natural resources research XXI

conservation, science and society

Contributions to the First International Biosphere Reserve Congress, Minsk, Byelorussia/USSR, 26 September - 2 October 1983

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PREFACE

by

Amadou-Mahtar M'Bow
Director-General
Unesco

Does nature conservation have sufficient links with science and society? At a time when increasing pressures are bearing on the world's remaining natural ecosystems, the need to conserve areas which harbour representative samples of the natural heritage of the world has become a vital issue.

People and governments are becoming more aware of mankind's dependency on natural areas and natural products for his socio-economic development and well-being. New raw materials, drugs, potential foodstuffs originating from previously uninvestigated plants, animals and micro-organisms are being discoveresd, the wild relatives of crops and hardy, ancient races of domestic animals are providing higher yielding, resistant, more nutritional strains and varieties. Furthermore, as mankind becomes more urbanized and cut off from rural life, there is a greater needs for natural areas for recreation as well as for green belts to fulfill such basic functions as cleansing the air, regulating hydrological regimes and preventing erosion of topsoil.

In consequence, nature conservation is no longer considered as a luxury for developed nations but rather a necessity underpinning the very possibilities of a country to maintain its natural resources and its socio-cultural identity. This process has resulted in a change of thinking about nature reserves and how they are to be protected and managed, particularly regarding their relationships with science and with socio-economic development. While scientists have long been interested in protecting natural areas -- especially to ensure the continued availability of the plants and animals which are the subjects of research -- they have seldom been directly involved in identifying, delimiting and advising on the management of nature reserves, particularly in an international systematic manner. Research is required to establish a scientific basis on how to conserve, through the selection, design and management of reserves, to resolve the land-use problems of peoples who live within or next to such areas, to provide facts upon which to build environmental education programmes.

At the same time, in protected areas and around them, man himself should now be considered as an integral part of the ecosystem and not as an intruder who is to be excluded. Local populations should thus become the best agents of a conservation process directly relevant to their

development needs. In this respect, more consideration should be taken of traditional lifestyles based on local natural resources and the impact of ancient practices such as grazing, hunting and burning, on the maintenance and evolution of the natural environment.

The need to link conservation, science and society has long been recognized by Unesco, which has always attempted to integrate in its programmes conservation, scientific research, environmental education and the development process. The "Biosphere Conference", convened by Unesco in 1968 first stressed the need for co-ordinated international action to allow for the "Utilization and preservation of genetic resources". This was subsequently woven into the interdisciplinary fabric of the Man and Biosphere Programme (MAB), launched in 1971, under the theme "conservation of natural areas and of the genetic material they contain".

Under this theme, Unesco is promoting an integrated approach to conservation, encouraging Member States to establish protected areas as "biosphere reserves" which encompass the multiple functions of genetic conservation, scientific research, monitoring, education and training and involvement with local communities. Such "biosphere reserves" constitute the only worldwide international network of ecologically representative areas devoted to in situ conservation of genetic resources and to furthering scientific knowledge in the interests of human welfare.

The First International Biosphere Reserve Congress comes fifteen years after the Biosphere Conference, nine years since the designation of the first biosphere reserves, and three years after the publication of the World Conservation Strategy, which pointed out that economic development can be based only on sustainable use of natural resources. The Congress enabled experts from all over the world to assess the progress made to date and drew up a list of recommendations which will form the basis of an "Action Plan" for further development of the international biosphere reserve network. As such, the Congress constitutes a landmark as regards what governments and the scientific community can and must do to enhance the role of biosphere reserves in harmoniously linking conservation science and society. Unesco is therefore proud to have organized this important meeting with the support of UNEP and in co-operation with FAO and IUCN and is grateful for the sustained efforts of the host authorities to ensure its success.

PREFACE

by

Mostafa Kamal Tolba
Executive Director
United Nations Environment Programme

Since its establishment in 1972, the United Nations Environment Programme has been keeping under review the world environmental situation to ensure that priority environmental concerns are given appropriate consideration. In the process of environmentally sound development which UNEP fosters, conservation plays an important part. Indeed, conservation contributes to the preservation of biological and genetic diversity, maintenance of essential ecological processes and life-support systems and the sustainable utilization of natural resources essential for the satisfaction of the material, spiritual and cultural needs of present as well as of future generations.

