maintenance ex situ (as a result of both physical limitations and technical difficulties).

It must therefore be apparent that not only is in situ conservation usually more effective, but it is also usually more cost-effective. Unless one is

selecting specific genetic traits within a population for defined purposes, the task of conserving genetic diversity becomes more difficult where genetic material is removed from its natural environment? This is not to deny the importance of ex situ conservation in a variety of circumstances (particularly in genetic improvement programmes, and within populations of species which are no longer 'viable' in natural situations) but it cannot be denied that most species cannot be conserved effectively by available ex situ methods.

What then is meant by in situ conservation? If we take the definition used by Oldfield (1984) above, what is immediately apparent is the wide range of conservation 'methods' this encompasses: from international conventions on protection of sites and species, to preservation of the habitat of the Californian condor, and from 'Save the Whale' campaigns to the formal establishment and management of protected areas and protected areas systems. It is apparent that this paper cannot cover all of these activities, nor is it intended that it should. Discussion will therefore be restricted to the status and trends in the protection of biological diversity by protected areas and protected area systems.

THE DATABASE

The primary interest in this paper is the status and trends in in situ conservation at a global level, and therefore it would perhaps initially seem that only the international database level needs to be discussed. However, a good supply (i.e. availability and continuity) of information is essential, and therefore when assessing the international level one must also consider the local.

Clearly there are at least three levels at which information needs to be available for effective management of natural resources within protected areas:

a) information on each individual area needs to be available within the area;

b) information on all areas within a country needs to be available within that country; and

c) information on all the world's protected areas needs to be available within an international database.

In each case the information is most valuable where it is managed on one site, and it should be emphasised again that in the first case it is generally desirable that that site be within or very near the individual protected area

concerned. (It should be noted here, and in other discussions in this paper, that the term database need not necessarily imply the use of computers.)

Obviously each of these databases manages a different set of information, with points of overlap. Within any given protected area there is a wide range of information available - some of it very specific. A subset of this is required by the protected areas system database - which is made up of the subsets of information from each protected area compiled together with other national information (vegetation patterns, geology, weather and climate, etc.). It is a subset of this particular database that is needed at the international level, compiled with similar information from every other country and with information at a global level on aspects of vegetation, climate, and so on.

The primary concern in this paper is the availability of this information within an international database. It is only by this means, for example, that it is possible to provide overview papers such as this one, which can indicate potential gaps within protected areas systems, and indicate status and trends world-wide. Other reasons are provided in earlier studies (e.g. Harrison et al, 1982), and include the provision of information to conservation agencies to help in making judgements on resource allocation, and the provision of introductory information to aid agencies on the conservation issues/problems within areas they are working or considering working. Clearly, without the information being available at the national level, it is extremely problematic to collect it at international level, and there is a need for good national databases, in turn leading to a need for good information handling procedures at an individual area level, but it must not be forgotten that information needs to be used in decision making and management at all levels. Most decisions are made at the local or national level, and hence the prime concern of these databases must be input information for use in these decision making processes. Provision of information outside this requirement will always be of secondary importance. It goes without saying that for good information flow to occur there must be both a willingness to cooperate with the need for information flow at all levels, and sufficient funding within these operations to allow for this process.

The international database

IUCN's Commission on National Parks and Protected Areas (CNPPA) has been collecting information on protected areas for more than 20 years, for use in both its programme development and its publications. Since 1959 IUCN has been

charged by the United Nations with maintenance of a United Nations List of National Parks and Equivalent Reserves (e.g. IUCN, 1985). Over the years the information management role has increased to the extent that in 1981 CNPPA set up the Protected Areas Data Unit (PADU) to manage the information. This unit is now a part of the Conservation Monitoring Centre (CMC), a division of the IUCN Secretariat.

The processes of information collection are many and varied, depending ultimately on how easily management authorities in each country are able to pass on the information needed, and how accurate (or reliable) that information is. The first step is close cooperation between PADU and CNPPA at the latter's regional meetings of parks managers and experts, which are held twice a year in different parts of the world (this year in India and Western Samoa, etc). PADU draws together the information currently available for the region in question, taking 'draft directories' of the information to the meeting for review by the participants.

However, we find that (for a variety of reasons) information obtained at meetings in this way is not usually sufficient, and correspondence must be maintained not only with the management authorities within each country, but also with numerous other individuals and organizations. It is also essential to be aware of the published literature on protected areas within each country, and of the numerous reports produced by other international agencies such as the FAO.

In other words, the collection of information is a very active process, and necessarily a labour-intensive process. It is also time consuming, especially when one considers that all information received must be compared with information already available, and then incorporated as appropriate. If one were to wait for the information to come flowing in, and were to believe everything that came, the resulting database would be rather poor both in terms of information content and accuracy.

The current database content

Measures needed to improve both data collection and management are dealt with in a later section, but what sort of information is currently available, and how good is it?

PADU currently has basic information on computer for between nine and ten thousand protected areas. This is, of course, nowhere near the total number of protected areas in the world: Sweden alone has 1200 nature reserves, and 1300 natural monuments (Esping and Larsson, in litt), Australia has 1248

nature reserves (Wilson, 1984), and the New Zealand register of protected natural areas includes some 1660 sites (Department of Lands and Survey, 1984). The PADU files essentially contain information on those sites of over 1000 hectares which are protected by the 'highest competent authority' (except islands, where the size cut-off is 100 hectares).

However, it is fair to say that the information held for some categories of protected area is much better than for others. The database contains much better information on national parks and nature reserves, and even natural monuments, than areas such as forest reserves and game management areas, which, although not designated for nature <u>protection</u> are usually designated for nature <u>conservation</u>. We have virtually no information on other types of 'restricted area' such as fishing reserves, or rock lobster sanctuaries (South Africa).

Moreover, PADU has relatively little information at present on 'privately' protected areas, i.e. those areas protected by individuals or non-governmental organizations. This may not seem too serious until one realises that this excludes the many important sites protected by the Nature Conservancy (for example) in the United States, or the Royal Society for the Protection of Birds or the National Trust in the United Kingdom.

That being said, PADU has reasonably complete lists of protected areas of over 1000 hectares (100 for islands) which are protected primarily for nature conservation purposes by the 'highest competent authority'. These are not the totally accurate lists which we should have available, and which we are working towards, but certainly lists that are good enough to demonstrate all the key points brought out in this paper.

Clearly PADU does not solely maintain lists of protected areas, but has on file information on the protected areas systems of each country, with basic details of legislation and administration, as well as further details of each individual site; location, physical features, flora and fauna, management, problems, etc. This is described more fully in the attached paper. However, the most crucial information, information that is often the most difficult to obtain, is not what is protected and where, but determining how well the area is protected, and if it is achieving its objectives. PADU, working with CNPPA, has recently reviewed the information on Africa (IUCN, in press), for example, and as a result of this work our appreciation of the conservation status of a number of African sites has changed. Assessment of this sort is continuing, but currently in a subjective rather than objective manner because of the patchy nature of the information. This is dicussed further below.

CLASSIFICATION AT A GLOBAL LEVEL

It is relatively straightforward to provide lists of protected areas within a country, arranged by definition (national park, nature reserve, etc.), and even mapped, but this fails to tell us three vital things - coverage of biological and geographical features, management objectives, and how well those objectives are being met. It therefore becomes important to try to arrange the information so that it can be made more comparable across the world, and so that it can be used to assess coverage of the world's natural features.

Classification and mapping of environments

A major objective of the protected area system of the world is the maintenance of the diversity of species and ecosystems, but the listing of protected area coverage by country provides little information on how well natural ecosystems are being conserved. The problem of determining how well this objective is being met is approached through biogeography, the science of distribution of species and ecosystems.

Though a useful tool, biogeography has its limitations; many of the world's species remain undiscovered (let alone described), species distributions remain unknown in many parts of the world, and the mapping of natural ecosystems has been rendered even more difficult by man's alteration of the environment. Further, botanists and zoologists have their own ways of looking at species distribution which can make it difficult to reach an agreement on broad patterns of distribution.

However, biogeographical maps for assessing the coverage of the world's ecosystems by protected areas are needed now, not when all of these problems have been solved. IUCN has therefore commissioned the development of two systems for assessing coverage, one for terrestrial environments (Udvardy, 1975) and one for marine and coastal environments (Hayden et al, 1984).

Udvardy (1975), following on from the earlier work of Dasmann (1973) and IUCN (1974), divides the land areas of the world into eight major realms, each of which is divided into a number of provinces (193 in total). Each province is characterised by a particular biome type (of which Udvardy describes 14). For example, the Sequoia National Park in California, within the Nearctic Realm, is in the Sierra-Cascade Province, which is characterised by a mixed mountain and highland system biome.

Hayden et al (1984) divide marine and coastal environments into Ocean

Realms, Coastal Realms, and Marginal Seas and Archipelagos, with 40 resulting Faunal Provinces along the coastlines. One of the principal differences in using this system is that only the faunal provinces are continuous, while ocean realms, coastal realms, and marginal seas and archipelagos are all disjunct in nature.

For further information on either system the publications concerned should be studied, as it is virtually impossible to understand their respective approaches without studying the associated maps.

Although Udvardy (1975) in defining a biogeographical province uses the definition given by Dice (1943) for his biotic provinces as areas characterised by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography and soil, it is clear from his work that lack of source material and data resulted in an emphasis on the use of vegetation patterns in defining provinces. A wider range of information is now available, and this has led to IUCN commissioning an update from Udvardy. It is anticipated that this will be completed soon.

Udvardy's approach is dependent largely on the analysis or interpretation of the biological/ecological effects of environmental factors. This is rather different from Hayden et al's (1984) approach for the coastal and marine environments where the classification is based on the assumption that the geophysical structure of the environment gives rise to a particular ecological response.

Bailey (1976, 1980, 1983) working on the deliniation of ecosystem regions for North America uses macroclimate for broad-scale subdivision of the continent. Following Crowley (1967) these areas are termed domains and are subdivided into divisions, again on the basis of climate criteria (though the divisions correspond to areas with definite vegetational affinities, and usually the zonal soils are also related). For example North America is split into four domains, polar, humid temperate, dry and humid tropical, the dry domain into semiarid steppe, semiarid steppe regime highlands, arid desert and arid desert regime highlands. The delimitation of these domains and divisions is largely based on Köppen (1931).

Divisions are in turn divided into provinces on the basis of the climax plant formation - often coincident with the major soil zones, and provinces are futher subdivided into sections on the basis of differences in the composition of the climax vegetation type. So, for example, the arid desert division is divided into the Chihuahuan and American (Mojave-Colorado-Sonoran) desert provinces, while the Chihuahuan province is divided into the

Grana-Tobosa and Tarbush-Creosote Bush sections. Further subdivision would be carried out using criteria such as land-surface form, soils, vegetation associations etc. though such subdivision is beyond the scope of Bailey (1976, 1980).

Bailey, who works for the U.S. Forest Service, is now hoping to extend his work to map domains, divisions and provinces for the world at a scale of 1:25,000,000 (as well as investigating more closely the links between ecosystem boundaries and soil distributions). This would supplement Udvardy in two ways, firstly the ecosystem regions would be based on correlation of several landscape features hopefully leading to the identification of units of greater ecological relevance, and secondly this would give a more detailed breakdown of the world's ecosystems.

Whatever systems are used, the classifications provided offer nothing more than an approximation based on a series of compromises. Any global biogeographical or biophysical mapping approach should only be regarded as a working document open to adaptation and modification. It should also be noted that completely consistent land and sea classifications are probably not possible (Hayden et al, 1984), though Bailey and Cushwa's (1982) ecoregions would seem to tally more closely with the proposed marine and coastal classification than Udvardy's (1975) provinces (Hayden et al, 1984), presumably because of a greater use of causal environmental factors in Bailey's approach (Bailey, 1983).

As it is the only biogeographical system covering the world, Udvardy (1975) is used here to make an assessment of coverage of the world's environments by protected areas. Similarly Hayden et al (1984) would be the system used for marine and coastal environments.

Caution: What must be appreciated in using these approaches, however, is the very basic nature of the method. These maps make no account of actual existing environments (e.g. how much of the tropical humid forest actually remains), nor are they fine enough to provide more than a rather general overview. It should also be noted that such systems only cover zonal features of the environment - azonal features such as wetlands, coral reefs, etc. cannot be covered, by definition. These problems, and others, are discussed further below. Also discussed below is the need for much more detailed information available on the distribution of actual ground features (including vegetation, land forms etc.), and information on distribution and conservatiuon status of a wide variety of species 'of conservation concern'.

Classification of protected areas

Around the world there are many different designations of protected area. In Kenya, for example, the terms used include national parks, national reserves, nature reserves and forest reserves, whilst in Spain, national parks (parque nacional), nature parks (parque natural) and national hunting reserves (reservas nacionales de caza). There are 'no hunting areas' in Thailand and game management areas in Uganda, while similar areas in Kiribati are designated wildlife sanctuaries - very different in conservation terms from the wildlife sanctuaries of India. In the same way the designated national parks of the United Kingdom are in no way similar to the national parks of the United States.

In an attempt both to clarify this situation, and to promote use of the full range of protected area 'types', IUCN (1978; 1984) identified a series of ten management categories defined according to management objectives (categories nine and ten being biosphere reserves and world heritage sites respectively). Although these ten categories have 'names' associated with them (eg. strict nature reserve, national park), categories are assigned according to management objectives, and not according to the designation of the area (see Table 1). In other words the national parks of the United Kingdom are placed under Category V (protected landscapes and seascapes) rather than Category II (national parks). This facilitates international comparisons, providing a framework into which all protected areas should fit. It also enables us, for the purposes of this paper to define which areas will be included in the analysis, those in Categories I through V, the areas of particular interest to CNPPA (IUCN, 1978).

For various reasons, any one 'type' of protected area defined by a particular country could belong to more than one category - this means that, of a number of national parks within any one country, some could be within Category II, and some within Category V depending on the objectives of their management. Within New Zealand, for example, scenic reserves can be in any of Categories I through IV, scientific reserves in Category I or III, and wildlife refuges in category IV or VIII (Department of Lands and Survey, 1984). It should also be noted that the system is currently used by IUCN according to the application of the management objectives, and not necessarily according to a sites legal definition (though Wetterberg et al (1985), for example, apply the defined categories according to management intent rather than management practice). To take an example from a country with some fairly severe management problems, Angola has six designated national parks, six

designated reserves, and one nature park. Of these only one area is listed as Category II, three as Category IV and one as Category V (IUCN, 1985; in press). Within the other areas, the management authorities have too many problems to enable them to achieve their management objectives (Braga, pers. comm., 1983).

Caution: As is apparent from these examples, the system is currently applied in a way which attempts to represent both the management objectives of an area, and how well these objectives are being achieved. This has its problems. There is a basic need to separate out these two aspects so that we can look at both the management objectives, and the effectiveness of an area independently. This is discussed further below.

WORLD COVERAGE OF PROTECTED AREAS

Growth of the Protected Areas Network

Since the first two national parks were established in the 1870s, around 3500 areas have been created which IUCN's Commission on National Parks and Protected Areas considers to be of sufficient status to be included in the 1985 United Nations List of National Parks and Protected Areas (IUCN, 1985). The total area protected includes some 4.25 million square kilometres. The rate of this growth is illustrated in Figure 1, which shows both the number of sites protected and the total area of these sites, plotted cumulatively from 1870. Figure 2 illustrates the number and area of sites added during each five year period since 1870.

Little needs to be said about these figures. Growth was slow in the early years, but began to pick up in the 1920s and 1930s, before being brought almost to a halt by the Second World War. By the early 1950s, momentum had begun to gather again and the decade from 1970 to 1980 saw about twice as many new areas created as had existed in 1969. The growth rate seems to have slowed a little over the last few years.

This rather crude overview can be broken down a number of other ways to illustrate particular aspects of this development. For example, Figure 3 shows the differences in rate of establishment between the 'developed' world and the 'developing' world (based on whether the country is a member of the Organisation for Economic Co-operation and Development (OECD) or not). What is, perhaps, most interesting here is the difference in shape between the

curves illustrating the number of areas protected, which increases slowly and steadily for OECD countries, but which has a very distinct break in it (around the second world war) for non-OECD countries. In fact the number of areas protected in non-OECD countries has remained below that in OECD countries right up to around 1970, but not only are numbers now higher, the rate of establishment is also greater. It is also apparent that if the Greenland National Park (70,000,000 ha) were removed from the OECD data the average size of areas in OECD countries would be considerably less. This illustrates the importance of looking at both size and number of protected areas.

Figure 4 categorises the figures by biogeographical realm, and clearly demonstrates differences. In the Afrotropical Realm, for example, while the number of protected areas established has increased steadily to around 360 in 1982, the average area protected is much greater than that in any realm other than the Nearctic (and that only because of the large effect of the inclusion of the Greenland National Park in 1974). These graphs also illustrate large differences in timing of the development of protected areas within each region. One should note, for example, the differences between the Australian and Nearctic realms, and the sudden increase in the Indomalayan realm after 1970.

A closer look at the situation within each biome can also be illustrative. For example, Figure 5 shows the situation in each of four major biomes defined by Udvardy (1975): tropical humid forest (biome 1); temperate broad-leaf forests (biome 5); mixed mountain and highland systems (biome 12); and mixed island systems (biome 13). The differences are very pronounced. Biome 5 (temperate broad-leaf forests), for example, covers large areas of the eastern United States, and much of Europe; highly populated areas, and hence containing a fairly high number of small areas with a steady pattern of development. The development pattern is the same in biome 12 (mixed mountain and highland systems) but starting to increase nearly 10 years earlier, and having much larger areas. Development of protected areas in both these biomes began earlier than in either biome 1 (tropical humid forest) or biome 13 (mixed island systems) where numbers of protected areas did not really increase until after 1920. Particularly noticeable is the sudden increase in the area protected in the tropical humid forest biome from 1970 onwards, indicating the establishment of much larger protected areas since 1970. Analysis of this work continues, and will be reported elsewhere.

Comparisons between countries

One particular advantage achieved with an international database is the opportunity for international comparison. Table 2 gives the number of areas protected in South America in IUCN management Categories I-V, and their total area, also presenting these figures as a function of the area of the country, and its population. The data are derived from various national reports, from information provided at the 18th Working Session of CNPPA, and from Wetterberg et al (1985). The wide differences between one country and another even within one continent are quite obvious.

However, care must be taken in making such comparisons in the absence of background information as hard figures such as these can be misleading. For example, although undoubtably valuable conservation areas, the national reserves of Peru are excluded. This is because national reserves in Peru, while being areas designated for protection and propagation of species of wildlife whose conservation is of national interest, are also areas where utilization of products is being carried out by the State. Thus these areas do not therefore fit into Categories I through V (Wetterberg et al, 1985).

Biogeographical Coverage - Global Review

The first approach to assessing coverage of the world's biota by protected areas using Udvardy (1975) is to examine coverage by biome, and by biome within realm. These figures are presented in Table 3. It is important to appreciate that biome type is not synonymous with habitat type; a protected area within a tropical humid forest biome may not necessarily contain tropical humid forest, and an area containing tropical humid forest could occur in another biome altogether (such as Mixed Island Systems).