More than a decade has passed since the Stockholm Conference on the Human Environment and the launching of the Man and the Biosphere Programme (MAB), and in that time there has been major progress in promoting conservation of natural terrestrial and marine ecosystems as an integral part of national economic and social development. The First International Biosphere Reserve Congress, organised jointly in Minsk by Unesco and UNEP in co-operation with FAO and IUCN at the invitation of the USSR, is a milestone in this direction as it is concerned with the further promotion of the biosphere reserve programme. The draft Action Plan on Biosphere Reserves, drawn up by the Congress, will help strengthen international cooperation in applying the results of ecological research and training for the management of natural renewable resources in a rational and sustainable manner so that the practical benefits of conservation can be brought to the people. The enhancement of the role of biosphere reserves for world-wide habitat and wildlife conservation is one of the key objectives of the proposed Action Plan. The global biosphere reserve network provides an unparalleled opportunity to use a system of protected sites of biological representativeness for long-term in-situ conservation of genetic resources in areas both of exceptionally high biological diversity and of importance as refuges for wild relatives of crops and domestic animals of economic significance to mankind.

Present scientific knowledge of biological and genetic diversity is surprisingly deficient. We do not know, for example, exactly how many animal and plant species now exist on our planet and how many are under threat of extinction. Present estimates suggest that at least 1,000 birds and mammals and some 25,000 flowering plants are dangerously rare or coming

under threat, but there may be many more since, for example, hundreds of new invertebrates are described every year. Perhaps two-thirds of these live in the tropics, mainly in rain forests. Thus with the steady removal of these rain forests many species may well vanish before man become aware of their presence. Given the speed with which biological and genetic diversity is being reduced and the necessity to maintain such diversity, in the interests of our own species it is crucial that we increase our knowledge of the ecology of wild animals and plants on our only one Earth.

My colleagues at UNEP and I believe that the Action Plan for Biosphere Reserves will also offer a very effective mechanism for the implementation of the World Conservation Strategy and that together they provide a means for coordinated and effective international effort in our search for solutions to interrelated environmental problems.

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ANNEXES

INTRODUCTION

The First International Biosphere Reserve Congress was held in Minsk, Byelorussia/USSR on 26 September to 2 October 1983 and was jointly organised by Unesco and UNEP, in cooperation with FAO and IUCN, at the invitation of the USSR and the Byelorussian SSR.

Biosphere reserves are protected areas serving the aims of conservation, research, monitoring, education and training which are established within the framework of the Man and the Biosphere (MAB) Programme of Unesco.

The Man and Biosphere (MAB) Programme was launched in 1971 as a world-wide programme of international scientific cooperation dealing with man-environment interactions in the whole range of bio-climatic and geographic situations of the biosphere - from polar to tropical zones, from islands and coastal areas to high mountain regions, from sparsely populated regions to dense human settlements. Research under the MAB Programme is designed to help to provide the kind of information needed to solve practical problems of resource management. It also aims to fill the still significant gaps in the understanding of the structure and functioning of ecosystems and of the impact of different types of human intervention. Key ingredients in the MAB Programme are the involvement of local peoples in research projects, training and demonstration in the field and the pooling of disciplines from the social and exact sciences in addressing complex environmental problems.

The International Coordinating Council which supervises the MAB Programme, at its first session in 1971, decided that one of the themes of this programme was to be the "conservation of natural areas and the genetic material they contain". Under this theme the concept of biosphere reserves was introduced, which was to consist of protected areas linked through a coordinated international network by common objectives and standards. The biosphere reserve concept was innovative in that it promoted a new approach to nature conservation, combining it with scientific research, environmental monitoring, training, education and local participation.

Since the very beginning of the implementation of the concept, the international biosphere reserve network has formed the backbone of the MAB Programme. This is due to several reasons. First, biosphere reserves are selected as being "representative ecological areas" corresponding to typical examples of an ecosystem. Thus for ecological research, biosphere reserves can provide more knowledge on the overall structure and function of the living systems of the earth than if attention were concentrated on unusual or unique sites. Second, conserving an area necessarily implies that there is a long-term commitment to safeguarding an area's naturalness. This means that observations can be collected and research repeated on the same site over a long period of time, thus allowing a better understanding of

longer term fluctuations and changes. Finally, the existence of an institutionalised international network facilitates the exchange of research data, the undertaking of comparative studies between ecologically similar sites and the establishment of integrated pilot projects based on biosphere reserves.

Since the first biosphere reserves were designated in 1976, the network has continued to grow steadily, until a total of 226 in 62 countries as at October 1983. In this same period of time, cooperation with other international organisations involved with conservation particularly the Food and Agriculture Organisation (FAO), the United Nations Environment Programme (UNEP) and the International Union for the Conservation of Nature and Natural Resources (IUCN) has been increasingly strengthened.

FAO has particular interest in biosphere reserves for their contribution to the in situ conservation of genetic resources, notably wild crop relatives, forest species and ancient races of livestock. UNEP has promoted the value of the international network for conservation in general and in particular for environmental monitoring using comparable methodologies and parameters. IUCN has considered that biosphere reserves constitute a separate management category of protected area in which conservation is linked directly with sustainable development.

It was therefore in the joint interests of FAO, UNEP, IUCN and Unesco that the First International Biosphere Reserve Congress was convened to review the experience of the past ten years and to lay down outlines to guide the development of the biosphere reserve network in the future.

More specifically, the objectives of the Congress were:

1. to present a synthesis of the current status and trends of biosphere reserves around the world;

2. on the basis of the above, to define more precisely the functions and role of biosphere reserves, stressing:

   - maintaining genetic variability;
   - informing the public at large of the benefits of conservation;
   - monitoring the state of the world's ecosystems;
   - undertaking basic natural ecosystems research and applying integrated ecological research results in the solution of environmental problems;
   - bridging the gap between research and management;
   - developing an institutional capacity to manage biosphere reserves;
   - improving management systems through further training of researchers and managers; and
   - assisting in the education of the students and the public in a spirit of conservation.

3. to determine the ways and means by which biosphere reserves can be

planned and managed more effectively so as to contribute to the carrying out of their functions and tasks as defined above including:

- expanded international support;
- stimulation of high-quality research;
- establishment of effective global monitoring systems;
- further development of conservation science;
- expanding the global network of biosphere reserves; and
- improving the organisation of biosphere reserves in order to meet the needs of the local population;

4. to further the development of the network of biosphere reserves, to strengthen their role in supporting social and economic progress and to promote international cooperation in keeping with the aspirations of the peoples of all countries.

Invitations to attend the meeting were extended to all countries participating in the MAB Programme and invited papers were requested from specialists in conservation, biosphere reserve managers, scientists undertaking conservation-related research and specialists in environmental monitoring, education and training.

Some 250 persons attended the Congress, of which 126 from 51 countries and the other 125 from the different Republics of the USSR.

The opening and the closing sessions of the Congress were held in plenary sessions at the Hotel Yubileinaya. Mr. V. S. Sheveloukha, Vice-Minister of Agriculture of the USSR and Chairman of the USSR Organising Committee, opened the Congress and presided as Chairman throughout its duration. The opening address of Mr. Sheveloukha is given as annex I. Welcoming addresses were given by Mr. Y. M. Khusainov, Vice-Chairman of the Council of Ministers of the Byelorussian SSR and Member of the Supreme Soviet of the USSR, Mr. G. G. Kovalenko, Chairman of the Organising Committee of the BSSR and Mr. Y. A. Izrael, Chairman of the USSR State Committee for Hydrometeorology and Environmental Control. Mr. Izrael's contribution is given as annex II. The representatives of Unesco, Mr. M. Batisse, and of UNEP, Mr. G. Golubev, also gave welcoming addresses which are given respectively in annexes III and IV. The representative of FAO, Mr. K. Thelen and of IUCN, Mr. K. Miller made welcoming remarks on behalf of their organisations. The scientific programme of the Congress was organised around three themes dealing with the biogeographic, scintific and social aspects of biosphere reserves. Keynote papers for these three themes were presented in plenary session by the Convenors, respectively Mr. K. Miller, Mr. D. Poore and Mr. G. Halffter, and subsequently three workshops were held simultaneously for presentation and discussion of invited case studies with corresponding poster sessions. Slide presentations and films were shown in the evenings and participants were able to visit the exhibits prepared by the MAB National Committees of the USSR and the BSSR, as well as the MAB exhibit prepared by the MAB Secretariat. One day of the meeting was devoted to the presentation

of reports by scientists of the Byelorussian SSR. Participants had also an opportunity to acquaint themselves with the nearby Berezinsky Biosphere Reserve which is an excellent example for successful implementation of the biosphere reserve concept.