It is also important to realize that the total area of each biome in each realm has not yet been determined with sufficient precision to assess percentage coverage. This can hide important differences in the figures. There are, for example, 122 areas covering 84,634 square kilometres in the Temperate needle-leaf forests/woodlands biome in the Palaearctic, but only nine areas covering 521 square kilometres in the mixed island systems biome. It would obviously be misleading to assume that temperate needle-leaf forests/woodlands are therefore better protected than the mixed islands system biome in the Palaearctic, since most of Asia between 55°N and the Arctic Circle and much of Europe, is within this biome, while only the Macronesian Islands and the Ryukyu Islands (in total about 17,820 square kilometres) are defined by Udvardy as within the mixed island systems biome; less than the

area of Temperate needle-leaf forest on the Soviet island of Sakhalin! In the same way, care should be taken when making comparisons within biomes.

Comparison of the biogeographic provinces suffers from the same limitations noted for biome comparisons; a 5000 hectare protected area in the relatively small Malagasy Thorn Forest (3.10.4), for example, would protect a much larger section of that province than an equivalent-sized reserve would in the huge Somalian province (3.14.7).

In fact there are protected areas within all biomes, although the number of areas and the total area protected varies considerably. Turning to coverage of biomes within realms, the only occasion where no protected areas are recorded is in the Lake systems biome within the Neotropical Realm. Only one lake, Lake Titicaca, is involved. It would be misleading, however, to assume that this lake was completely unprotected, as the Reserva Nacional de Titicaca extends along about 10% of the Peruvian shore. (As noted above, Peru's national reserves do not fit into IUCN management Categories I-V.)

Further analysis of the figures based on a knowledge of the area of each biome is clearly required, one would be concerned, however, at the low area protected (and the low numbers of protected areas) in certain of the biomes within particular realms (following IUCN, 1980, defined as having less than 1000 square kilometers protected). These are:

Temperate broadleaf forests	Neotropics	(Province 22)
Cold winter deserts	Neotropics	(Province 26)
Temperate Grasslands	Neotropics	(Province 31-32)
Mixed island sysytems	Palaearctic	(Province 40-41)
	Afrotropical	(Province 23-25)
Lake systems	Palaearctic	(Province 42-44)
	Afrotropical	(Province 26-29)
	Neotropical	(Province 47)

However, one should note that but for the Cold winter deserts of Patagonia, and the Temperate Grasslands of Argentina, Uruguay and southern Brazil, these are all relatively small provinces. In the case of the Mixed Islands system in the Palaearctic, for example, nearly 3% of the biome is already receiving protection. It should also be noted, however, that there are fewer than five protected areas within the majority of these areas.

Analysis by biogeographical province is rather more 'fine grain', and, therefore, as expected more gaps in the system are highlighted (Table 4). Provinces without any areas within our definition are:

Arctic Archipelago	*1.15.6*	*Greenland Tundra*	*1.16.6*
Lake Ladoga	*2.42.14*	*Lake Baikal*	*2.44.14*

Ascension/St Helena	*3.23.13*	*Lake Rudolf*	*3.26.14*
Lake Tanganyika	*3.28.14*	*Burman Rainforest*	*4.4.1*
Laccadive Islands	*4.17.13*	*Maldives/Chagos*	*4.18.13*
Pacific Desert	*8.24.7*	*Argentinian Pampas*	*8.31.11*
Revilla Gigedo Island	*8.42.13*	*South Trinidade*	*8.46.13*
Lake Titicaca	*8.47.14*		

There are some changes which will be apparent from Harrison et al (1982), in particular the appearance of some provinces in this list that were not in it before. The two Africa Lakes are added as the reserves on their shores protect little of the lakes themselves (Lake Baikal and Lake Ladoga also have reserves on part of their shorelines). Although there are legislated protected areas in Burma, it has been reliably reported that these are currently not effectively managed because of a number of difficulties within the country (and hence their categories have been modified within our files). Both the provinces in Peru have national reserves, which have also had their categories modified in our file for the reasons stated above.

30 provinces have 5 or fewer protected areas and an area of less than 1000 sq.km protected. These are:

Tamaulipan	*1.10.7*	*West Anatolian*	*2.13.5*
Atlas Steppe	*2.28.11*	*Hindu Kush Highlands*	*2.37.12*
Szechwan Highlands	*2.39.12*	*Ryukyu Islands*	*2.41.13*
Aral Sea	*2.43.14*	*Malagasy Thorn Forest*	*3.10.4*
Comores/Aldabra	*3.24.13*	*Mascarene Islands*	*3.25.13*
Lake Ukerewe (Victoria)	*3.27.14*	*Lake Malawi*	*3.29.14*
Ceylonese Rainforest	*4.2.1*	*Seychelles/Amirantes*	*4.16.13*
Cocos-Keeling/Christmas	*4.19.13*	*Taiwan*	*4.27.13*
Micronesian	*5.2.13*	*Central Polynesian*	*5.5.13*
East Melanesian	*5.7.13*	*Insulantarctica*	*7.4.9*
Campechean	*8.1.1*	*Brazilian Planalto*	*8.9.2*
Guerreran	*8.14.04*	*Chilean Araucaria Forest*	*8.22.5*
Chilean Sclerophyll	*8.23.6*	*Patagonian*	*8.26.8*
Cuban	*8.39.13*	*Cocos Island*	*8.43.13*
Fernando de Noronja	*8.45.13*		

A further 10 provinces have less than 1000 square kilometers protected but have more than 5 protected areas, while a further 29 have 5 or fewer protected areas but an area of over 1000 square kilometers protected. Again there are some anomalies, all of Cocos Island is protected, for example, as is a sizeable part of Christmas Island, parts of several of the Ryukyu Islands and the Atol das Rocas close to Fernando de Noroja. Most of the islands of Insulantarctica also already receive a fair degree of de facto protection (Clark and Dingwall, 1985).

Nevertheless, this rather crude application of what is a rather crude tool suggests that a number of these provinces may be poorly protected, and

therefore <u>may</u> be areas where attention should be focused. This should not be interpreted to mean that it is more important to establish a protected area in Lake Ladoga than in the Congo rainforests for example (as might be understood from Map 3 in the World Conservation Strategy, IUCN, 1980), this sort of decision would depend on numerous other arguments such as the vulnerability and fragility of the biome type, and the threats (and hence the urgency).

This brief survey shows us that the coverage is patchy, but to determine exactly how patchy, more analysis of the figures is required, based on accurate estimations of the size of the provinces; this work is in progress.

Turning to the marine biophysical approach of Hayden <u>et al</u> (1984), it has not yet been possible to carry out the research necessary for a similar review of marine and coastal protected areas, though the necessary information is available to CMC. IUCN is actively seeking funds for this project.

<u>Biogeographical coverage - application at the local level</u>

It is clear that the global biogeographic approach provides useful information primarily at the global level. For application of this information on the ground, we need to turn to either the regional or national level where the same biogeographic principles can be applied with considerably greater precision, yielding proportionally more useful results (though again, in many cases, much of the basic information such as species distribution, remains to be collected).

Various countries have produced biogeographical maps for use in the assessment and planning of their own protected area systems, and various assessments of coverage have been made (or attempted) for a wide range of countries. (See for example recent papers on Pakistan, Indonesia and India in Thorsell, 1985a).

Rodgers (1985) describes a biogeographical classification for India which has been designed by the Wildlife Institute of India for conservation planning purposes. The Institute is coordinating a national inventory of protected area coverage in relation to this biogeographical approach. Based on the results of this inventory, and the described biogeographical approach, a 'consultant team' will be able to make recommendations concerning the protection (or increased protection) of particular areas.

Wetterberg <u>et al</u> (1981) describe how the protected area coverage of the Amazonian region was assessed using the phytogeographic regions of Prance (1977). This was followed up by the definition and mapping of 'Pleistocene refugia' (in effect centres of endemism and/or diversity) for birds, lizards,

butterflies and woody plants, derived from the available literature. The points of overlap were noted, and after further refinement (taking into consideration rural development plans and other factors), 30 general areas were identified where efforts to establish protected areas could be concentrated. Brazil was able to incorporate much of this work into its protected areas system plan (IBDF, 1982), and several protected areas (covering several million hectares) have since been set up - mainly within recommended regions.

Terborgh and Winter (1983) use the distribution patterns of bird species having ranges of less than 50,000km^2 in Ecuador and Colombia to make recommendations on the siting of reserves within these countries - based on the premise that such species (which over the continent as a whole comprise about a quarter of the terrestrial avifauna) are more vulnerable to deforestation than more widespread species. Within these two countries, 156 such species were identified, and their distributions mapped, and then a 'concentration map' was prepared by superimposition of all individual species maps. Zones of maximum overlap obtained are described as areas obviously meriting protection in a rational conservation plan, though the authors also note areas of importance not immediately apparent from this approach. Terborgh and Winter (1983) clearly show that while a large majority of these species could be protected in a few well-situated reserves, virtually none of the crucial areas are contained within the existing or proposed protected area systems of either country.

Huntley and Ellis (1983) used the then available vegetation maps of southern Africa (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe) to estimate the total area of each country covered by each vegetation type (out of a total of 189). Maps of the protected areas in each of these countries were then accurately plotted on the vegetation maps so that the total area protected of each vegetation type in each country could be estimated. This analysis served to highlight the tremendous emphasis on conservation of areas with large and spectacular ungulate and carnivore species. Some of those areas with the greatest biotic diversity and most complex ecological processes were the most poorly conserved.

Following on from the work of Huntley and Ellis (1983), and also from the earlier work of Lamprey (1975) and others, IUCN is working on a systems plan for the Afrotropical region based on a wide range of published and unpublished work including the Unesco/AETFAT/UNSO vegetation map of Africa (White, 1983), and the Afrotropical Directory prepared by CMC and CNPPA (IUCN, in press).

Similar work is also under way in both the Indomalayan and Oceania regions. The methods and intentions are described more fully by MacKinnon (1985), and have been summarised for OTA by Thorsell (1985b). Similar activities are under way in the Neotropical region.

Other biogeographic considerations

There are a number of 'kinds' of ecosystem that do not fall easily within the types of biogeographical system described so far at the international level, these are ecosystems such as wetlands and coral reefs, and to a certain degree mountains and oceanic islands. In each case the ecosystem concerned forms a sort of mosaic of 'islands' superimposed onto other biogeographic considerations, and is thereby azonal.

The approach to studying the protection of these systems therefore has to be correspondingly different. The method used most frequently is the listing and studying of all potentially important sites, followed by analysis of what is protected, and what needs protection. A good example of this approach would be the lists of important wetland sites drawn up by a number of countries (often at least partially as a result of the efforts under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)).

Few studies of this kind have been carried out at an international level (though there are notable exceptions over certain regions). However, over the last year or two attempts have been made to carry out this type of survey for several major ecosystem types including wetlands, coral reefs and oceanic islands. In essence the approach has been to collect information on all sites of international importance in each ecosystem type, but as the exact approach varies these initiatives are described separately.

Collection of information on coral reefs has been directly coordinated by CMC, working with the IUCN Commission on Ecology. This has involved collection of information on all reefs protected within national parks and reserves, all those proposed for protection, and all those recommended by qualified experts as requiring protection or management on the basis of their scientific interest or economic importance. Much of the information made available so far is compiled as the First Version of the IUCN Directory of Coral Reefs of International Importance (three volumes each of about 500 pages) prepared for the 5th International Coral Reef Congress in Tahiti, May 1985.

Collection of information on wetlands of international importance has

continued for a number of years under projects partially or wholly supported by IUCN, the International Wildfowl Research Bureau (IWRB), the International Council for Bird Preservation (ICBP), and UNEP. U.S. Federal agencies and NGOs have also been involved in funding some of the work in south and central America and the Caribbean. In this case, definition of a wetland of international importance is essentially based on the 'Heiligenhafen' criteria as modified by the first conference of contracting parties to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Cagliari, 1980 (IWRB, 1980).

So far, information on wetlands of international importance has been collected and published for the Western Palaearctic (Carp, 1980; Scott, 1980), and for all sites listed under the Wetlands Convention (IUCN, 1983). The initial collection of information is completed for the neotropics and is now with IUCN for publication (Scott and Carbonell, in press). Work is also under way for Africa, assisted by the availability of much limnological information collected by SCOPE which is also due to be published next year (Burgis and Symoens, in press). Work will begin shortly on the Indomalayan region, building on work already being done by ICBP, the Interwader project and others.

Oceanic islands are an 'ecosystem group' for which information is widely scattered, even within a single region (e.g. Dahl, 1980), and where there are many particularly urgent problems. There is a therefore a real need to reestablish the database initiatives of the International Biological Programme (Douglas, 1969; Nicholson and Douglas, 1970). ICBP have already carried out the pilot project for an oceanic islands database (jointly planned with the IUCN Conservation Monitoring Centre), and therefore with the earlier IBP work much of the necessary groundwork has been done. IUCN and ICBP are actively seeking funding for the extension of this work to establish a fully developed database.

Concommitant with these database developments is the need for IUCN to develop computer software to help in handling the information. This is discussed further below, and again IUCN are actively seeking funding to carry out this work. This is particularly important, as in all cases the information derived from the above projects, when linked with other information available to CMC, can be used to assess the current conservation situation in each of the different ecosystems types, not only in terms of what is protected and what is not, but in terms of values, threats and so on. This type of database approach is clearly applicable to any discrete habitat type, and is an important development area for CMC.

USE OF THE INFORMATION

Assuming that the information is available, improvement in the use of the available information on status and trends of the in situ conservation of ecosystems depends on two groups of people: those who manage the information, and those who use it. At the international level, and in the case of IUCN the information on protected areas is managed by CMC's Protected Areas Data Unit, but it is used by several other groups, in particular IUCN's Commission on National Parks and Protected Areas (CNPPA).

CNPPA carries out and fosters a wide range of activities for IUCN including development of international priorities for management, focussing of public attention on protected area issues, training, development of publications, support for regional expert meetings, provision of advice to international protected area programmes, and so on. The Commission's activities are largely spelled out in detail in the Bali Action Plan (Miller, 1984), and have been further described for OTA by Thorsell (1985b). As has been noted earlier there is close contact between CNPPA and PADU, with joint work including the use of global biogeography to identify areas where there is inadequate protected areas coverage, and the development of publications which help to identify priorities and to publicise what is being done. Information on specific sites or groups of sites is also of value to CNPPA in making evaluations of world heritage nominations, and was used in 1984 in preparing a presentation on the world's most threatened protected areas.

However, it will be apparent, and has been indicated above, that information on protected areas has much wider application than in the further management and development of protected area systems. Such areas also have a key role to play in wider land-use management and planning, a role that is implicit in much of the work of IUCN and others on protected areas, and which was a central theme in the World National Parks Congress held in Bali, Indonesia, in 1982 (McNeely and Miller, 1984). This role is discussed in a wide variety of publications already quoted, and the aims are well stated in the Bali Action Plan (Miller, 1984) and Action Plans subsequently developed for Africa (in IUCN, 1983), Indomalaya (in Thorsell, 1985a) and more recently for Oceania.

One international programme of particular relevance to this theme is Unesco's Man and the Biosphere Programme, and in particular MAB Project 8; Biosphere Reserves. In summary, biosphere reserves are areas where there can be long-term in situ conservation of plant and animal genetic resources,

together with research on ecosystem management and conservation, monitoring of changes in the biosphere, training of specialists, and environmental education (Batisse, 1985). The aims and achievements of the Biosphere Reserve programme so far were extensively discussed during the First International Biosphere Congress held in Minsk, Byelorussia/USSR, in 1983 (Unesco-UNEP, 1984). The congress derived an Action Plan for Biosphere Reserves which has now been adopted by the International Co-ordinating Council of the MAB Programme (Unesco, 1984). The need for an international database on biosphere reserves to help implement this plan is clear, and was addressed at the congress by Harrison (1984), who also discussed standardisation in research and monitoring. In the same session Gregg (1984) discussed the development of scientific programmes to support the multiple roles of biosphere reserves. Both papers make mention of the plan developed by the US National MAB Committee (1979) for development of a staged programme for monitoring and research in biosphere reserves. Unesco are now working with various groups including the US MAB Committee, the Nature Conservancy and the Smithsonian Institution, as well as IUCN, to develop and implement an information system for biosphere reserves which should considerably enhance their value for in situ conservation of biological diversity.

The Global Environment Monitoring System (GEMS) was set up at UNEP, Nairobi, with the specific aim of coordinating environmental monitoring at the global level in order to standardize data collection techniques and to make quality control, monitoring methods and data accessible (Croze, 1984), in order to be able ultimately to produce information necessary and sufficient for the understanding and management of ecosystems. GEMS, therefore, aims to coordinate and direct existing talent and facilities, making use, for example, of other specialised agencies of the United Nations; the World Health Organisation, the World Meterological Organisation, the Food and Agriculture Organisation, Unesco, and so on. The 'nature conservation' part of this database is provided by the IUCN Conservation Monitoring Centre. To be useful, this central database must also be run on computer, so GEMS has embarked on a two-year pilot project to set up a computerized Global Resource Information Database (GRID).

Because the input is from a far wider range of resources than is currently available to the IUCN database (for example satellite imagery, aerial photographs), once GEMS have the GRID fully implemented this will lead to a far better understanding of the status and trends within each ecosystem. Combined with the information IUCN now has, and the improved information it

will have by the time GRID is operational (on protected areas, species of concern, discreet habitats and so on) this will enable information users to be much more effective in their use of information to implement conservation action.

Other key users of environmental information are the major development banks. Where these agencies can be provided relatively quickly with background information on conservation concerns within the region - in terms of protected areas, species, habitats etc. - they may be influenced to modify projects to take this sort of information into account, or to obtain and use this information in project development. This stage does not and cannot replace the use of expert consultants on field missions, but provides the necessary background and advance information necessary in project development and planning. The importance the World Bank attaches to environmental aspects of development projects is discussed by Goodland (1984), who also discusses the role of wildlands management in economic development (Goodland, 1985). Additionally, CMC's recent experience is that the private sector is also interested in having such an information service available.

It is clear therefore that the potential for use of information on the situation, status and trends in ecosystems, and the situation, status and trends of in situ conservation in ecosystems, is both wide-ranging and varied, and potentially involves many organisations at the national, regional and international level, as well as governments and individuals.

Because of the wide range of potential users, it would be rather presumptive to suggest how use of the information could be improved, except to say that the better the information and the better the handling of that information, the more effectively it can be used (measures for improvement of the international database which IUCN is already developing are detailed in the next section). What can be stressed however, is the need to:

1. Encourage and support those organisations which use or foster use of environmental data in conservation of ecosystems; and
2. Encourage both wider use of the available information and further research into the land-use, management and planning aspects of the application of that information.

The majority of decisions affecting development and use of natural resources are made at the national or local level, and it should therefore also be noted that there is a specific need to:

3. Encourage the use of a wide range of environmental data in the making of decisions affecting the management and use of natural resources at all levels.

Needless to say, many organizations, government departments, etc., are already working in this area, and what is needed in may case is the additional support and encouragement (both financial and otherwise) to ensure that such activities become an integral and essential part of land-use planning.

Clearly another factor affecting the use of the data available is its accessibility. Information held by the IUCN Conservation Monitoring Centre is, in principle, available to anyone, though the need to both maintain the database and to prepare information for those needing it inevitably leads to the need to make some charge for it. At present we normally respond to written queries from external users offering to provide either packages of basic - largely uninterpreted - data, or by writing reports tailored to a user's requirements. We are however investigating the use of direct access methods with the U.S. National Park Service. It should nevertheless be noted that direct access methods can only provide a 'quick and dirty' answer to any given query at present because information cannot currently be incorporated by CMC as fast as it is being received. This is detailed further below.