The Chairman of each of the workshops, under the guidance of the three Convenors for the three main congress themes, drew up a series of recommendations which were used to elaborate a draft Action Plan for Biosphere Reserves. This draft document was presented to the Congress on the final day and, after taking account of the comments from Congress participants, shall be subsequently presented for approval to the International Coordinating Council of the MAB Programme at its eighth session to be held in December 1984. The Action Plan will then be submitted to the governing bodies of UNEP, FAO, Unesco and IUCN and the various elements of the Action Plan for Biosphere Reserves incorporated into the programmes of these organisations.

The present volume is presented in accordance with the three main themes of the First International Biosphere Reserve Congress. It includes the keynote papers for the three themes prepared by the Convenors and the invited contributions to the workshop sessions. Unesco wishes to thank J. A. McNeely and D. Navid of IUCN for their assistance in the editing of the papers for this volume. Unesco wishes to express its gratitude to all those who made the publication of this volume possible through their papers and comments and to thank the USSR Centre for International Projects GKNT for publishing this volume in four languages.

BIOSPHERE RESERVES THROUGHOUT THE WORLD: CURRENT SITUATION AND PERSPECTIVES

by

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Unesco

The term 'biosphere reserves' was not used during the 1968 Intergovernmental Conference of Experts on the 'Rational use and conservation of the resources of the Biosphere' from which the Man and Biosphere (MAB) Programme originated. The term first appeared in 1970 as a rather vague concept which was elaborated gradually over the following years. It was only in 1976 that the first biosphere reserves were formally designated: the significance and actual scope of the concept have been refined in the process of putting theory into practice. (Batisse 1982, di Castri and Robertson 1982).

Given these conditions, it is not surprising to note that there is a certain confusion as to the exact nature of biosphere reserves and to note even some contradiction views as to their role. This situation results from the evolution of the concept as its scientific basis was being developed and as its application in the field was taking place over the years. It is also linked to the extreme diversity of ecological conditions in different countries and to the rather variable - and often fortuitous - manner in which biosphere reserves have been nominated.

As the Biosphere Reserve Congress in Minsk aims at examining the current state and trends of the biosphere reserves programme and at promoting the further development of a truly international biosphere reserve network, it seems necessary first to outline the main problems facing biosphere reserves and to pick out some of the points on which discussion should focus. This is what is being attempted here, from the point of view of the MAB International Co-ordinating Council and its Secretariat, without pretending in any way to present an exhaustive list of the questions which the Congress should address.

Links with MAB

From the start, it is essential to recall the particular importance of biosphere reserves within the MAB Programme. The Programme aims mainly at harmonising, or reconciling through field research the use of natural resources with the conservation and the perpetuation of these resources in a practical manner. This international, interdisciplinary programme is based on a considerable wealth of scientific work undertaken in more than one hundred countries. Such work has often been undertaken in the framework of integrated pilot projects in the field which

frequently benefit from the existence and the scientific infra-structure of biosphere reserves. It should be noted that the closest possible links have been established among MAB projects, notably within the networks of integrated pilot projects in operation in humid tropical regions and in arid and semi-arid zones. It is obvious that the combination of integrated pilot projects with biosphere reserves is a particularly successful means of implementing the MAB programme, and is being promoted wherever possible. Such a combination is not only favourable for research and conservation activities, but also allows for training of specialists in the field, as much on the local, as well as national and regional levels, as has been clearly demonstrated in several concrete examples (Batisse 1980).

Given their conceptual link with the MAB Programme and its objectives, it is evident that biosphere reserves must serve very different objectives, which can even appear to be contradictory. It is probably this effort to combine the function of conserving plant and animal genetic resources with other functions focussing on human needs and the rational use of natural resources which is most characteristic of biosphere reserves and which distinguishes them from other protected areas in the world.

Objectives and characteristics

It is useful to recall the three-fold objective of biosphere reserves as set forth in 1979 by a MAB Task Force organized jointly by Unesco and UNEP (Unesco 1974):

1) to conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural ecosystems, and to safeguard the genetic diversity of species on which their continuing evolution depends;

2) to provide areas for ecological and environmental research including, particularly, baseline studies, both within and adjacent to such reserves, such research to be consistent with objective (1) above;

3) to provide facilities for field education and training.

In order to attain these objectives, the Task Force then proposed a certain number of characteristics which biosphere reserves might display and which can be expressed as follows:

1) A biosphere reserve is a protected area of land or coastal environment including one or more of the following categories:

   (i) Representative examples of natural biomes.
   (ii) Unique communities or areas with unusual natural features of exceptional interest.
   (iii) Examples of harmonious landscapes resulting from traditional patterns of land use, and/or:
   (iv) Examples of modified or degraded ecosystems capable of being restored to more natural conditions.