These comments will apply to most databases, so even though the networking of information sources is desirable, and probably inevitable, one should never loose sight of the fact that it is unlikely that the computer files will ever contain all the information available to a database, nor is it likely that a computer will ever be able to replace the interpretive ability of an expert familiar with the data. Added to this is the additional problem of different databases using different conventions in the interpretation of their data for codifying it. It should therefore be stressed that

4. Close cooperation between all organisations managing information on conservation issues should be actively encouraged and supported, to ensure good flow of information, avoidance of duplication of effort, and use of similar methods of interpreting data where necessary, with the ultimate aim of improving the use of information.

Possible U.S. response

Recommendations on actions that can/should be taken by various U.S. institutions, development banks, non-governmental groups etc. have been prepared for Congress in two recent documents, the U.S. Strategy on the Conservation of Biological Diversity (an interagency Task Force Report, 1984) and Conserving International Wildlife Resources: The United States Response (a report by The Secretary of State and The Secretary of the Interior, 1984). Within these documents a number of the recommendations clearly relate to the

importance of information on the status and trends of ecosystems and their conservation, and directly relate to use of that information. As noted by Thorsell (1985b), IUCN is in general agreement with the thrust of the whole range of recommendations contained within these documents.

Thorsell also recommends a number of actions that could be taken within the United States which would involve use of information directly provided by the IUCN Conservation Monitoring Centre. This includes wider use of the database within the ongoing programmes of USAID, the State Department, and the Department of the Interior. It is also suggested that all U.S. missions abroad should hold up-to-date information on conservation issues within the countries concerned, and that such information could be provided by IUCN/CMC on a subscription basis. As has been noted, IUCN is currently investigating with U.S. National Park Service the possibility of on-line access to protected areas information. Clearly other U.S. organizations may also be interested in using this sort of access, including other federal agencies, the Nature Conservancy and the World Wildlife Fund.

However, perhaps the most important point to make here is that if the United States agencies, institutions etc. encourage and support the use of environmental data in decision making, and use such data in their own decision making processes, this should in itself encourage the development of the information base at all levels. This information base will then provide an improved tool both for making new planning decisions, and reviewing the effects of previous decisions. Further development of the use of information within the U.S. will hopefully also lead to further use of environmental information within planning and managment in other parts of the world.

IMPROVING THE DATABASE

Within the protected areas database now run by IUCN we already have an international database which we believe to be of some value, and which was recognised by the World National Parks Congress as being a valuable tool in the implementation of the Bali Declaration (Recommendation 1, World National Parks Congress, 1984).

The IUCN Conservation Monitoring Centre is also recognised by Conserving International Wildlife Resources: The United States Response (a report by The Secretary of State and The Secretary of the Interior, 1984) as the "principal focal point for information on the status of plants and animals, existing

parks and protected areas". Recommendation 2.1 of that report, which emphasisies the value of collecting "in one world repository, sources of information concerning conservation status of species and habitat" also notes that CMC has already made "important strides in this regard and, because of sovereignty sensitivities, would be more likely to receive information freely from all countries" than a similar database in Washington.

This being the case, it is worthwhile discussing further here a number of requirements/shortcomings in the existing database which are apparent to us. Many of these points could equally apply to other databases at local, national and regional levels, and several of the recommendations at the end of the section also apply to these databases. Other recommendations relate to the actual groudwork necessary for the collection of information, which is not discussed in much detail here (it is presumably covered by other papers solicited by OTA).

Assuming that the aims and objectives of the database are clear, there remain three main parts to its development and maintenance:

a) continual collection, verification and compilation of information on protected areas;

b) the management of that information; and

c) use of that information.

The last item has already been discussed.

<u>Collection, verification and compilation of information on protected areas</u>

As was emphasised earlier, good flow of information to an international database ultimately depends on the availability of information within each country; ideally with good information flow from each area to the national level, and from here on to the international database. At each level this information is of value when stored within a database of some form (not necessarily a computer database). Decisions are generally made at the local or national level, therefore within a specific area that information is of value in the management of that site (and of similar sites elsewhere), while at the national level the information is of value in assessment, management and planning within the national system. It is clear that not only must these databases exist, but the wherewithal must be provided for them to interrelate with each other, and with the international database.

In some countries information flow is currently good, in others it is not. It therefore follows that the flow of information to the international level is itself rather variable. The information that comes to CMC also comes from

a variety of different sources, from the management authorities, from NGOs, from individual scientists, and so on. In other words, the process of information collection is rather labour intensive, since information must be compared and often verified before the work of incorporating it into either data files or protected area information sheets begins. As a result of this and low staff numbers (PADU is currently limited to a staff of four) this becomes rather a slower process within the IUCN database than is desirable.

In many cases it is also necessary to review the relevant literature on parks and reserves, and to have it to hand for further information, verification of facts, etc. Much of this literature is available in libraries, but it would be sensible in the future to ensure receipt of many more unpublished reports, and other papers and publications direct from the protected areas authorities, international organisations and others responsible. IUCN's Conservation Monitoring Centre does not currently have any set budget for purchase of relevant publications, but this clearly needs to be a future budgetary item.

As well as the national databases mentioned above, a number of regional databases, or 'specialist' databases also exist with which it is important to interrelate. Currently, interrelationship is often hampered by the lack of available funds for the necessary travel to make effective contact between those responsible for organisation of these databases. This is unfortunate not only because of the resulting lower level of interaction, but also as it may result in several international groups approaching a country for essentially similar information.

Within the IUCN Conservation Monitoring Centre we are currently in the process of reviewing data collection procedures on protected areas and are already implementing some improvements. These procedures will also be an item for discussion by a working group set up by IUCN's Commission on National Parks and Protected Areas to look into data collection, management and dissemination. It is intended that this working group will be an advisory body for the IUCN Conservation Monitoring Centre's work on protected areas.

The above would suggest that some of the key actions needed to ensure that good information is available at the international level are to:

1. Strengthen and encourage national and local conservation database development;
2. Foster the free exchange of information and maintain its flow from the local to the national and on to the international level (including support for regional meetings such as those organized by IUCN's Commission on National Parks and Protected Areas);

3. Encourage closer ties between the various regional and international databases dealing with conservation issues; and
4. Strengthen existing database capability of IUCN with the provision of more staff time to improve the capacity to collect and compile information on protected areas, and the provision of proper library facilities.

It should finally be noted here, that the current limiting factor on collection (and management) of information on protected areas by the IUCN Conservation Monitoring Centre remains inadequate staffing levels. There is urgent need for at least two further senior research staff and appropriate support.

As has been mentioned above, the development of national and/or regional conservation databases is a logical step for a variety of reasons, and many are being, or have been, set up in many countries (note for example the work of the U.S. Nature Conservancy in this regard). IUCN's experience in development of its conservation database could be put to good use in assisting in this national/regional development. It is also worth noting that there is still a general lack of use of computers in management of conservation information.

IUCN's Computer Service Unit (within the Conservation Monitoring Centre) has the capability but not the opportunity to develop a standard software package which could be used on micro-computers for establishment of national databases. Apart from the obvious advantage of the simplicity of being able to get a system 'off the shelf' (once the software has been developed) this would also mean that the information would be stored within these databases in a form which could be readily understood within IUCN's computers. It would be likely that CMC would cooperate closely with the U.S Nature Conservancy (International Programme) in this sort of activity.

Management of information

Geographical Information System: Clearly to be of maximum benefit in the analysis of the status and trends of in situ conservation of biological diversity, all of the information available on protected areas must be tied as closely as possible (preferably within the computer database) with information on species and ecosystems, so that comparisons and analyses can be readily carried out. Various 'classification' systems exist which can be used in the assessment of the protected area coverage of various ecosystems. These can be divided into two forms, those that are map based and those that are not.

Mention has already been made of the maps and methodologies of Udvardy (1975), Bailey (1983) and Hayden et al (1984). Other major regional maps which may be important in this sort of analysis are, for example, those for the ecoregions of the United States (Bailey, 1976) and North America (Bailey and Cushwa, 1981), the physical geographical regions of the Nordic countries (Nordic Council of Ministers, 1983), the physical geographical regions of the Soviet Union (Gvozdetskiy, 1968), and so on.

Clearly IUCN needs the capability to handle maps so that information within their database can be quickly located on any part of any map. The ideal solution, and the best long term solution, is the availability of computer hardware and software to handle the maps and their information content, and the necessary support staff to assist in their use. Once this software and hardware is available, in theory any map can be input (including vegetation maps, species distribution maps, distribution of remaining 'virgin' forest, geological maps, soils maps, climatic maps, etc.), and analysis can then be made of protected area coverage using any combination of maps required.

It is also of value to consider information on non-biological or geographical aspects such as distribution of the human population, relative effect of man on different regimes, desertification, estimated productivity, etc. in analysis of in situ conservation. Much of this information can be input as maps, and therefore could be easily handled with full Geographical Information Systems (GIS) capability.

An improved Geographical Information System (GIS) will also bring a series of other benefits. It will make it much easier to relate one area to another, making the database more able to indicate where areas meet, overlap or fall one within another. For example, when asked for a list of conservation areas over 1 million hectares it will not only provide a list of those over this figure, but also a list of sites where their contiguity to other sites takes them over this figure. It will similarly simplify analysis of 'percentage cover' of any given geographical region.

Such a system would also enable us to determine where within a given area another smaller area lies. That this capability is important can be demonstrated by two simple examples. Firstly, it will be able to tell us very quickly which protected areas are on international borders, or the coast and so on. Secondly it will enable IUCN to identify not only which areas are within which biogeographical regions, but which are near the boundaries of those regions. As Pielou (1979) pointed out the areas where transitions occur are important in their own right and deserve special attention.

Another valuable corollary of the development and use of a full GIS would be the capability of relating the information on the size of an area with that on its relative isolation from other protected area, and perhaps also its shape. This should allow further detailed assessment of reserve networks and their efficiency, especially when combined with further information on the effectiveness of management, and eventually on species and species numbers/trends.

Habitats: It is clear that all information within a database must not only be linked to all geographical information based on maps, but on actual ground features. We need to know for example which protected areas actually contain tropical rain forest, elfin forest or mangroves, which contain sea grass beds, glaciers or limestone karst topography and so on. It therefore follows that information on each protected area needs to be linked with a 'habitat' classification system or with numerous partial systems such as vegetation systems (e.g. IUCN, 1973; Unesco, 1973), geomorphological systems, island systems (e.g. Dahl, 1980), wetland systems (e.g. Cowardin et al, 1975) etc. Information on each protected area is very variable, as we have noted, so classifications clearly need to be hierarchical so that information can be used, however crude or sophisticated. It has been suggested that a single system should be developed which will be used not only by IUCN for management of its information on protected areas and species, but also by the GRID.

Once such a scheme is available, this will form a major 'skeleton' throughout the CMC database, with both protected areas and species linked to the habitat types which they contain, or are found associated with, respectively. Implementation will be a very time consuming task, however, and one for which outside funding will be required.

Ecosystem inventories: As was noted earlier, IUCN has also been involved in projects concerning management of information on specific ecosystem types such as coral reefs, wetlands and oceanic islands. Work like this clearly needs to be improved and extended so that information on ecosystems of concern can be more effectively collected and managed, and linked with information on both the species and protected areas in those ecosystems. Only in this way can full assessment of the conservation status of these particular systems be made, and only when much of this information is together can recommendations and advice be given to conservation and development agencies and other interested groups.

Species inventories: One of the principal justifications given for the establishment and maintenance of protected areas is the conservation of genetic resources in situ. Therefore, it is of vital importance that information on what is found where is available to those needing it. The amount of information available at the local level is growing, and with the increasing availability of improved information handling methods it would seem likely that local and national database activity on the location of genetic resources will increase.

It is obvious, however, that an international database maintaining links with local, national and regional database activity is essential. The role of such a database would be to provide an overview; to demonstrate what is found where (i.e. an information retrieval service); to highlight resources that do not appear to be protected; and to draw the attention of management authorities to the relative importance of some of the species they protect (important resources that may not be protected elsewhere, for example).

CMC already has growing databases on both species and protected areas, while other groups such as Unesco (MAB programme), FAO and IBPGR are also exploring this type of database activity for either particular species groups or particular areas. Unesco (MAB), for example, are interested in developing a much more detailed information system for biosphere reserves. The U.S. National Committee for MAB have just funded an initial project between the Smithsonian Institution, the U.S. Nature Conservancy and the U.S. National Park Service to look at methodologies for developing and storing information on biosphere reserves (including the status of plant and animal taxa). A pilot testing of the methodologies will be carried out in selected biosphere reserves in China, Mexico and the U.S.A., but the system will be extended in time to cover all biosphere reserves. The IUCN Conservation Monitoring Centre will be involved in this project, and it is intended that CMC become an integral part of the international database on biosphere reserves.

IUCN already has on file large amounts of information on species of conservation concern (threatened species, economic plants/animals and other 'genetic resources', etc.). The most visible part of this database is the well known Red Data Book series (Lucas and Synge, 1978; Thornback and Jenkins, 1982; Groombridge, 1982; Wells et al, 1983; Collar and Stuart, 1985; Collins and Morris, 1985). However, to be able to establish to what degree particular species are actually represented in protected areas requires both a large increase in the amount of information collected and maintained by CMC, and the full linking of the information on protected areas and species within the

computer.

In many cases, however, this information may not actually exist yet - especially when information on species population size, status and trends are required. Also, the amount of information that could be included is infinite, and the process must therefore be restricted. However, no full assessment has yet been made on what species it would be valuable for such a database to include (though some work on this has been done for plant species), or from what types of areas. It is therefore necessary initially to carry out a study of what information is required for what species and from what areas, followed by an implementation stage which would involve a computer programming component, as well as the information collection and management. This work would be carried out in close collaboration with other international groups and agencies working in this field.

It should be noted, however, that establishment of a full species-area database would be a long term. labour intensive programme of work at all levels, from the information collectors, to local databases, and right through to the international level. Speeding up the process would require better information at the 'field' level, improved database activity, and improved coordination. IUCN, in cooperation with others, can assist in ensuring improved coordination, but perhaps of as much value would be the development by the IUCN Conservation Monitoring Centre of database software which could be used not only within CMC's database, but at all levels - thus ensuring increased compatability.

Effectiveness of management: It was noted above that IUCN's application of the system of management categories also currently attempts to take into account elements of management effectiveness rather than just management objectives. It would seem sensible to actually look at these issues separately, and IUCN's Commission on National Parks and Protected Areas are working on a questionnaire which can be used to evaluate the effectiveness of an area in achieving its management objectives. Wide use of such a questionnaire should lead to a better understanding of how effective the conservation effort is within different ecosystems. Again, as with most of these improvements in available information, implementation will be a time intensive process at all levels.

Additional key actions needed to ensure good management of information at the international level are therefore to:

5. Strengthen existing database capability of IUCN with the provision of a full GIS, the hardware to run it on, and the support staff to implement it.
6. Support the development of a comprehensive 'habitat information' classification, and once developed, support its implementation by international databases, and where relevant by national and regional databases.
7. Encourage application of improved methods to assess the achievement of management objectives for use at all database levels.

Also, to answer the full series of relevant questions on <u>in situ</u> conservation of ecosystems all this information relies on the available information on species and ecosystems. It is therefore necessary to:

8. Strengthen the existing database capability of IUCN to improve the capacity to collect and compile information on species of conservation concern, and ecosystems, and to link it more fully with information on protected areas.

Implicit in all of this discussion is that the information is of value at all levels - not just internationally, and therefore there is a need as recommended above to:

9. Encourage the development of national and local databases managing information for use in decision making and planning at those levels.

What must also be apparent, however, is the need for large amounts of information on species and habitat distribution. The more accurate and complete the records are, the more objective the biogeographical analyses can be, and hence the better the proposals/judgements made based on these analyses. This information depends on two factors, collection/identification, and coordination of information. There is therefore a need to:

10. Encourage and support the necessary basic research requiring systematists (to classify the species in the first place), fieldworkers and other scientists to identify and locate items of the biota (including habitats), and biogeographers and other scientists to analyse the available information);

and to:

11. Encourage the development of effective cross-linking/networking of databases maintaining information on species/habitat, location/distribution.

Clearly both of these activities are at the very core of information work in conservation, and involve a wide body of people from a wide range of

organizations. In particular one should note the role of museums and universities, as well as government offices such as parks and wildlife departments. The funding sources for these activities are similarly diverse.

Possible U.S. response

As was mentioned in the previous section, recommendations on actions that can/should be taken by various U.S. institutions, development banks, non-governmental groups etc. have been prepared for Congress in two recent documents, the U.S. Strategy on the Conservation of Biological Diversity (an interagency Task Force Report, 1984) and Conserving International Wildlife Resources: The United States Response (a report by The Secretary of State and The Secretary of the Interior, 1984). Many of the recommendations of these reports, if carried out, will lead to great improvement in the available information, and hopefully an improvement in information flow to the IUCN Conservation Monitoring Centre, and an improvement in information quality.

Clearly, however, CMC needs further resources to carry out these tasks. Direct core funding is perhaps the most obvious aspect of this requirement, and the most useful, but there are others. The possible input that could be made by U.S. agencies is therefore:

1. Contribution of additional core funding;
2. Payment of subscription fees to CMC for provision of information on a number of agreed topics over a given period of time;
3. Provision of funding for specific projects where CMC provides information to U.S. agencies;
4. Placement of U.S. personnel to work with the IUCN Conservation Monitoring Centre for given periods of time on specific agreed projects (or financial support for the same post).

In addition U.S. agencies should take an active role in development of the whole information network through:

5. Providing encouragement and support for those organisations actively involved in the development of such databases.
6. Providing support for international meetings of experts which foster the exchange of information.
7. Encourage and support the basic research necessary to provide much of the required background information.

This last point is a major one, and could in itself take up a whole paper.

SUMMARY

The following recommendations have been made in the preceeding discussion, but have been rearranged here in order to clarify their meaning when stated without the accompanying text. Several dealing with similar issues have been amalgamated.

Recommendations relating to the availability of information

1. Encourage and support the necessary basic research, requiring systematists (to classify the species in the first place), fieldworkers and other scientists to identify and locate items of the biota (including habitats), and biogeographers and other scientists to analyse available information.

2. Encourage and support the development of effective cross-linking and networking of all databases maintaining information on species/habitat locations/distributions.

Recommendations relating to national and local conservation databases

1. Encourage and support national and local conservation database development.

2. Encourage the use of a wide range of environmental data in the making of decisions affecting the management and use of natural resources at all levels.

Recommendations relating to improvement of information exchange

1. Foster the free exchange of information and maintain its flow from the local to the national and on to the international level (including support for regional meetings such as those organized by IUCN's Commission on National Parks and Protected Areas);

2. Encourage and support close cooperation between all organisations managing information on conservation issues to ensure good flow of information, avoidance of duplication of effort, and use of similar methods of interpreting data where necessary.

Recommendations relating specifically to IUCN's international database

1. Strengthen existing database capability of IUCN with the provision of more staff time to improve the capacity to collect and compile information on protected areas, and the provision of proper library facilities.

2. Strengthen the existing database capability of IUCN to improve the capacity to collect and compile information on species of conservation concern, and ecosystems, and to link it more fully with information on protected areas.

3. Strengthen existing database capability of IUCN with the provision of a full Geographical Information System, the hardware to run it on, and the support staff to implement it.

4. Support the development of a comprehensive 'habitat information' classification, and once developed, support its implementation by international databases, and where relevant by national and regional databases.

5. Support the development and application of improved methods to assess the achievement of management objectives within protected areas for use at all database levels.

Recommendations relating to use of the information

1. Encourage and support those organisations (at all levels) which use or foster use of environmental data in conservation of ecosystems.

2. Encourage both wider use of the available information and further research into the land-use, management and planning aspects of the application of that information.

However, perhaps the most important point to make in conclusion is that if United States agencies, institutions etc. encourage and support the use of environmental data in decision making, and use such data in their own decision making processes, this should in itself encourage the development of the information base at all levels. This information base will then provide an improved tool both for making new planning decisions, and reviewing the effects of previous decisions. Further development of the use of such information within the U.S. will hopefully also lead to further use of environmental information within planning and management in other parts of the world.

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LIST OF ABBREVIATIONS

CMC	IUCN Conservation Monitoring Centre
CNPPA	IUCN Commission on National Parks and Protected Areas
FAO	Food and Agriculture Organization of the United Nations
GEMS	UNEP Global Environment Monitoring System
GIS	Geographical Information System
GRID	GEMS Global Resource Inventory Database
IBP	International Biological Programme
IBPGR	International Board for Plant Genetic Resources
ICBP	International Council for Bird Preservation
IUCN	International Union for Conservation of Nature and Natural Resources
IWRB	International Waterfowl Research Bureau
MAB	Man and the Biosphere (a Unesco programme)
OECD	Organization for Economic Cooperation and Development
PADU	CMC's Protected Areas Data Unit
UNEP	United Nations Environment Programme
Unesco	United Nations Educational, Scientific and Cultural Organization
USNPS	U.S. National Park Service
USFWS	U.S. Fish and Wildlife Service

Table 1: Categories and management objectives of protected areas

I	Scientific Reserve/Strict Nature Reserve: To protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring, education, and for the maintenance of genetic resources in a dynamic and evolutionary state.
II	National Park: To protect natural and scenic areas of national or international significance for scientific, educational, and recreational use.
III	Natural Monument/Natural Landmark: To protect and preserve nationally significant natural features because of their special interest or unique characteristics.
IV	Managed Nature Reserve/Wildlife Sanctuary: To assure the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific human manipulation for their perpetuation.
V	Protected Landscape or seascape: To maintain nationally significant natural landscapes which are characteristic of the harmonious interaction of man and land while providing opportunities for public enjoyment through recreation and tourism within the normal life style and economic activity of these areas.
VI	Resource Reserve: To protect the natural resources of the area for future use and prevent or contain development activites that could affect the resource pending the establishment of objectives which are based upon appropriate knowledge and planning.
VII	Natural Biotic Area/Anthropological Reserve: To allow the way of life of societies living in harmony with the environment to continue undisturbed by modern technology.
VIII	Multiple-Use Management Area/Managed Resource Area: To provide for the sustained production of water, timber, wildlife, pasture, and outdoor recreation, with the conservation of nature primarily oriented to the support of the economic activities (although specific zones may also be designed within these areas to achieve specific conservation objectives).
IX.	Biosphere Reserve: To conserve for present and future use the diversity and integrity of representative biotic communities of plants and animals within natural ecosystems, and to safeguard the genetic diversity of species on which their continuing evolution depends.
X.	World Heritage Site: To protect the natural features for which the area was considered to be of World Heritage quality, and to provide information for world-wide public enlightenment.

Adapted by Thorsell (1985) from IUCN (1984)

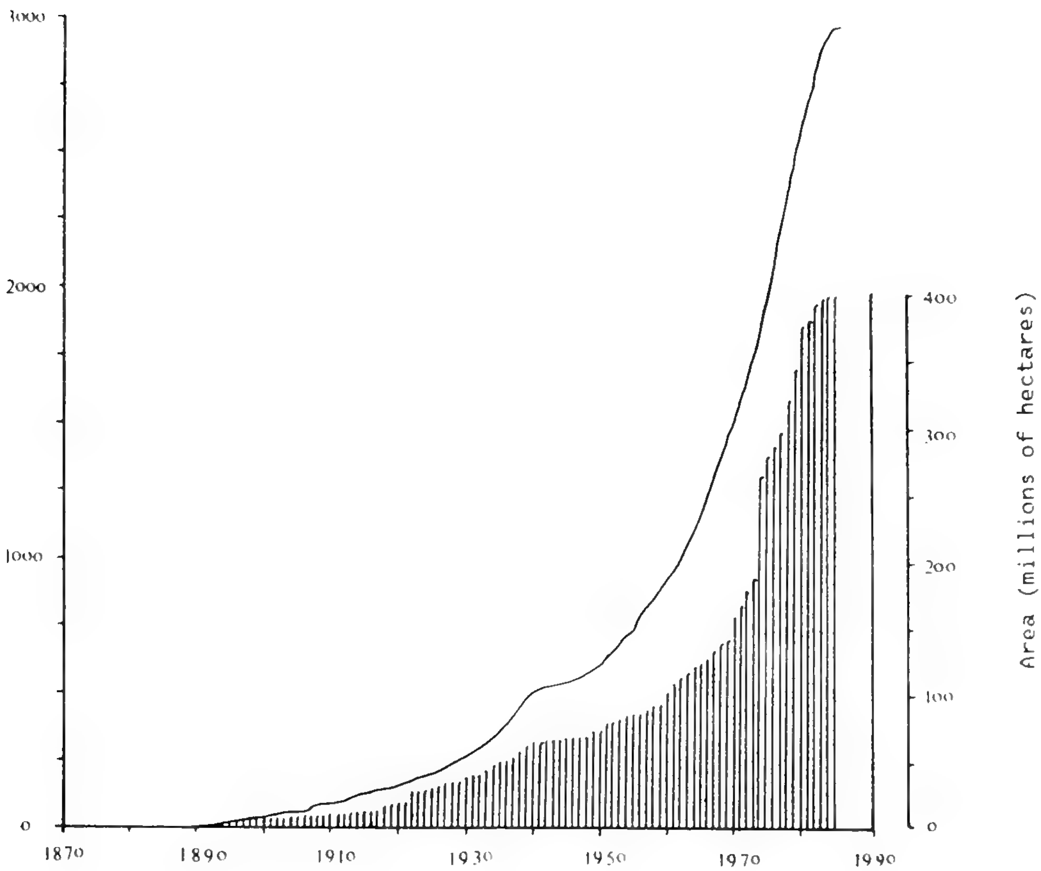


Figure 1 Growth of the world coverage of protected areas.
Number of protected areas (————) and total area protected (|||||||||||) in IUCN management categories I–V

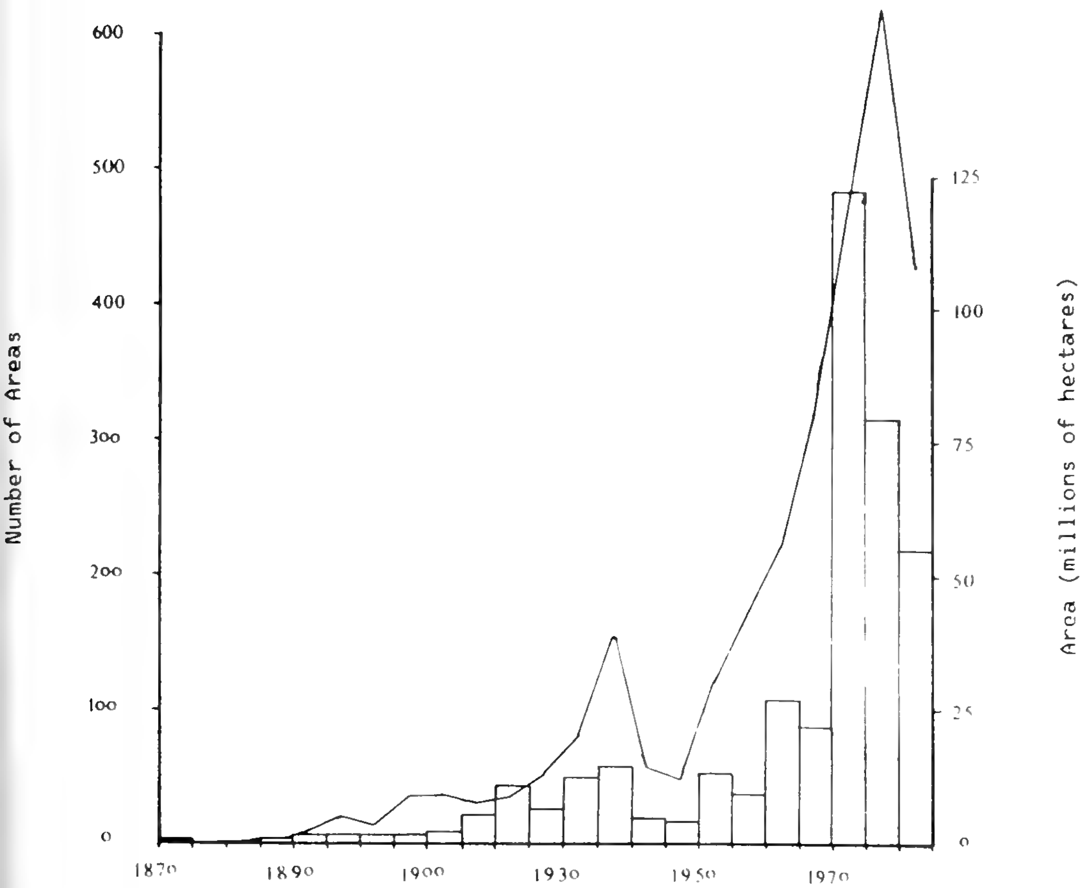
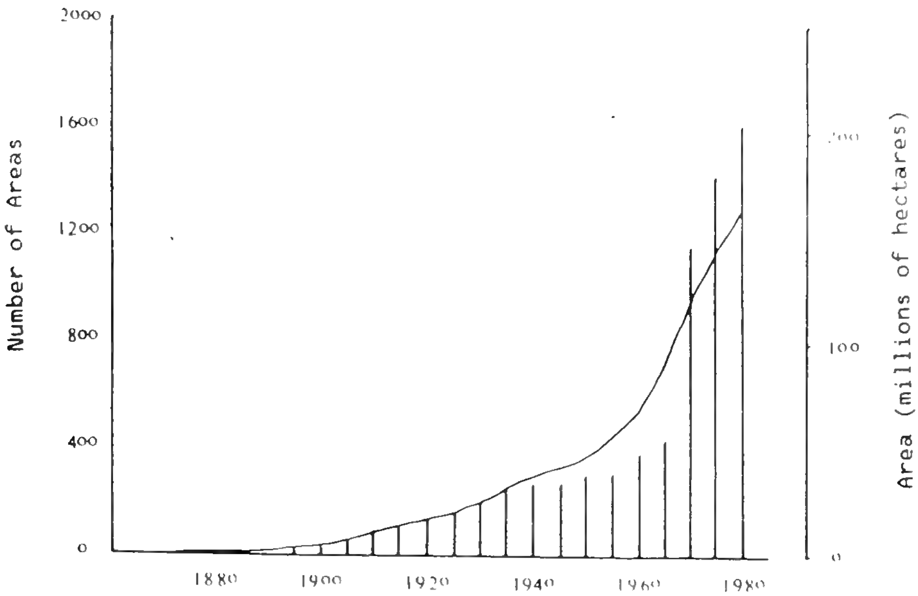
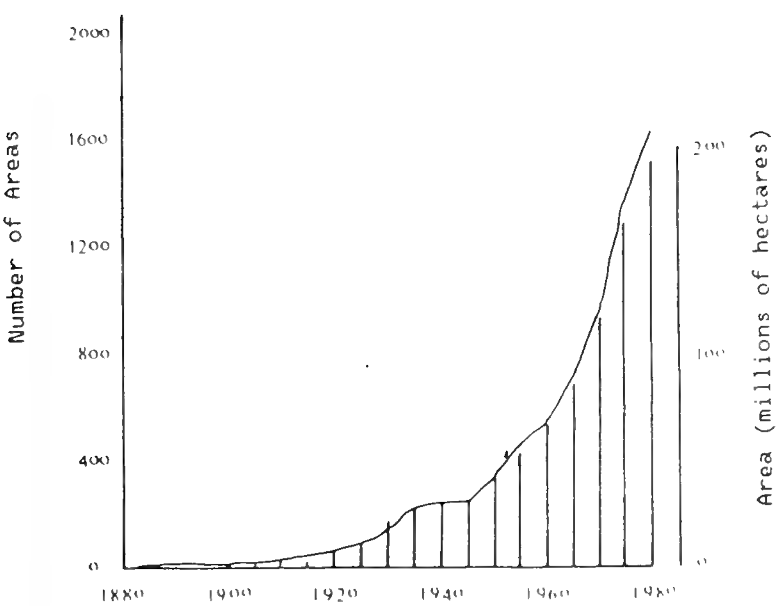


Figure 2 Number of protected areas established (———) and their total area (bar chart symbol) in each five year period since 1870. IUCN management categories I–V.

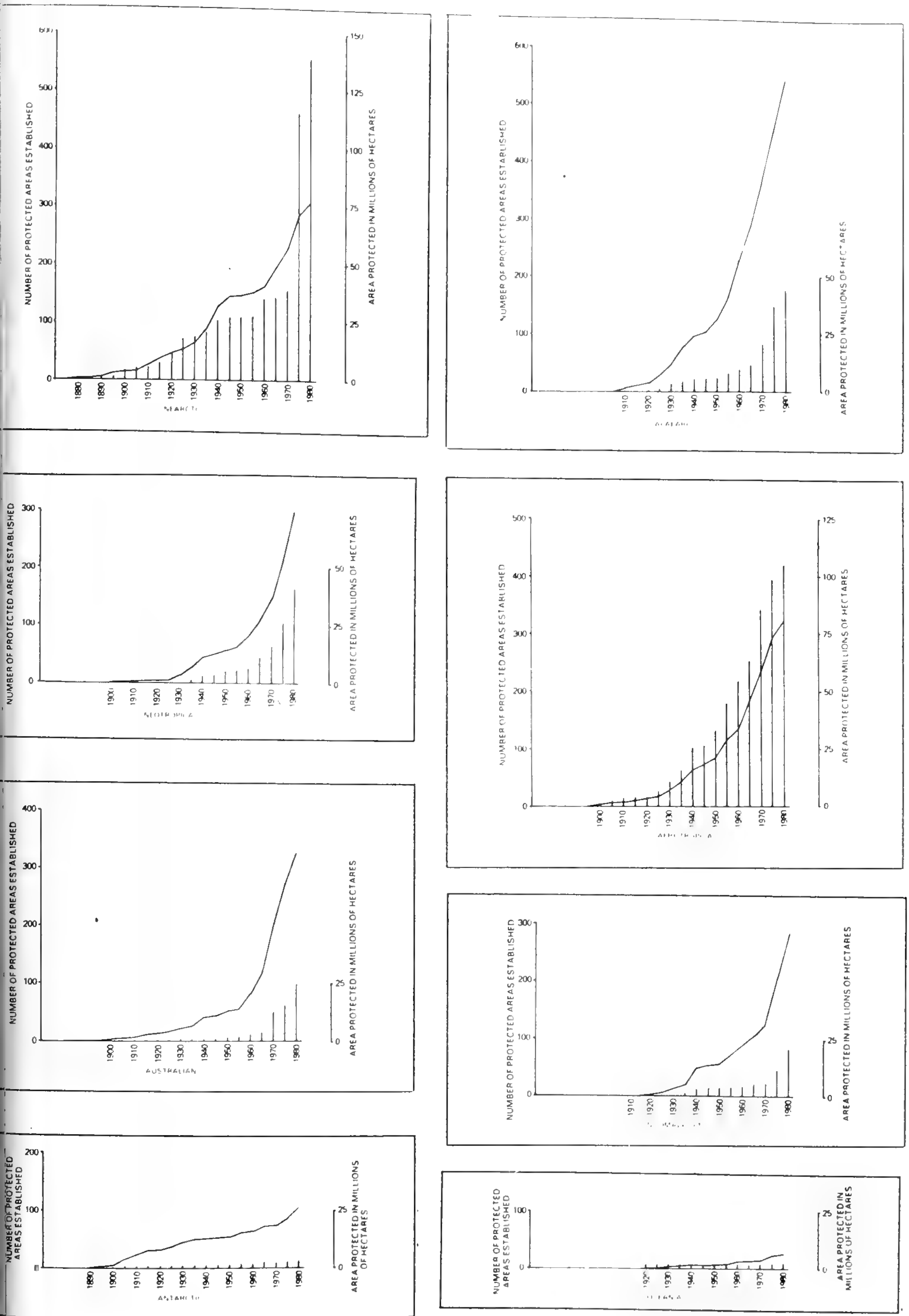
OECD countries



Non—OECD countries



igure 3 Number of protected areas (———) and total area protected (|||||||) in IUCN management categories I–V broken down by whether the sites are within countries which are members of OECD or not.



<u>Figure 4</u> Number of protected areas (———) and total area protected (|||||||||) in IUCN management categories I–V, broken down by biogeographical realm (after Udvardy, 1975).