2) Each biosphere reserve should be large enough to be an effective conservation unit, and to accommodate different uses without conflict.

3) A biosphere reserve should provide opportunities for ecological research, education and training. It will have particular value as a benchmark or standard for the measurement of long-term changes in the biosphere as a whole.

4) A biosphere reserve must have adequate long-term legal protection.

5) In some cases a biosphere reserve may coincide with, or incorporate, existing or proposed protected areas, such as national parks, sanctuaries or nature reserves.

Although the MAB Co-ordinating Council has discussed these questions several times, it can be stated that nothing has contradicted the theoretical framework provided by the 1974 working group.

Nevertheless, practical implementation has gradually imposed the constraints of reality upon these criteria. In the first place, it became clear that the majority of biosphere reserves could not, at least to begin with, systematically provide for all the possible functions, of conservation, research, monitoring, demonstration, training and education. In other words, biosphere reserves could not offer some miraculous panacea to solve all the complex problems encountered in integrated rural development.

On the other hand, and whatever the merit of any new conservation effort, it would be useless to establish biosphere reserves if these were simply a duplication to already existing biological reserves. In this connection, the term 'biosphere reserve', which needs to be kept for reasons of continuity, may have been interpreted in too limited a sense. This is why today the explanatory phrase 'representative ecological area' has been added to it. This clarification is particularly important in the densely populated regions of the world where, since ancient times man has shaped the landscape by traditional agriculture or forestry and where there are very few truly natural areas left. This is the case for example of a good part of Europe and Southern Asia.

World coverage

The first question to be asked in examining the current situation of the biosphere reserve network is about the representativity of its world coverage. As of today, 226 biosphere reserves have been designated in 62 countries. Obviously this does not mean that all reserves satisfactorily meet the criteria listed above, nor that they are well spread out over the world. To accomplish the latter, these would need to be at least one reserve for each of the main biogeographical provinces of the planet, but this is far from being realized. There are 'gaps' in coverage, notably in the humid tropical, warm-arid and boreal regions. The conspicuous absence of marine/coastal biosphere reserves in almost all areas

of the world is also a matter of concern. In addition, a great many biosphere reserves are located in the 'mixed mountain and highland systems' biome, a bias explained by the fact that these are inaccessible, hilly areas where ecological conditions are not particularly favourable for agriculture and human settlement, and where consequently, the protection of nature does not conflict with other interests. In this connection, the large number of biosphere reserves located in already existing protected areas, such as national parks, nature reserves and state forests is an important factor in the problem of global coverage, since the most pressing needs for conserving genetic material concern regions where current protection is insufficient.

There is certainly no reason why some areas could not be considered both as national parks and as biosphere reserves so long as the latter designation adds on new functions and wider geographical range. But care should be taken that the notion of a protected area as a 'closed system' is effectively replaced by that of a more 'open system' which is characteristic of biosphere reserves.

Finally, since it is obvious that a statistical analysis of the world coverage of biosphere reserves depends on the kind of classification system used to clarify the major ecosystems and biogeographical provinces, such an analysis can be quite misleading. In this connection, the first attempts at classification can certainly be improved. But whatever the classification approach adopted, a systematic effort to substantially enhance the geographical coverage of the network appears to be absolutely necessary.

Conservation function

The first function of a biosphere reserve, that which is justification in itself for its establishment, is to conserve species and ecosystems. Here, the new concept of the biosphere reserve must bring a significant new contribution to the efforts already made, whatever their form. In this respect, biosphere reserves should help to give a truly scientific basis to conservation (Frankel 1984). However, little has been done so far to evaluate to what extent the core areas of biosphere reserves effectively contribute to long-term conservation. In fact, very few attempts have been made to study core areas from the point of view of biological viability, and little use has been made of the most recent ecological and genetic principles concerning the size, shape and management of the core area and of the populations of endangered species which it may contain. Also, very few biosphere reserves fall within the recognized centres of diversity for cultivated species (Vavilov Centres). And yet it is becoming more and more urgent to safeguard the wild relatives of cultivated plants and the local races of livestock: their conservation *in situ* in biosphere reserves is theoretically a very good solution (Prescott-Allen and Prescott-Allen 1982). On the other hand, it is increasingly being realized that the biosphere reserve represents the best type of protected area for preserving traditional agricultural practices and the ancient cultural activities associated with these - whether in developing or developed countries - insofar as it truly constitutes a 'representative ecological area'.