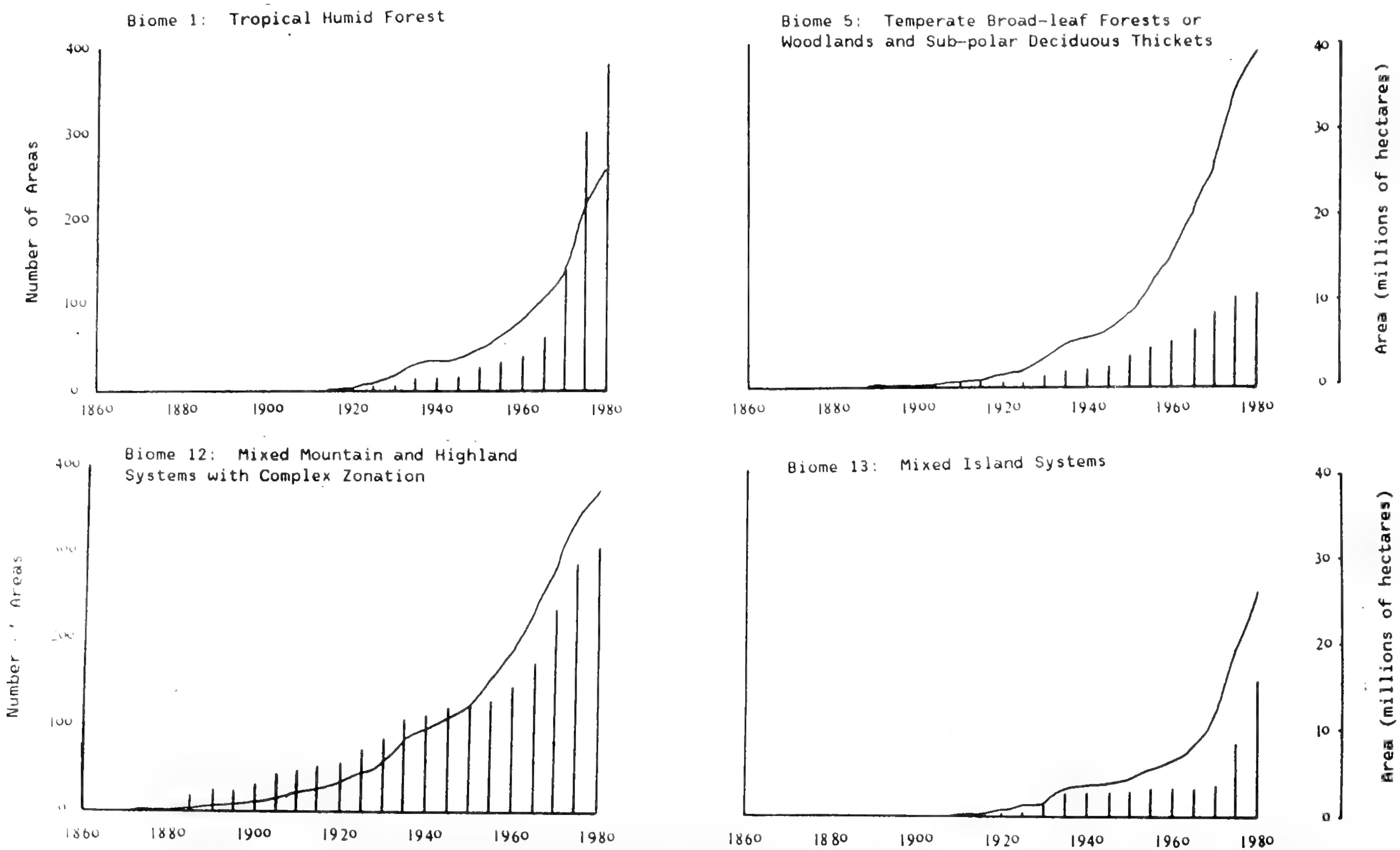


Figure 5 Number of protected areas (———) and total area protected (| | | | |) in IUCN management categories I-V, broken down by biome type (after Udvardy, 1975)

Table 2: Protected areas in South America

Country	Size of country	Population	No of Areas	Total area (hectares)	ha/sqkm (%)	ha protected per 1,000 head
ARGENTINA	2,776,643	26,393,000 (1978)	29	2,594,351	0.93	98.30
BOLIVIA	1,098,575	6,113,000 (1978)	12	4,707,690	4.29	770.11
BRAZIL	8,511,968	115,397,000 (1978)	50	11,894,302	1.40	103.07
CHILE	756,943	10,656,000 (1977)	64	12,737,360	16.83	1,195.32
COLOMBIA	1,138,907	25,048,000 (1977)	30	3,958,750	3.48	158.05
ECUADOR	455,502	7,814,000 (1978)	12	2,627,365	5.77	336.24
FRENCH GUIANA	90,000	59,000 (1977)	0	0		
GUYANA	214,969	819,000 (1978)	1	11,655	0.05	14.23
PERU	1,285,215	16,819,000 (1978)	11	2,407,642	1.87	143.15
PARAGUAY	406,750	2,888,000 (1978)	9	1,120,538	2.75	388.00
SURINAME	163,820	448,000 (1977)	9	582,400	3.56	1,300.00
URUGUAY	186,925	2,864,000 (1978)	6	28,778	0.15	10.05
VENEZUELA	912,047	13,122,000 (1978)	34	7,388,912	8.10	563.09

Total area of South America	17,998,264 sq km
Total population	228,440,000
Total number of protected areas	267
Total area protected	50,059,743 hectares
Percentage protected	2.78 ha protected/sq.km
Comparison with population	219.14 ha/1000 people

Based on IUCN (1985), IUCN Management Categories I-V

Table 3: Analysis by biome type

Biome and Realm	Number of areas	Total area (hectares)
Tropical humid forests		
Afrotropical	44	8,905,733
Indomalayan	122	5,092,774
Australian	53	7,776,347
Neotropical	61	17,277,197
	280	39,052,051
Subtropical/temperate rainforests/woodlands		
Nearctic	18	4,250,171
Palaearctic	48	1,742,994
Australian	26	904,976
Antarctic	145	2,783,281
Neotropical	38	8,848,838
	275	18,530,260
Temperate needle-leaf forests/woodlands		
Nearctic	53	30,321,679
Palaearctic	122	8,463,690
	175	38,785,369
Tropical dry forests/woodlands		
Afrotropical	240	48,673,552
Indomalayan	238	10,420,406
Australian	10	934,272
Neotropical	93	5,501,447
	581	65,529,677
Temperate broad-leaf forests		
Nearctic	82	1,890,216
Palaearctic	400	9,631,346
Neotropical	1	5,415
	483	11,526,977
Evergreen sclerophyllous forests		
Nearctic	6	52,010
Palaearctic	122	3,374,156
Afrotropical	41	1,620,967
Australian	301	6,918,823
Neotropical	5	38,795
	475	12,004,751

Table 3 (cont.): Analysis by biome type

Biome and Realm	Number of areas	Total area (hectares)
Warm deserts/semi-deserts		
Nearctic	22	3,962,948
Palaearctic	7	616,534
Afrotropical	57	23,783,085
Indomalayan	35	1,628,854
Australian	33	10,165,383
Neotropical	7	1,446,751
	161	41,603,555
Cold-winter deserts		
Nearctic	15	657,128
Palaearctic	57	12,854,167
Neotropical	4	36,700
	76	13,547,995
Tundra communities		
Nearctic	20	107,924,951
Palaearctic	8	7,247,904
Antarctic	12	295,034
	40	115,467,889
Tropical grasslands/savannas		
Australian	12	2,041,393
Neotropical	18	7,011,403
	30	9,052,796
Temperate grasslands		
Nearctic	25	387,751
Palaearctic	22	805,408
Australian	34	670,163
Neotropical	9	70,516
	90	1,933,838
Mixed mountain systems		
Nearctic	81	8,321,078
Palaearctic	231	8,071,815
Afrotropical	38	5,104,626
Neotropical	86	11,037,282
	436	32,534,801

Table 3 (cont.): Analysis by biome type

Biome and Realm	Number of areas	Total area (hectares)
Mixed island systems		
Palaearctic	9	52,142
Afrotropical	4	23,033
Indomalayan	177	10,426,372
Oceanian	54	4,127 602
Neotropical	26	1,190,599
	270	15,819,748
Lake systems		
Nearctic	7	444,713
Palaearctic	1	18,300
Afrotropical	2	55,100
Neotropical		
	10	518,113
Biogeographical classification unknown	132	7,866,578
TOTAL	3,514	423,774,398

Table 4: Analysis by biogeographical province

	Name of Province	Number of areas	Total area (hectares)
1 01 02	Sitkan	12	3,869,827
1 02 02	Oregonian	6	380,344
1 03 03	Yukon Taiga	12	21,010,636
1 04 03	Canadian Taiga	41	9,311,043
1 05 05	Eastern Forest	39	1,155,364
1 06 05	Austroriparian	43	734,852
1 07 06	Californian	6	52,010
1 08 07	Sonoran	11	3,464,499
1 09 07	Chihuahuan	10	493,332
1 10 07	Tamaulipan	1	5,117
1 11 08	Great Basin	15	657,128
1 12 09	Aleutian Islands	7	7,025,370
1 13 09	Alaskan Tundra	9	25,292,471
1 14 09	Canadian Tundra	2	4,557,110
1 15 09	Arctic Archipelago		0
1 16 09	Greenland Tundra		0
1 17 09	Arctic Desert and Icecap	2	71,050,000
1 18 11	Grasslands	25	387,751
1 19 12	Rocky Mountains	46	6,783,793
1 20 12	Sierra-Cascade	16	1,251,492
1 21 12	Madrean-Cordilleran	19	285,793
1 22 14	Great Lakes	7	444,713
		329	158,212,645
2 01 02	Chinese Subtropical Forest	10	312,509
2 02 02	Japanese Evergreen Forest	38	1,430,485
2 03 03	West Eurasian Taiga	106	5,061,090
2 04 03	East Siberian Taiga	16	3,402,600
2 05 05	Icelandian	22	791,431
2 06 05	Subarctic Birchwoods	14	258,590
2 07 05	Kamchatkan	1	964,000
2 08 05	British Islands	34	1,463,117
2 09 05	Atlantic	96	1,063,740
2 10 05	Boreonemoral	55	743,047
2 11 05	Middle European Forest	97	1,232,282
2 12 05	Pannonian	22	245,056
2 13 05	West Anatolian	1	11,338
2 14 05	Manchu-Japanese Mixed Forest	22	1,480,074
2 15 05	Oriental Deciduous Forest	36	1,378,671
2 16 06	Iberian Highlands	42	1,835,557
2 17 06	Mediterranean Sclerophyll	80	1,538,599
2 18 07	Sahara	2	117,094
2 19 07	Arabian Desert	5	499,440
2 20 08	Anatolian-Iranian Desert	32	5,499,190
2 21 08	Turanian	13	1,170,858
2 22 08	Takla-Makan-Gobi Desert	2	4,507,850

Table 4 (cont.): Analysis by biogeographical province

	Name of Province	Number of areas	Total area (hectares)
2 23 08	Tibetan	1	266,913
2 24 08	Iranian Desert	9	1,409,356
2 25 09	Arctic Desert	5	3,491,000
2 26 09	Higharctic Tundra	1	795,650
2 27 09	Lowarctic Tundra	2	2,961,254
2 28 11	Atlas Steppe	3	51,775
2 29 11	Pontian Steppe	16	581,053
2 30 11	Mongolian-Manchurian Steppe	3	172,580
2 31 12	Scottish Highlands	20	81,723
2 32 12	Central European Highlands	105	2,037,182
2 33 12	Balkan Highlands	32	390,241
2 34 12	Caucaso-Iranian Highlands	42	2,236,152
2 35 12	Altai Highlands	2	935,093
2 36 12	Pamir-Tian-Shan Highlands	17	616,490
2 37 12	Hindu Kush Highlands	1	14,786
2 38 12	Himalayan Highlands	10	1,708,148
2 39 12	Szechwan Highlands	2	52,000
2 40 13	Macaronesian Islands	7	48,095
2 41 13	Ryukyu Islands	2	4,047
2 42 14	Lake Ladoga		0
2 43 14	Aral Sea	1	18,300
2 44 14	Lake Baikal		0
		1,027	52,878,456
3 01 01	Guinean Rain Forest	15	907,720
3 02 01	Congo Rain Forest	23	7,754,775
3 03 01	Malagasy Rain Forest	6	243,238
3 04 04	West African Woodland/Savanna	53	13,543,787
3 05 04	East African Woodland/Savanna	36	7,873,091
3 06 04	Congo Woodland/Savanna	5	2,990,700
3 07 04	Miombo Woodland/Savanna	33	13,396,995
3 08 04	South African Woodland/Savanna	105	10,437,555
3 09 04	Malagasy Woodland/Savanna	7	388,224
3 10 04	Malagasy Thorn Forest	1	43,200
3 11 06	Cape Sclerophyll	41	1,620,967
3 12 07	Western Sahel	7	1,726,000
3 13 07	Eastern Sahel	2	1,719,700
3 14 07	Somalian	18	4,142,182
3 15 07	Namib	7	6,768,070
3 16 07	Kalahari	8	9,282,803
3 17 07	Karroo	15	144,330
3 18 12	Ethiopian Highlands	5	636,000
3 19 12	Guinean Highlands	2	335,625
3 20 12	Central African Highlands	9	3,622,985
3 21 12	East African Highlands	9	431,108
3 22 12	South African Highlands	13	78,908

Table 4 (cont.): Analysis by biogeographical province

	Name of Province	Number of areas	Total area (hectares)
3 23 13	Ascension and St Helena Islands		0
3 24 13	Comores Islands and Aldabra	1	19,000
3 25 13	Mascarene Islands	3	4,033
3 26 14	Lake Rudolf		0
3 27 14	Lake Ukerewe (Victoria)	1	45,700
3 28 14	Lake Tanganyika		0
3 29 14	Lake Malawi (Nyasa)	1	9,400
		426	88,166,096
4 01 01	Malabar Rainforest	30	1,303,273
4 02 01	Ceylonese Rainforest	1	97,956
4 03 01	Bengalian Rainforest	22	657,352
4 04 01	Burman Rainforest		0
4 05 01	Indochinese Rainforest	28	1,780,756
4 06 01	South Chinese Rainforest	21	165,709
4 07 01	Malayan Rainforest	20	1,087,728
4 08 04	Indus-Ganges Monsoon Forest	136	6,835,608
4 09 04	Burma Monsoon Forest	18	515,429
4 10 04	Thailandian Monsoon Forest	20	942,417
4 11 04	Mahanadian	17	1,022,379
4 12 04	Coromandel	3	105,828
4 13 04	Ceylonese Monsoon Forest	36	544,709
4 14 04	Deccan Thorn Forest	8	454,036
4 15 07	Thar Desert	35	1,628,854
4 16 13	Seychelles and Amirantes Islands	2	2,893
4 17 13	Laccadives Islands		0
4 18 13	Maldives and Chagos Islands		0
4 19 13	Cocos-Keeling and Christmas Islands	1	1,600
4 20 13	Andaman and Nicobar Islands	8	28,592
4 21 13	Sumatra	29	4,253,807
4 22 13	Java	38	644,930
4 23 13	Lesser Sunda Islands	10	174,155
4 24 13	Sulawesi (Celebes)	22	1,093,265
4 25 13	Borneo	39	3,791,061
4 26 13	Philippines	26	390,932
4 27 13	Taiwan	2	45,137
		572	27,568,406
5 01 13	Papuan	24	3,747,672
5 02 13	Micronesian	5	13,258
5 03 13	Hawaiian	4	214,502
5 04 13	Southeastern Polynesian	8	53,977
5 05 13	Central Polynesian	4	44,055
5 06 13	New Caledonian	7	48,796

Table 4 (cont.): Analysis by biogeographical province

	Name of Province	Number of areas	Total area (hectares)
5 07 13	East Melanesian	2	5,342
		54	4,127 602
6 01 01	Queensland Coastal	53	7,776,347
6 02 02	Tasmanian	26	904,976
6 03 04	Northern Coastal	10	934,272
6 04 06	Western Sclerophyll	138	2,444,584
6 05 06	Southern Sclerophyll	56	1,413,727
6 06 06	Eastern Sclerophyll	95	2,741,356
6 07 06	Brigalow	12	319,156
6 08 07	Western Mulga	10	2,144,280
6 09 07	Central Desert	13	3,657,703
6 10 07	Southern Mulga/Saltbush	10	4,363,400
6 11 10	Northern Savanna	9	1,458,655
6 12 10	Northern Grasslands	3	582,738
6 13 11	Eastern Grasslands and Savannas	34	670,163
		469	29,411,357
7 01 02	Neozealandia	145	2,783,281
7 02 09	Maudlandia	6	34,959
7 03 09	Marielandia	1	160,000
7 04 09	Insulantarctica	5	100,075
		157	3,078,315
8 01 01	Campechean	4	63,918
8 02 01	Panamanian	6	660,902
8 03 01	Colombian Coastal	6	1,019,000
8 04 01	Guyanan	21	2,155,078
8 05 01	Amazonian	14	12,733,681
8 06 01	Madeiran	2	448,150
8 07 01	Serro Do Mar	8	196,468
8 08 02	Brazilian Rain Forest	16	447,233
8 09 02	Brazilian Planalto	2	15,839
8 10 02	Valdivian Forest	13	4,018,459
8 11 02	Chilean Nothofagus	7	4,367,307
8 12 04	Everglades	9	774,279
8 13 04	Sinaloan	5	462,994
8 14 04	Guerreran	5	66,873
8 15 04	Yucatecan	2	106,970
8 16 04	Central American	23	825,207
8 17 04	Venezuelan Dry Forest	26	1,125,794
8 18 04	Venezuelan Deciduous Forest	11	546,930

Table 4 (cont.): Analysis by biogeographical province

	Name of Province	Number of areas	Total area (hectares)
8 19 04	Equadorian Dry Forest	3	181,300
8 20 04	Caatinga	3	236,100
8 21 04	Gran Chaco	6	1,175,000
8 22 05	Chilean Araucaria Forest	1	5,415
8 23 06	Chilean Sclerophyll	5	38,795
8 24 07	Pacific Desert		0
8 25 07	Monte	7	1,446,751
8 26 08	Patagonian	4	36,700
8 27 10	Llanos	3	1,207,000
8 28 10	Campos Limpos	3	3,192,000
8 29 10	Babacu	1	155,000
8 30 10	Campos Cerrados	11	2,457,403
8 31 11	Argentinian Pampas		0
8 32 11	Uruguayan Pampas	9	70,516
8 33 12	Northern Andean	9	913,288
8 34 12	Colombian Montane	8	1,397,050
8 35 12	Yungas	9	1,108,268
8 36 12	Puna	13	1,168,439
8 37 12	Southern Andean	47	6,450,237
8 38 13	Bahamas-Bermudean	4	122,540
8 39 13	Cuban	4	24,305
8 40 13	Greater Antillean	9	225,230
8 41 13	Lesser Antillean	6	87,875
8 42 13	Revilla Gigedo Island		0
8 43 13	Cocos Island	1	3,200
8 44 13	Galapagos Islands	1	691,200
8 45 13	Fernando De Noronja Island	1	36,249
8 46 13	South Trinidade Island		0
8 47 14	Lake Titicaca		0
		348	52,464,943
	Biogeographical classification unknown	132	7,866,578
	TOTAL	3,514	423,774,398

An introduction to the Protected Areas Data Unit, IUCN Conservation Monitoring Centre

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The work of the IUCN Conservation Monitoring Centre is a contribution to the Global Environmental Monitoring System of the United Nations Environment Programme

Cambridge, 1985

INTRODUCTION

For well over two decades IUCN has been collecting information on the world's conservation sites, both for use in its own programmes, and to assist in its work with other conservation organizations. During the late 1970s, IUCN's Commission on National Parks and Protected Areas (CNPPA) was reorganized on a regional basis and, as a part of this process, data-gathering on protected areas was made more systematic. The resulting increased flow of information created the need for an office to handle it, and the Protected Areas Data Unit (PADU) was set up in 1981 with the assistance of the United Nations Environment Programme (UNEP) and the US Nature Conservancy. The unit now forms part of the IUCN Conservation Monitoring Centre (CMC) and is based in Cambridge, in the United Kingdom. The information handling capabilities of the unit depend on a Wang VS mini-computer which provides an integrated data-processing and word-processing system. The following paragraphs give a brief outline to some of the work carried out by PADU, and provide an introduction to how the unit is integrated within IUCN's conservation monitoring activities. Further details on the development of the CMC computer database are discussed by Mackinder (1984).

HANDLING THE INFORMATION

IUCN has a worldwide network of contacts, many of whom can provide information on protected areas within their respective regions. Many of these contacts are members or consultants of IUCN's Commission on National Parks and Protected Areas (CNPPA), and PADU receives much of its information through the regional working sessions of the Commission which PADU staff attend, and where the participants are asked to review information on the region. Information collected in this way is added to through correspondence and literature research, and in discussion with scientists and land managers from around the world.

Information is received in a variety of forms ranging from departmental reports to scientific papers, though many contacts provide information on standard forms, or correct draft information sheets prepared by PADU staff. Although it is easier to deal with information sent on standard forms, it is important to also receive original information such as management plans, maps, departmental reports, scientific papers, and species lists. The availability of such documentation not only enables extraction of further information, and verification of information where necessary, it also means that if detailed information is required by IUCN for any given region the original documents can be quickly found and used.

Initially basic data are abstracted from the information received, and entered into the main data file on the computer. These files are constantly being extended, and the programs which handle them improved, but the core information includes the name of the protected area, the country it lies within, its size, year of establishment, management category (according to IUCN/CNPPA, 1984), its definition within the country (eg National Park, Nature Reserve), and its biogeographic code (according to Udvardy, 1975). Various other codes, such as document addresses (explained shortly), those indicating what sort of maps PADU has on file, and a unique number (one for each protected area) are used in cross-referencing information.

Using the computer this information can be handled in a wide variety of ways, and data items can be selected and sorted using any character or group of characters within the data file. It is possible, for example, to obtain a

list of protected areas of over 100,000 hectares within the Tropical Humid Forest biome in Latin America, a list of sites in Burma and Thailand in IUCN management category I, or a list of all the protected areas established between 1954 and 1972. By sorting the data, it is relatively straightforward to put together volumes like the UN List (IUCN, 1982a; 1985b). In this case information is first selected from the data file, then sorted by country, by management category within country, by size within management category within country, and so on. The material which has been sorted can then be put into the right format by careful programming so that it is ready for publication.

Programs can also be written to summarise the information in a wide variety of ways, and several summaries have already been published by IUCN (1982a; 1985b), Harrison, Miller and McNeely (1982) and Unesco (1983). Two examples will perhaps illustrate this capability. By mid 1982, over 2,600 areas had been created which were considered to be of sufficient status to be included in the 1982 UN List, and the total area protected as of October 1982 included some 4 million square kilometres. The rate of growth to achieve this is illustrated in Figure 1 from information held and sorted by the computer. These data can be further broken down to illustrate the situation in each of the different realms (Figure 2), again using information selected from data files, and sorted appropriately. Using other programs, protected areas in IUCN management categories I–V can be sorted into size classes facilitating the plotting of frequency histograms (Figure 3).

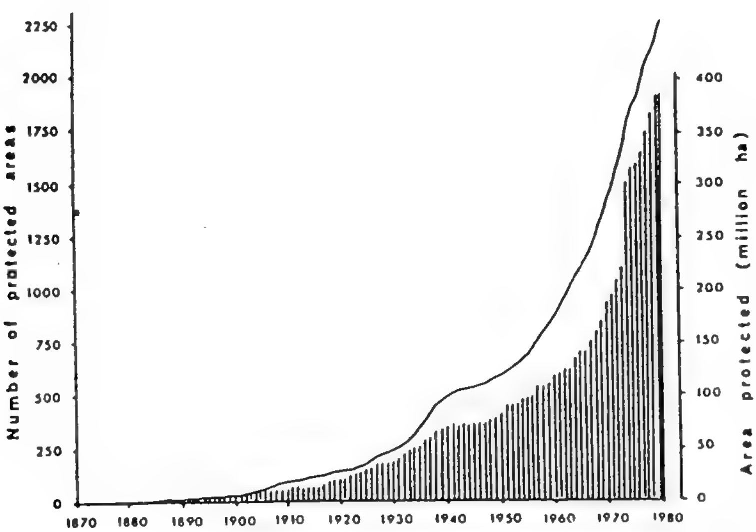

Figure 1 Growth of the world coverage of protected areas (——) number, (ıııllll) total area in hectares.

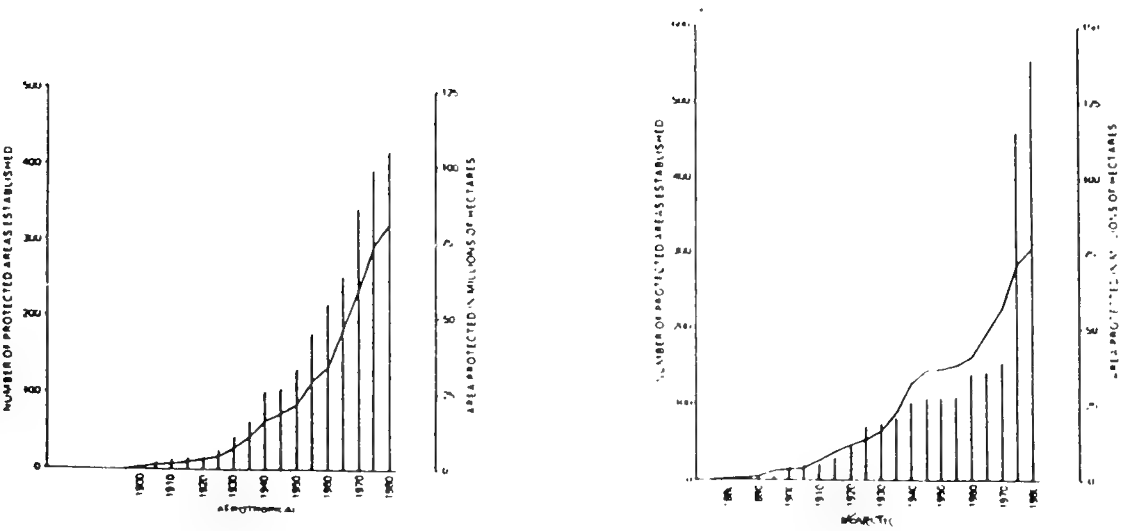

Figure 2 Growth of regional protected areas coverage (——) number, (|||||) total area in hectares.

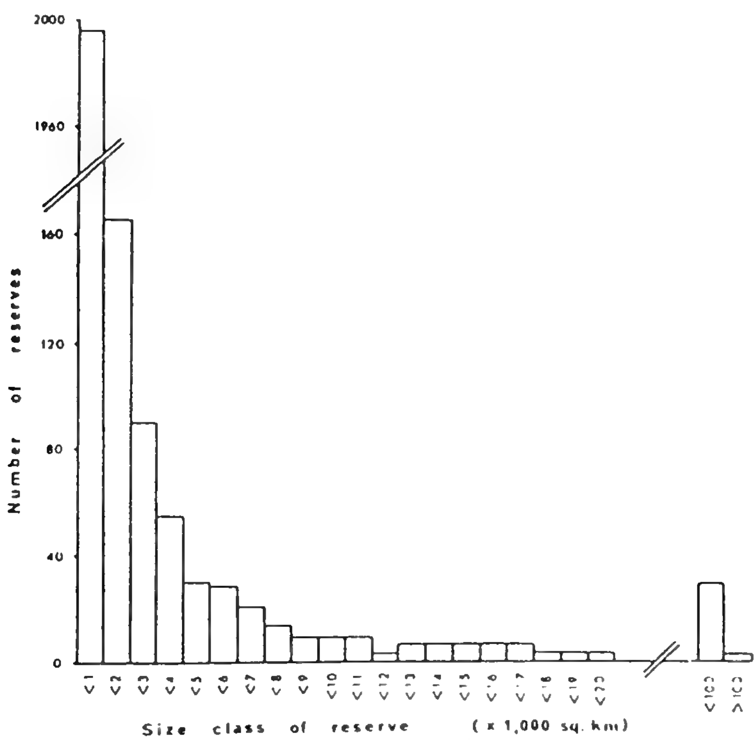

Figure 3 Size distribution of protected areas in IUCN management categories I–V

Use of the data files is only half the story. Data on each area are compiled into an 'information sheet' where information is grouped under a number of specific headings (Figure 4). As noted earlier, the information may already have been supplied to in this format. Each of these information sheets is entered into the computer as a word processing document or text file. The text can be stored by the machine and recalled for correction or reformating whenever necessary. Each text file has a document identification, and it is this number which we enter into our data file as the document address mentioned above. This gives is the essential cross-link between the basic information and the detailed text.

The information in these text files is regularly checked and added to, using material from various sources. More systematic checking is accomplished by taking all of the sheets for any given region to each CNPPA meeting in that region for review. In this way, material can be prepared for publication. The IUCN Directory of Neotropical Protected Areas was published at the time of the World National Parks Congress in Bali, Indonesia (IUCN, 1982b), and during 1984 final drafts of both the Directory of Wetlands of International Importance (IUCN, 1984) and the IUCN Directory of Afrotropical Protected Areas were prepared. The Afrotropical Directory will be published shortly (IUCN, 1985a), and work is now in progress on both the Indomalayan and Oceanian regions.

Name of protected area	Noteworthy flora
Management category	Noteworthy fauna
Biogeographic province	Conservation management
Legal protection	Zoning
Date established	Disturbances and deficiencies
Geographical location	Visitor facilities
Altitude	Scientific research/facilities
Size of area	Principal reference material
Land tenure	Staff
Physical features	Budget
Habitat/Vegetation	Local administration

Figure 4 The major headings under which information is collected on protected area information sheets

The word-processing system is also being used to manage the documentation on World Heritage sites for the secretariat at Unesco, and plans are under way to carry out similar projects for biosphere reserves and sites listed under the Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

USE OF THE INFORMATION

It is abundantly clear that any one country will have far more information available on its own protected areas than could ever be handled by a few people in an office in the United Kingdom. Similarly many countries have the capacity to establish computer systems and are able to maintain their own information on protected areas in ways that meet their own needs. How then

does PADU aid conservation? There are in fact a variety of reasons, of varying levels of importance, for maintaining a global overview.

a) Broad comparisons of protected areas networks

Around the world there are many different designations of protected area. In Kenya, for example, the terms include national parks, national reserves, nature reserves, forest reserves, and in Spain national parks, natural parks and national hunting reserves. In Thailand there are areas known as no hunting areas, in Uganda game management areas, while in Kiribati similar areas are designated wildlife sanctuaries. However, the definitions of any one designation will vary country to country, for example the national parks of the United Kingdom are certainly not national parks in any international sense.

In an attempt to clarify this situation, and to encourage the use of a wide range of protected area 'types', IUCN (1978) identified a series of ten management categories defined according to management objectives. PADU is using these ten categories to classify areas, and hence is able to give a better comparative picture of the protected area situation country to country than could be achieved by use of the national designations.

b) Biogeographical analysis of protected area coverage

A major objective of the global protected area system is to maintain the diversity of species and ecosystems, but listing protected area coverage by country does not provide much information on how well natural ecosystems around the world are being conserved. IUCN has therefore been using the system of biogeographical provinces described by Udvardy (1975) to make a first estimate of the coverage of major living resources by protected areas. This system divides the world into eight major realms, each of which is divided into a number of provinces. Each province is characterised by a particular biome type. Hence the Akagera National Park in Rwanda, for example, is within the **Afrotropical Realm**, in the **East African Woodland/Savanna Province**, which is characterised by a **tropical dry or deciduous forests or woodlands** biome.

A first approach to assessment of coverage of the world's biogeographic variety by protected areas is to examine coverage by province and biome. At present such comparisons are relatively crude, and it is important to note, for example, that biome type is not synonymous with habitat type, and also that the total area of each province or biome is not the same; problems which can hide important differences in the figures (Harrison et al, 1982). However, for all of its limitations the approach through biogeographic provinces does provide a useful tool for identifying major holes in the protected area network. For example 13 of the biogeographical provinces did not have protected areas included in the 1982 UN List, and some 34 provinces had 5 or fewer protected areas covering an area of less than 100,000 hectares. The rather crude tool of global biogeography could therefore suggest that these poorly protected provinces may be where international attention should be focussed. We know that coverage is patchy. To determine exactly how patchy, more analysis of the figures is required, based on more accurate estimations of the size of the biomes and provinces; this work is in progress.

It is clear that the global biogeographical approach provides useful information primarily at the global level. For national systems, the same biogeographic principles can be applied with considerably greater precision yielding proportionally more useful results; examples of such applications include those in Costa Rica, Canada, New Zealand, and in the Amazonian region of Brazil. Also, with more detailed continent-wide biogeographic maps, such as the vegetation map of Africa (Unesco/AETFAT/UNSO, 1983), it is possible to make more accurate assessments of protected area cover at this level. The information held by PADU is currently being used in the development of protected areas systems plans for two of the major tropical regions, the Afrotropical and Indomalayan realms. This project is described in detail by MacKinnon (1985).

The system of marine biophysical provinces and coastal biogeographical provinces described at the World National Parks Congress in Bali, Indonesia (Hayden et al, 1984), has important applications in identifying the major gaps and weaknesses in the present coverage of coastal and marine ecosystems. This is something that has not been systematically tackled before for the whole world, and should lead to a significant increase in the number and size of protected areas in these aquatic habitats. Work will begin on this shortly.

c) Development of publications on protected areas

Having all this information available on one site enables PADU to work with CNPPA in developing a variety of publications on protected areas. The United Nations List has already been mentioned, as has the series of directories of protected areas. The directories, which give basic details on the protected area networks of each country and one or two pages of information on each protected area, are intended to serve as handbooks for the protected areas of each major land mass. Volumes on the Neotropical Realm and the Afrotropical Realm have been produced so far (IUCN, 1982b; 1985a), and work is now under way on volumes to cover the Indomalayan and Oceanian realms.

PADU is also in a good position to prepare or help prepare general overview papers on protected areas issues.

It is also possible to produce publications on request; a volume on a particular country; on the vegetation of parks and reserves of South East Asia; on the protected areas of tropical rain forest around the world; on the threats to all protected areas containing tigers, bowerbirds, or coco de mer; or on those areas set up to protect important watersheds, or protected under specific international conventions or programmes. Some of these would be more difficult to produce than others, but we already hold much of the necessary information.

d) Providing information to conservation agencies

IUCN, the World Wildlife Fund, and other international conservation agencies need a basis for determining high priority areas for allocation of scarce conservation funds. Using PADU, IUCN is in a position to supply essential background information on protected areas. For example, the results of the projects mentioned above to evaluate

protected area coverage in the tropics will have direct effects on the conservation efforts made by IUCN and others in different parts of each region.

The World Heritage Convention requires global information in order to ensure that sites inscribed on the World Heritage List are of truly "outstanding universal significance". IUCN is responsible for the technical evaluation of natural sites nominated for inclusion on this list, and the information held on these sites by PADU is an important component of this work. In the future, analyses of the information available on natural World Heritage Sites will be required in order to assess the working of the Convention, and to systematise the information on what is listed under it. Because of its developing expertise in this field, PADU is perhaps in the best position to do this type of work - in particular because of the possibilities for comparison of World Heritage Sites with other protected areas.

Unesco's Man and the Biosphere Programme requires global information to ensure that representative areas of all biogeographic provinces are established as Biosphere Reserves. Much of the information available on Biosphere Reserves also needs to be analysed. PADU is already in a position to carry out some of this work, and produced analyses of Biosphere Reserve information for the First International Congress on Biosphere Reserves in Minsk, Byelorussia (Unesco, 1983). As with World Heritage Sites there is a need for a more systematic monitoring system, and it is hoped that in the future PADU will be able to provide this type of service.

PADU also acts as the repository for information on sites listed under the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971), and is responsible for maintaining an up-to-date list of sites. As with all other areas discussed, an information sheet for each site is also prepared, and a draft directory of these sites was presented to the second conference of contracting parties to the convention in Groningen (IUCN, 1984).

e) Providing information to aid agencies

If international development agencies such as the World Bank and US-AID could be provided with quick, accurate, large-scale overviews of protected areas needs and problems, they would be in a position to avoid adversely affecting particularly sensitive areas. Also, if they could be given the right background on all the conservation issues in the area concerned, they would perhaps be able to design their projects to enhance sustainable development.

PADU would not be in a position to supply all of the information itself, but by incorporating data held by PADU with that held by other units of CMC, IUCN could give the agency concerned a good introduction to conservation needs and problems in the region, and perhaps help further by suggesting consultants to carry out the vital field assessments. Reports of this kind prepared so far by CMC include preliminary environmental profiles of the Sind-Kutch region of the India-Pakistan borderlands, and of the Madhya Pradesh region of central India.

This type of information might also be of interest to a wide range of multinational companies.

f) Providing information to governments

Many governments need to know what is being done in the field of protected areas management elsewhere, in order to enhance their own efforts and to avoid repeating mistakes. In particular, information is required by two groups of people, the decision makers and the management agencies, who require background information on which to base and justify decisions. The biogeographical analyses mentioned above will be of relevance here, for example, as they can be used as strong arguments for the siting of protected areas in given regions. Management agencies may be more in need of technical assistance, for example on some particular management problem. A centralised source of information will hopefully be able to detail where this type of work has been done before.

In large countries (such as the United States of America) there are many different types of protected area, run by a variety of agencies. In some cases, our efforts to collect this type of information may mean that such national information is being collected together in one site for the first time.

Manipulating conservation data by computer is still a relatively new field and it may be some time before governments develop their own information systems. IUCN is developing a strong capability in the use of computers for conservation, and this expertise could be made available to those needing assistance in setting up their own systems.

g) Providing information to scientists

Scientists often need to make comparisons over a wide range of habitat types, or over complete species ranges. Information on the species and habitats in protected areas may therefore be of particular use in pinpointing research sites or illustrating distributions. Analyses of site protection are also being carried out, and information held by PADU has helped in projects as diverse as the identification of coastal wetland protected areas in the Neotropics, and an assessment of the workability of the Gunung Mulu management plan.

There are also numerous examples of the application of a protected area database in the area of genetic resource conservation. A plant breeder, for example, may need to know where wild ancestors of particular domestic agricultural crops can be found in protected areas, in order to locate sources of genetic diversity for improving crop breeds. This type of information is not available at present, but we are working towards it, and various proposals made to IUCN and others, if carried out, will increase the available information considerably.

Information is also required by scientists planning expeditions. Provision of such advance information can be important in project development, and may lead to a greater emphasis on conservation and management needs.

h) Providing information for education and training

It is of particular value both in the teaching of nature conservation and in the training of nature conservation personnel to put what is being taught into a global or regional context. Analyses and syntheses

of the information held by PADU can be used by teachers and trainers to provide that context. PADU can also make available original material such as maps and management plans which can be used in developing education and training programmes.

i) Providing information to the media

The international effort to promote protected areas requires a centralized source of information for publications, requests from journalists, and other promotional and publicity uses. If this type of information is available from a central office, journalists, writers and broadcasters can quickly obtain information on both the issue concerned and the background to it. For instance during the recent South-West Tasmania argument, PADU was able to give not only information on the national parks of that area, but also on the World Heritage Convention (and to further draw attention to the fact that the UK had not at the time ratified the convention). In addition lists were provided of a number of other sites that had been (or were) threatened by damming projects, together with some background information on these areas. In other words a central information office on protected areas is of value in ensuring adequate and accurate media coverage of issues concerning protected areas.

Any of PADU's outputs could be produced by other individuals or organizations given sufficient time and energy, and sufficient back-up - PADU only provides what is fed into it. But the amount of information already available to PADU, and the fact that much of it is already on computer, means that we have the capability of reproducing the data quickly, providing analyses as necessary, and providing the outputs in a wide variety of configurations. We will not replace any of the human element in protected area management, but should allow managers, development planners, conservationists, and scientists to be more efficient by providing the data they require, when it is needed, and in the form required.

Perhaps more importantly, collection and presentation of protected areas information in a professional and competent manner demonstrates to governments, development agencies, and individuals around the world that national parks and reserves are valuable land-use tools for managing areas which should, for various reasons, be kept in a natural or semi-natural state. Making data on protected areas more accessible will help to ensure that the reserves can play their proper role in resource management and development.

FUTURE DIRECTIONS

PADU is still developing, and is not yet in a position to do all we would like. For example, currently information cannot be sorted by habitat or vegetation type. As noted earlier, this means that it is not possible to produce lists of protected areas protecting tropical rain forests, although we can produce lists of areas within a tropical humid forest biome. Therefore a future need is the development and implementation of a coding system which would allow us to do this. Implementation will involve sorting through our files manually and assigning habitat codes for each protected area, codes which can then put into the computer files. This process will take some time.

Information is gradually being extracted from our manual files and from the text files on the computer so that the data sorting and selection facilities can become even more useful. In the future, for example, we hope to be able to sort information on criteria such as the practical benefits accruing from a protected area (watershed management, inshore fisheries protection, etc), on climatological or geomorphological characteristics, and of course on the indigenous flora and fauna. Work is already underway on pilot projects to link the protected area data files with those on threatened animals and plants managed by other parts of the Conservation Monitoring Centre. CMC is rapidly working towards greater integration at all levels (see Mackinder, 1984), and we use a number of common programs and files on the computer (particularly those concerned with geographical location, and with bibliographies). Future developments will include the integration of computer mapping and map handling techniques.

National conservation databases are now being developed or planned in several countries, and CMC is already working with a number of these. Working with such databases has the dual advantage that not only is much of our information coming from one source, but also that it can be sent to us in computer compatible form. Information on parks and reserves in both New Zealand and South Africa, for example, has been supplied on computer diskette, and most of the information on the subantarctic islands has also been supplied in this way. CMC's senior programmer has been assisting various conservation organizations in managing information on micro-computers, and again we are able to accept information directly from many of these machines.

Despite all these developments and the evident usefulness of PADU and CMC, the ability to carry out all of the tasks required ultimately depends on the information available, and our capacity to make use of that information. For outputs to be of most use to conservation planners at all levels, the data need to be both flexible and broadly based. This is a central aim of our operation. Crucial to this aim is the maintenance of high quality, accurate, information, and this is leading to the development of an ever broadening contact network. Currently our information is patchy, and we know that much more work must be done in improving it. This work is under way.

THE WIDER IMPLICATIONS

As the number and extent of protected areas continues to increase, and as the existing networks develop, management will in the future need to be much more effective, and integrated on an international scale. Managers must define clear objectives for each site, and make hard decisions to attain these objectives (especially where there are many alternative demands on an area). Effective management depends ultimately on knowledge, and the disseminaton of that knowledge, be it on management techniques, or on ecosystems and their management needs.

This knowledge can be, and is being, gleaned at the local level by scientists and conservationists throughout the world, but can be put to best use if it is gathered and disseminated not just at a local level, but also through a central office (facilitating, for example, the application of global arguments to local issues). If this is done through the framework of international organizations, then the results can in many instances be even more powerful and useful than if those same functions were performed independently at national or regional level. IUCN is aiming to provide such an international framework through its Conservation Monitoring Centre.

However, for conservation ideals to become more fully integrated into management and management planning on a global scale, information is required from a far wider range of disciplines than those normally associated with 'nature conservation'. The Global Environment Monitoring System (GEMS) was set up by the United Nations Environment Programme to "keep track of environmental trends, to be able to predict events and to provide decision-makers with sound information upon which to base environment action plans" (UNEP, 1982). They are now in the process of establishing a Global Resource Information Database (GRID), of which CMC will be a part. GEMS is not an organization, but a programme, coordinating and directing existing talent and facilities, making use of organizations such as the World Health and Meteorological Organizations, the Food and Agriculture Organization, Unesco, and of course IUCN (Croze, 1984).

If GEMS is the hub of the wheel of organizations associated with the environment, CMC occupies a similar position with respect to organizations and government departments associated with nature conservation, and within CMC, PADU deals with that sector of CMC work relating to protected areas and protected area issues. The organization is involved, and acronyms abound, but this should not detract from the value, and indeed the necessity of the work. For many reasons our environment requires management; the key to successful management of the environment is information.

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The first version of this paper was prepared from a presentation made to the World National Parks Congress, October 1982, and presented to the Bureau of the World Heritage Committee in 1983. A revised version was prepared for the 16th IWCN General Assembly in Madrid, October 1984. The paper has again been revised May 1985 for presentation to a CNPPA Working Group on Data Collection and Monitoring.

MONITORING ENVIRONMENTAL CONSERVATION: TOWARDS AN INTEGRATED GLOBAL OVERVIEW

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The International Union for Conservation of Nature and Natural Resources (IUCN) is essentially a global network of governments, governmental agencies, non-governmental organisations, scientists and other conservationists joined together in the common cause of promoting the protection and sustainable use of living natural resources. In undertaking this mission, one of IUCN's principal functions has been the gathering of data on species and habitats under threat, in order that scientifically-based conservation actions might be taken.

With 537 members located in 116 countries and having the ability to tap the knowledge of the some 2,000 technical experts comprising IUCN's six Commissions and their working groups, this network is capable of gathering a vast amount of information which is directly relevant to environmental conservation. A historical difficulty of the network, however, has been the lack of an effective ability to archive the data, update them and rapidly retrieve them when required. The need for this central focus gave rise to IUCN's Conservation Monitoring Centre (CMC) which now has the mission of handling and putting to best advantage the amount of data being received.

In undertaking this task CMC has utilised computer technology to develop a global database on species, wildlife trade, protected areas, habitats and ecosystems of conservation concern. Such computerisation has led to the ability to integrate and overlay the data in a variety of new and unique ways. CMC is thus not constrained merely to considering questions about a single species or area, but is capable of analysing quite complex issues. For example, an application recently undertaken consists of identifying the 100-200 sites globally whose protection would do most for plant conservation.

In addition to reviewing the structure, function and operations of CMC, this paper thus cites examples of how the database has contributed to the resolution of global conservation concerns. Also discussed is how the monitoring network might be improved in order to enhance CMC's abilities to provide a global perspective.

WHAT DOES THE CONSERVATION MONITORING CENTRE DO?

The primary function of CMC is the continuous collection, analysis, interpretation and dissemination of data as a basis for conservation. Species, habitats and areas of relevant conservation concern include those having current or potential economic import as well as those believed to be under threat.

CMC undertakes its function by integrating four monitoring activities (our major management units) which cover the status of:

* Animal species (Species Conservation Monitoring Unit)
* Plant species (Threatened Plants Unit)
* Wildlife trade (Wildlife Trade Monitoring Unit)
* Protected areas (Protected Areas Data Unit)

Data resulting from these activities are linked by common geographical and taxonomic coding systems within the computer. The result is a highly sophisticated database capable of producing integrated outputs on a wide range of contemporary conservation issues.

CMC disseminates this information through a series of publications, including the renowned IUCN Red Data Books on plants and animals, and by producing special reports tailored to the needs of clients.

WHERE DOES THE INFORMATION COME FROM?

The accuracy and relevance of CMC's data are owed to an unrivalled network of organizations and specialists all over the world. These include:

** The network of IUCN members, which include governments, government agencies and non-governmental organizations that make IUCN the international union of conservation organizations.

** The international network of scientists and other cooperators affiliated to IUCN and its six commissions. Our principal contacts, the combined memberships of the Species Survival Commission, the Commission on National Parks and Protected Areas and the Commission on Ecology, number over 2,000 individuals worldwide.

** The researchers under contract for over 300 IUCN/WWF field projects annually.

** The IUCN Environmental Law Centre, which provides a similar service to ours but on legal matters, and the IUCN Conservation for Development Centre, which maintains a roster of consultants able to undertake conservation and development projects.

** The network of TRAFFIC offices (Trade Records Analysis of Flora and Fauna In Commerce). Established in several countries, each office monitors trade in wildlife to and from its region. CMC co-ordinates them and draws on their data.

** The professional contacts set up by CMC staff with colleagues around the world. CMC staff call upon the knowledge and experience of scientists and conservation experts who work in government agencies, universities, zoos and botanic gardens, and museums and libraries.

** International organizations with whom we cooperate. In particular CMC works with the International Council for Bird Preservation (ICBP), the International Wildfowl Research Bureau (IWRB), the UN Food and Agriculture Organization (FAO), the UN Environment

Programme (UNEP), and the UN Educational, Scientific and Cultural Organisation (Unesco).

Although CMC staff are not usually sent into the field themselves they are thus in direct contact with those individuals who are at the forefront of conservation action. On any one subject CMC staff can seek the guidance of the foremost experts in the world.

WHAT DO WE DO WITH THE INFORMATION?

Once the raw data have been collected and verified, they are critically interpreted, summarised and entered into the computer in two different yet complementary forms:

** <u>Text</u> is handled in a word-processing system and can be as detailed and extensive as required. It can be rapidly modified to incorporate new information.

** <u>Data files</u>. Summaries of the information are coded into data files, permitting rapid processing and analysis. This is done because computers cannot efficiently extract and sort information from plain text.

The two types of file are linked by common geographical and taxonomic coding systems. This dual approach produces an unusually flexible system, giving CMC the advantage of rapid computer selection and sorting of information but avoiding the problem of forcing variable biological data into a rigid data processing format. The information on computer is backed up by more detailed material on manual files and the capability to locate and contact the relevant experts on any particular issue. CMC is thus well equipped to respond rapidly and accurately to requests for information.

HOW IS CMC ORGANISED?

a) Monitoring the status of animals

Animals, particularly vertebrates, have been the traditional focus of many IUCN/WWF conservation projects. This emphasis has generated a demand from many sectors for quite specific data on the conservation status of a wide range of animal species. Monitoring activities have consequently developed to answer this demand and led to the publication of the internationally respected IUCN Red Data Books, a series of authoritative references on threatened species. Collection of data for this series continues to provide an important focus for CMC's work.

However, the collection of data is not confined just to threatened species. The database includes information on all species of conservation concern, including widespread but depleted wild taxa of economic importance, and wild relatives of domestic stock.

Although continually under development, the animal data-file currently contains summary information on 17,000 taxa of conservation concern. Detailed 'Red Data Book' accounts have been prepared for 2,000 of these taxa. These sheets provide comprehensive information on distribution, population status, habitat needs, ecology, threats to survival and

proposed conservation measures, along with a comprehensive reference list.

Information on individual species is readily available for the higher vertebrates (birds and mammals) but different approaches have had to be developed for the less well studied lower vertebrates (fish, reptiles and amphibians) and invertebrates. These approaches have included the collection of data on an area basis, e.g. on such specific places as the Banks Peninsular in New Zealand or the Usambara Mountains in Tanzania, or on specific habitats such as coral reefs. This work links up with other area-based information in the CMC database, particularly that on plant sites and protected areas.

b) Monitoring the status of plants

The increasing demand for information on the conservation status of plants has accompanied the growing realisation that plant species are critical for maintaining the ecosystems upon which mankind relies. In 1970 only Belgium had produced a list of its threatened plants. Today, virtually all countries of the geopolitical 'North' (including Australia, New Zealand and South Africa) have produced threatened plants lists, often as national Red Data Books. Many countries of the 'South' are now taking similar action. This rapid progress has coincided with a decade of intense activity by IUCN on threatened plants, much of it dedicated to encouraging and helping countries to document their threatened plants.

With estimates of the world's threatened flora ranging up to 40,000 species, no one book could attempt to list them all, let alone describe them in detail. However, with computer assistance, CMC is able to monitor a major proportion of the key species identified by our information networks. Although still under development, the CMC database now holds basic information on 30,000 plant taxa and provides a basis on which to plan the conservation of plants around the world.

Knowing which species are threatened in the wild also enables CMC to monitor their status ex situ (off-site), principally in botanic gardens. The plant data-file is used to produce lists of threatened species which are circulated to the 130 gardens that subscribe to IUCN's Botanic Gardens Conservation Co-ordinating Body. Gardens then return lists of the threatened species that they grow. The aim is to help gardens work as a network, avoiding duplication and contributing to the cause of preserving plant genetic resources.

Whereas the plant data-file contains many species found in temperate and subtropical climates or on islands, most of the world's plants occur in the less studied mainland tropics where habitat destruction is accelerating. Because of the size of the flora involved in these areas, a species approach is less practical, and alternatives are being investigated. These include gathering data on specific groups of plants such as those of economic or medicinal value, or those threatened by trade or habitat destruction. These floristic data are being used to identify key sites for conservation, leading to the publication of a Plant Sites Directory that identifies which areas of the world are most significant for plant conservation.

c) Monitoring wildlife trade

Trade in wild species and their products has become an immense, multi-million dollar enterprise, encompassing many diverse products ranging from rhino horn to coral and from exotic butterflies to tropical hard woods. Trade in threatened species of animals and plants has particularly aroused public concern. Through its Wildlife Trade Monitoring Unit, CMC collects information on the volume and trends of all such trade, and especially on the implementation and effectiveness of the international measures designed to control it.

One of the major initiatives in this area is the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Parties to CITES are required to submit annual reports to the CITES Secretariat, detailing permits issued for international trade in taxa protected by the Convention. Data from these reports are managed by CMC under contract to the CITES Secretariat. Currently 210,000 records of wildlife trade transactions are logged on the computer, representing reports submitted to CITES over the last nine years.

The analysis of these data provides an indication of the impact of trade on the species listed on the CITES appendices. It also allows comparisons to be made between trade statistics for importing and exporting countries. The discrepancies revealed give an insight into how well the Convention is being implemented. The presentation of such analyses enables the Parties to pinpoint ways in which the Convention is not working and to identify measures for making it more effective.

The CITES data are complemented by information collected from consultants and correspondents around the world, from the 'TRAFFIC' network of national trade monitoring offices, from reports on wildlife trade and from the published import and export statistics for a number of countries. Coupling this extensive data-file with those for animals and plants has enabled CMC to undertake a wide variety of special trade analyses under contract to international and governmental agencies, non-governmental organizations, and trade associations. Such projects recently included analyses of wildlife farming and ranching, international trade in elephant ivory, international trade in marine mammals, and the extent of trade in kangaroos, seals and corals. The TRAFFIC Bulletin, published five times per year, carries reports on these special analyses, as well as recent trade news.

d) Monitoring protected areas

A principal method used for the conservation of species and ecosystems is the protection of sites. To be able to plan effectively, both conservation and development agencies need to know which sites are already protected, how successfully they are managed, and what they contain in terms of animals, plants and critical habitats. CMC maintains a comprehensive overview of protected areas around the world, with summary data in the computer on over 10,000 sites and detailed accounts on 3,000 of these areas so far.

At the request of the United Nations, a summary of the protected areas data-file is published periodically as the UN List of National Parks and Protected Areas. CMC also publishes, with IUCN's Commission on National Parks and Protected Areas, detailed accounts of sites

occurring in various realms of the world in the series of IUCN Directories on Protected Areas.

Apart from the ability to provide information on protected areas to interested parties, the linking of this information with other files in the database enables CMC to help CNPPA identify significant gaps in protected area coverage worldwide and subsequently to help plan conservation action. In particular, new approaches are being undertaken to survey protected area coverage in various parts of the tropics using CMC data to provide the initial overview on which further study can be based.

CMC has also developed databases on sites of concern under contract to other organizations. Such efforts have recently included maintaining a database for Unesco on natural sites listed under the World Heritage Convention, assisting them further by managing information on Biosphere Reserves, and establishing a prototype database on sites listed under the Ramsar Wetlands Convention.

e) Monitoring the status of significant ecosystems

Certain ecosystem types are of particular conservation interest and it therefore becomes important to try to inventory and describe the major sites where these ecosystem types occur. CMC has been involved for several years in the development of an information base on coral reefs, for example. More recently CMC has also become involved in the development of a wetlands database, based on the results of various projects to inventory and describe internationally important wetlands in various parts of the world.

These aspects of the database are of particular importance in assessing the conservation status of the respective habitat types covered. They also facilitate the development of proposals to protect, or to better conserve such areas.

HOW DOES IT ALL FIT TOGETHER?

CMC is capable of producing integrated outputs which draw upon all files within the database. This is possible because the information is linked by a common skeleton of taxonomic and geographic names. The system also records the relationship of these taxonomic or geographical names to others within a variety of hierarchical systems (e.g., species within families, counties within states). Sorting of data files to obtain the information needed by clients can thus be accomplished relatively quickly, and the linkage of data files with the text files enables reports to be developed rapidly.

CMC is also developing new database components, drawing information from the four existing major data files. In particular, as has been mentioned, area-based information is being synthesized for specific habitats which will be the subject of new international conservation initiatives: coral reefs, wetlands, oceanic islands, etc.

WHAT HAS CMC ACHIEVED?

CMC is a young organization and has spent much time developing the conservation database. Nevertheless the following achievements illustrate that the Centre has already progressed well towards the goal of being able to provide timely advice on conservation and development issues. We have:

** Defined new areas of conservation concern. CMC published the IUCN Invertebrate Red Data Book in 1983 as the first attempt to bring the international problem of threatened invertebrates to public attention. It has sold well and has been reviewed internationally from Chile to Hong Kong. Many important initiatives including field projects, surveys, captive breeding programmes, meetings and legislation followed its publication.

** Developed a lead in plant conservation. During 1983-84 CMC helped prepare the IUCN/WWF programme and campaign to promote plant conservation around the world. The database showed which places in the world had the greatest diversity of plant life and where among these places the threats were most acute, a vital ingredient for choosing the limited number of countries in which IUCN/WWF could reasonably sponsor projects. The programme is now running and with its combination of strategic and field projects, it not only sets new ground for IUCN/WWF, but is beginning to make plant conservation a more accepted part of conservation as a whole.

** Provided background information and a rationale for new legislation. Based on CMC data, IUCN submitted a formal memorandum to the Council of Europe describing how their Bern Convention could work for plants. IUCN suggested criteria to select plants for inclusion under the Convention and applied these to the database to produce a list of 119 species. These were accepted without dispute. This illustrates how CMC can act as a bridge between scientists and politicians. Only scientists know which plants are threatened, but politicians can only work to avert the threats if appropriately informed.

** Helped conservation organizations lobby governments better. In early 1983 a wealthy American asked the British Government for permission to settle on Henderson Island, an uninhabited coral island in the middle of the Pacific. At the request of WWF, CMC assisted in the preparation of a report for submission to the British Government regarding the island's unique flora and fauna. These and other efforts were rewarded when the Government announced that Henderson Island would not be settled.

** Provided crucial statistics on success of conservation measures. In 1983, CMC informed the Parties to CITES at their regular biennial meeting that as much as 45% of transactions in animal trade and 79% in plant trade in species of concern to CITES were not being reported as required. The analysis indicated that the Parties had far to go in making CITES an effective conservation body. CMC's ability to supply such precise figures provides powerful incentive for concerned governments and bodies to improve their compliance with agreed measures.

** Assisted forward planning for development projects. During 1984-1985 CMC assisted the development community through the provision of conservation briefings. These are resumes of available information on threatened species, critical habitats, parks and reserves, along with pertinent bibliographic citations and contact names, which indicate the key conservation issues that a potential development might encounter. Clients, including the World Bank and firms in the oil industry, have indicated that such briefings tailored to their specific needs have been extremely useful in pre-project planning and evaluation.

FUTURE DIRECTIONS

CMC is still developing and not yet in a position to do everything that is planned. To take one example, information on protected areas or species cannot currently be easily sorted by habitat or vegetation type using the computer, and if this needs to be done it must be done by hand. A future need is the therefore development and implementation of a coding system which would allow us to do this.

Information is gradually being extracted from our manual files and from the text files on the computer so that the data sorting and selection facilities can become even more useful. In the future, for example, we hope to be able to sort information on criteria such as the practical benefits accruing from a protected area (watershed management, inshore fisheries protection, etc) or specific habitat type such as a wetland. Projects are also underway to link more closely the protected area data files with those on threatened animals and plants, and, as noted above, we use a number of common programs and files on the computer (particularly those concerned with geographical location, and with bibliographies). Future developments will include the integration of computer mapping and map handling techniques.

National conservation databases are now being developed or planned in several countries, and CMC is already cooperating with a number of these. Working with such databases has the dual advantage that not only is much of our information coming from one source, but also that it can be sent to us in computer compatible form. Information on parks and reserves in both New Zealand and South Africa, for example, has been supplied on computer diskette, and most of the information on the subantarctic islands has also been supplied in this way. CMC is also starting to assist in the development of some of these databases.

Despite all these developments and the evident usefulness of CMC, the ability to carry out all of our tasks required ultimately depends on the information available, and our capacity to make use of that information. For outputs to be of most use to conservation planners at all levels, the data need to be both flexible and broadly based. This is a central aim of CMC's operation. Crucial to this aim is the maintenance of high quality, accurate information, and this is leading to the development of an ever broadening contact network. Currently the information is patchy, and much more work must be done in improving it. This work is under way.

THE WIDER IMPLICATIONS

As the World population continues to expand, and as development of available resources continues to increase, use and management of natural resources will in the future need to be much more effective, and integrated on an international scale. Effective management depends ultimately on knowledge, and the disseminaton of that knowledge, be it on management techniques, or on ecosystems and their management needs.

This knowledge can be, and is being, gleaned at the local level by scientists and conservationists throughout the world, but can be put to best use if it is gathered and disseminated not just at a local level, but also through a central office (facilitating, for example, the application of global arguments to local issues). If this is done through the framework of international organizations, then the results can in many instances be even more powerful and useful than if those same functions were performed independently at national or regional level. IUCN is aiming to provide such an international framework through its Conservation Monitoring Centre.

However, for conservation ideals to become more fully integrated into management and management planning on a global scale, information is required from a far wider range of disciplines than those normally associated with 'nature conservation'. The Global Environment Monitoring System (GEMS) was set up by the United Nations Environment Programme to "keep track of environmental trends, to be able to predict events and to provide decision-makers with sound information upon which to base environment action plans". GEMS are now in the process of establishing a Global Resource Information Database (GRID), of which CMC will be a part. GEMS is not an organization, but a programme, coordinating and directing existing talent and facilities, making use of organizations such as the World Health and Meteorological Organizations, the Food and Agriculture Organization, Unesco, and of course IUCN.

If GEMS is the hub of the wheel of organizations associated with the environment, CMC occupies a similar position with respect to organizations and government departments associated with nature conservation. The organization is involved, but this should not detract from the value, and indeed the necessity of the work. For many reasons our environment requires management; the key to successful management of the environment is information.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES
UNION INTERNATIONALE POUR LA CONSERVATION DE LA NATURE ET DE SES RESSOURCES
Conservation Monitoring Centre — Centre de surveillance continue de la conservation de la nature

Dr S. Shen
Project Director
Office of Technology Assessment
Congress of the United States
Washington D.C. 20510

16 December 1985

Dear Dr Shen,

Please find enclosed the final copy of my paper on 'Status and trends of in-situ conservation of biological diversity worldwide'.

I have taken account of all review comments sent to me with your letter of 19 September, though I may not have covered all points to the satisfaction of your reviewers. This is partly because a number of the comments relate to topics rather outside my brief (e.g. the need for armies of systematists) while in others I do not claim sufficient competence to do the topic full justice (e.g. discussion on biogeographical classifications). That being said I have expanded on both points and I hope this is of value.

One of your reviewers takes me to task for my implied acceptance of Pleistocene refugia. I would point out that where I use the term it appears within quotation marks and followed by the phrase 'in effect centres of endemism and/or diversity'. Whether these areas are refugia or not, if they are areas of high diversity or endemism they must surely be areas of potential importance for conservation. While noting the same reviewers comments on island biogeography and design of reserves, this is not the reason I have taken this section out. The comments would apply much more to the paper by Jim Thorsell (who I assume you have contacted on this).

In this version I have gone into more detail on the need for national and local database development (though it should be noted in this context that I do not necessarily mean computer databases). This is a development area which is generally thought to be particularly important, and which I have therefore decided to include although it doesn't fall exactly within my brief. I have also said a little more on the actual 'ground level' collection of information.

Bearing in mind your specific query on integration of data, as I said on the phone, I felt that it would be inappropriate to go into such specific detail on one item within the paper. I have therefore appended this as a 'project concept' along with several other such 'concepts'. I hope this is of value. Please note, however, that this is for a feasibility study, not for the full database you inquire after in your letter. Establishment and maintenance of such a database would clearly be a very labour intensive task, the magnitude of which would depend on the number of species we would expect to cover. I

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would think at a minimum we would be talking about a further US$5,000 to US$10,000 for overhead expenses, followed by an annual cost in the order of US$100,000 to US$150,000. Even with this sort of input, implementation would be 'slow and steady'. Perhaps if you want more hard figures at this stage you could contact me again.

Also, to put some of the other CMC needs into context, I have included 'project concepts' for the set up and initial running of database sections on oceanic islands and wetlands, as well as two specific projects related to the Protected Areas Data Unit (the Africa research officer post, and one on marine and coastal protected areas). These are examples, however, and I could as easily have given you a proposal for a database on mangroves and sea-grass beds, or one for an Indomalayan research officer post within PADU, or one to provide CMC (or just PADU) with adequate library facilities.

In other words, although these are real proposals, which we would like to see implemented, they should not necessarily be construed as being the most important for CMC's development <u>now</u>. For example our two most pressing needs currently are not for funding of these proposals, but for sufficient funding to provide both new accomodation and a new computer system. As you may already be aware, we currently have a machine on which we cannot implement the Geographical Information System we need (and which is discussed in my paper), nor can it support any of the new graphics equipment. We would need something in the order of US$500,000 to US$750,000 to purchase all the necessary hardware and software (quite apart from the costs of using it). We also see development and implementation of a habitat 'skeleton' within the database as a particularly important project.

Could I suggest, therefore, that if you wish to make specific suggestions relating to CMC you ought to discuss these with Dr Michael Tillman.

I have now included a summary within the paper, which details the main recommendations, slightly rearranged and with some amalgamated. These if you like are the key points - the action strategy - for improving the level of available information. The fact that there are more recommendations relating to CMC's needs should not be taken to mean that we see development of CMC as more important than, say, development of national and local conservation databases. This is so simply because it is easier to make more detailed recommendations relating to your own particular sphere of activity than to others, and also because these relate more specifically to items I was asked to discuss.

You will note that I have not included even approximate costs of achieving any of the recommendations. This is largely because any estimates would be so gross that I would not want to include them within a paper which in other ways attempts to be fairly objective. Within most of the items anyway, the amount that could be spent is unlimited by anything other than lack of available finance. I would, however, attempt to put prices to these items if you <u>really</u> need this.

You will also note that in many cases it has not been possible within the available space to either identify who (specifically) should be carrying out some of the recommendations, and where funding should come from. This is

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largely because these activities cannot be regarded as the responsibility of any one group, either for funding or for implementation. Again, if you want me to go into specific detail on any given item I will attempt to do so.

Please get in touch if I can provide further information, assistance, or clarification.

Yours sincerely,

Jeremy Harrison
Protected Areas Data Unit

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Copies of this paper have been sent to the following people, who you may wish to contact on certain items or projects mentioned:

Dr Robert Goodland	Office of Environmental and Scientific Affairs The World Bank 1818 H Street NW, Washington DC 20433
Dr Michael Gwynne	GEMS-Programme Activity Centre United Nations Environment Programme PO Box 30552, Nairobi, Kenya
Dr Guillermo Mann	Director (Science), International Programme The Nature Conservancy 1785 Massachusetts Avenue NW, Washington DC 20036
Mr Rob Milne	Chief, International Affairs National Park Service U.S. Department of the Interior
Dr Jane Robertson	Division of Ecological Sciences, Unesco 7 Place de Fontenoy, 75700 Paris, France
Dr John Sullivan	Office of Forestry, Environment, and Natural Resources U.S. Agency for International Development
Dr Jim Thorsell	Executive Officer CNPPA, IUCN Avenue du Mont-Blanc, CH-1196 Gland, Switzerland
Dr Michael Tillman	Director, IUCN Conservation Monitoring Centre

PROJECT PROPOSAL SUMMARY

Title Feasibility study on linking species and protected area information within the CMC database

Proposed project developer IUCN Conservation Monitoring Centre

Proposed project executant IUCN Conservation Monitoring Centre

Proposed project duration One year

Short description (Objectives, justification, activities)

One of the principal justifications for protected areas is the conservation of genetic resources in situ. Therefore, it is of vital importance that information on what is found where is available to those needing it. The amount of information available at the local level is growing, and with the increasing availability of improved information handling methods it would seem likely that local and national database activity on the location of genetic resources will increase.

It is obvious, however, that an international database maintaining links with local, national and regional database activity is essential. The role of such a database would be fourfold:

a) to provide an overview;
b) to demonstrate what is found where (an information retrieval service);
c) to highlight resources that do not appear to be protected;
d) to draw the attention of management authorities to the relative importance of some of the species they protect (important resources that may not be protected elsewhere, for example).

CMC already has growing databases on both species and protected areas, while other groups such as Unesco (MAB programme), FAO and IBPGR are also exploring this type of database activity for either particular species groups or particular areas. The species and protected areas databases managed by CMC are not fully linked yet, though it has already been agreed that this is a major priority. Indeed CMC has already obtained funding from British Petroleum to develop better methods for handling area information. This software improvement will be vital to the proper development of the species-area links.

It would clearly be an impossible (and probably valueless) task to document the occurrence of all species in all protected areas at this time. This is cetainly at the international level. There are, for example some 4170 mammals described, approximately 9000 birds, 8240 reptiles and amphibians, 21,000 fish, 250 000 plants, and literally millions of invertebrate species. Also, much of the information is not currently available, and may never have been collected. For example there are many protected areas within the United States that have yet to complete species inventories.

A feasibility study is therefore necessary for the following reasons:

a) to harden up the choices of what species and areas CMC should start its database activity on;
b) to test the availability of the data;
c) to work closely with other groups (such as Unesco-MAB) to ensure CMC's activities are complementary to other efforts in this field;
d) for initial development and testing of the basic computer software.

Trials of the computer software will require the initial build up of part of the database for testing purposes. To keep this to manageable proportions, information researched in detail at this stage will be restricted to protected areas and some of the threatened animal species of Africa.

Outputs

The principal output of this project will be a detailed strategy of how CMC can proceed with the linking of species and areas information, along with the development of project proposals for soliciting the necessary funding. This is something that would be rather difficult to achieve without an investigation of approaches and available information, without the development of guidelines for identifying appropriate species for monitoring in this way, and without further liasion with other agencies working in this field. This work will be carried out during the course of the project, along with initial development of the computer software required.

The feasiblity study is therefore an essential stage in the development of a database which could, in future years, not only identify which protected areas species are found within (and their status in those areas), but which could also be used to investigate how well 'covered' any given species is by protected areas, and to demonstrate to managers which of the species they have are regarded as being particularly important.

In addition, the improved linking of information that will be used for trial purposes (threatened species and protected areas of Africa), may be of some direct value in the planning of conservation in Africa. If this project is carried out soon enough, the information will be available to the current IUCN project developing a protected areas systems plan this region. Clearly, however, the value and importance of this particular aspect of the project depends on how good the available information is, a factor which the project itself aims to investigate.

Estimated total budget US$20,000

Status Ready to proceed as soon as funding becomes available

Date of proposal December 1984

A complete copy of this proposal is available from the IUCN Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom

PROJECT PROPOSAL SUMMARY

Title Assessing the Conservation status of Marine and Coastal Ecosystems

Proposed project developer IUCN Conservation Monitoring Centre

Proposed project executant IUCN Conservation Monitoring Centre

Proposed project duration One year

Short description (Objectives, justification, activities)

It is clear that much remains to be done in the protection of marine and coastal zones, and for this reason both IUCN and WWF have put some emphasis on conservation action within this area. To be able to plan conservation action effectively one needs to have good information on which to base decisions. In the case of marine and coastal protected areas this means having complete lists of such areas, and their locations, (as well as more detailed information on each site). The information must also be arranged within a biogeographical framework such as has recently been prepared for IUCN.

The objectives of the project are therefore to:

a) ensure that CMC has complete and accurate lists of marine and coastal protected areas which can be further identified by presence or absence of island, marine, estuarine, coral etc. components;

b) use the lists developed along with the classification of coastal and marine environments in order to make a preliminary assessment of the world coverage of marine and coastal environments by protected area.

This project will therefore involve the hiring of a staff member to go through all information available to CMC on marine and coastal protected areas, and to obtain further information from our contacts. This information will then be analysed using the biogeographical methods mentioned, and a report prepared analysing the world coverage of marine and coastal environments by protected areas.

Outputs
- Full lists of marine and protected areas for limited circulation and possible publication
- Preliminary report analysing the world coverage of marine and coastal environments by protected areas
- Preparation of a paper for publication from the above (with CNPPA)

The project will also contribute to development of CMC's growing information base on marine and coastal environments, areas which would appear to be of particular interest to aid agencies and industry.

Estimated total budget Approximately US$10,000

Status Ready to proceed as soon as funding becomes available

Date of proposal December 1985

A complete copy of this proposal is available from the IUCN Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom

PROJECT PROPOSAL SUMMARY

Title Creation and maintenance of an Oceanic Islands Database

Proposed project developer IUCN Conservation Monitoring Centre

Proposed project executant IUCN Conservation Monitoring Centre

Proposed project duration Three years

Short description (Objectives, justification, activities)

Much has been written on the nature of island ecosystems, and the effect of time, isolation and small area has on their biota (leading to the development of unique assemblages of species, varying endemic forms etc.). However, oceanic islands are particularly susceptible to habitat loss and species extinction from forest clearance, agricultural and urban encroachment, and introduced predators and competitors. At the same time, information on these islands and their conservation status and problems is often widely scattered.

The principal objective of this project is to assimilate and render readily available much of the existing information on the conservation status of oceanic islands or island groups. An information base of this sort will not only be of value for both conservation and development communities in providing information on what is going on where, and demonstrating which areas are poorly known (and where efforts can be directed to improve our knowledge of islands), it would also be instrumental in development of a more detailed strategy for the conservation of oceanic islands.

It is anticipated that the research and implementation phase of this project would involve two research staff and a secretary, working closely with staff of the International Council for Bird Preservation, who would deal with aspects of the project relating to birds. At the same time, development of CMC's database software would enable it to also handle information on islands, which would then be linked in to other parts of the CMC database.

Outputs This proposal does not include publication budgets, but would cover preparation and circulation of draft directories and lists of oceanic islands along the lines of Douglas (1969) and Clark and Dingwall (1985).

The principal achievement of the project, however, would be the development of an accessible database on conservation aspects of oceanic islands. Information from such a database would be of value to both development and conservation communities.

Estimated total budget US$350,000 over 3 years; It is expected that further sources of funding would be identified by the end of the initial three year period.

Status Ready to proceed as soon as funding becomes available

Date of proposal December 1985

A complete copy of this proposal is available from the IUCN Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom

PROJECT PROPOSAL SUMMARY

Title Appointment of a research officer for protected areas in Africa

Proposed project developer IUCN Conservation Monitoring Centre

Proposed project executant IUCN Conservation Monitoring Centre

Proposed project duration 1986 onwards

Short description (Objectives, justification, activities)

One of the principal methods used for the conservation of both species and ecosystems is the legal protection of sites. To be able to plan effectively, conservation agencies need to know which sites are already protected, how successfully they are managed, and what they contain in terms of animals, plants and critical habitats. Similarly development agencies need information on these areas in order to avoid inadvertently damaging sites when implementing their projects.

Clearly the maintenance of a database on the protected areas of the world is a large and complex task, requiring a staff of professionals to carry out the work. The task is continual, resulting in a need to employ staff for long periods of time both to increase familiarity with any given region, and to maintain a continuity of contact with park system managers, scientists etc. in the field. Unfortunately this continuity has not been possible to date within CMC's Protected Areas Data Unit.

The aim of this proposal is to obtain funding to appoint a full time research officer within the Protected Areas Data Unit to work on the African region, collecting, maintaining and synthesising all information available to CMC on African protected areas, and maintaining and extending our network of African contacts. This will be carried out in close collaboration with IUCN's Commission on National Parks and Protected Areas. As well as covering the salary and overheads involved in employment of a research officer, the proposal also includes provision for support staff (50% research assistant, 50% secretarial time).

Outputs No specific outputs are envisaged under this proposal, though the work will lead to an improved database on protected areas within Africa, with more detailed and more accurate information becoming available for future publication and reports.

More importantly, the project will lead to the availability of a more detailed and more accurate body of information, of use, and accessible to, both conservation and development communities.

Estimated total budget Approximately US$30,000 per annum. The work carried out under this proposal will continue and build on work carried out by CMC over the past few years.

Status Ready to proceed as soon as funding becomes available

Date of proposal December 1985

A complete copy of this proposal is available from the IUCN Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom

PROJECT PROPOSAL SUMMARY

Title Creation and maintenance of a Wetlands Database

Proposed project developer IUCN Conservation Monitoring Centre

Proposed project executant IUCN Conservation Monitoring Centre

Proposed project duration Three years

Short description (Objectives, justification, activities)

Wetlands are among the world's most productive environments, providing benefits to mankind through fishery production, maintenance of water tables for agriculture, water storage and flood control, shoreline stabilisation, timber production, waste disposal and water purification, and recreational opportunities. They also provide crucial habitats for waterfowl and other birds, as well as for countless mammal, reptile, amphibian, fish and invertebrate species.

Despite this, wetlands are among the world's most threatened habitats. This is due mainly to accelerated drainage, land reclamation, pollution and over-exploitation of wetland species. Yet in the face of this threat, the conservation network is frequently unable to respond either because we have little idea where many of the important areas are (or what they contain), or know what ecological and economic value many of these wetlands have. This means that not only are conservation agencies not able to easily gauge the value of any given wetland, they are not able to advise development agencies and industry on how they can reduce the impact of development projects.

IUCN has been working with a number of other agencies and NGOs to improve the situation by supporting and planning the development of inventories of the most important wetlands in many parts of the world. This project aims to draw together all information gathered under these wetland inventory projects, particularly those in the Palaearctic, Neotropical, African and Indomalayan regions, using it to provide a framework for developing a full wetlands database which can be accessed to provide information of value to both conservation and development communities. The project also aims to develop further with the U.S. Fish and Wildlife Service a database on wetlands values.

Outputs The principal achievement of this project would be the development of an accessible database which can be used both by the conservation community for conservation planning and directing action, and by the development community for help in planning to avoid adversly affecting important sites, and to help ensure maintenance of essential values of wetlands associated with their projects. This includes preparation and circulation of various draft directories and lists of wetlands.

Estimated total budget US$255,000 over 3 years. Much initial work has been carried out under other budgets. It is expected that further sources of funding would be identified by the end of the initial three year period.

Status Ready to proceed as soon as funding becomes available

Date of proposal December 1985

A complete copy of this proposal is available from the IUCN Conservation Monitoring Centre, 219c Huntingdon Road, Cambridge CB3 ODL, United Kingdom