Research and Monitoring

Research and monitoring are two other very important functions of biosphere reserves. An inventory of on-going research projects in biosphere reserves has indicated that their potential for research had not been fully exploited, particularly as concerns comparative ecological research and long-term studies. Most research work has been sectoral in nature, with emphasis on geological, geomorphological and autecological studies. It would also appear that insufficient use has been made of the buffer zones and their adjacent areas for experiments linked with agriculture, forestry, fish-farming or other activities relating to man's use of local resources.

Monitoring - particularly of climatic variables and of certain pollutants - is an activity which is potentially very important in biosphere reserves and efforts have been undertaken (especially in the USA and in the USSR) to encourage international cooperation in this field, to compare methodologies and data collected in ecologically analogous biosphere reserves. Such efforts are limited however, and it appears that biosphere reserves, by working within the GEMS programme and in cooperation with WMO, could play a crucial role in monitoring in the years to come.

Management problems

From the point of view of protection and management, we have seen that at present many biosphere reserves throughout the world are extensions of pre-existing protected areas. This overlap of a national designation with an international one can have advantages, particularly when it is realized that few countries have the possibility to create new reserves in natural environments. However, in such cases of overlap, it is important to review management plans and policies to take account of the passage from a single-function protected area to a multiple-function biosphere reserve. The tendency however is to simply continue the same policy and the same type of management as before. Although it seems likely that the application of rigid, universal legislative standards to biosphere reserves would only hamper their adaptation to local conditions and circumstances, it is also true that many countries need guidelines as to how to apply their own legislation to put the biosphere reserve concept into practice. Such legislation easily applies to core areas which need strict protection but is generally poorly adapted to the buffer zones. Some countries such as Honduras or Mexico have drawn up special national legislation for biosphere reserves. However, legislation alone is insufficient unless it is enforced locally. In addition, the nomination and designation of an area as a biosphere reserve should not provide an alibi for avoiding adequate legal protection.

Biosphere reserves can play a very important role in integrated rural development if they are managed in such a way that they provide information and experimental data on the rational use of ecosystem resources (Maldague 1984). This link between biosphere reserves and development, although it is generally expressed as a good intention, appears in most cases to be somewhat theoretical and probably requires more systematic application.

The social dimension

Experience has increasingly shown that effective long-term protection cannot be achieved without the participation of local populations, who should therefore be involved as directly as possible. In this respect, the biosphere reserve concept, with its buffer zones where studies on rational use of natural resources can be carried out, is particularly attractive and can allow the population to truly participate in maintaining the integrity of protected areas. In the biosphere reserves of Mexico, this idea has been applied systematically and has allowed the development of both agriculture and of local industries. Such reserves have probably better chances of 'survival' than most even though the majority of land is privately owned and the legal protection provided under the national system is not the strictest. (Halffter 1981).

One innovation of the biosphere reserve is, therefore, the attempt to link conservation with human activities and rural development. However, it is probably true to say that in practice, rather few measures have been taken to increase the participation of local communities, of private enterprises and the various public services or private groups which 'use' the area, once it has been designated as a biosphere reserve. In most cases, compartmentalisation tends to prevail, i.e. the management of the reserve is confined to its own limits and there is hardly any interaction between the protected area and the surrounding region and its people.

In these conditions, the social dimension of biosphere reserves remains very tentative and reflects both the lack of information on the programme in general and the difficulty of transforming the 'protectionist' approach of classical management policy into one which effectively integrates the local community. And yet, the keys for setting up an ethic of long-term conservation lie above all with education, with demonstration of improved techniques of managing resources (taking account of the potentialities, the social organisation and the cultural traditions of a given region) as well as with practical training, improving the welfare of those who, in the end, shoulder the responsibility for this conservation.

International co-operation

Each biosphere reserve is justified in itself and by the role that it plays both at the local and national levels. However the universality of the concept, even though it must remain flexible and be adaptable to each particular situation, invites the exchange of information and personnel between reserves and enables the building-up of a veritable international network, covering every area of the world as systematically as possible and functioning in an active, dynamic manner. In this respect, such a network would appear to have no equal as a potential tool for international co-operation in the *in situ* conservation and study of genetic resources. However, the network forms only an outline for the moment: not only must it be completed by designating new reserves, but also improved by activating the functions of many existing reserves and by strengthening the as yet far too weak links which exist between them.

Conclusion

At the time of the Minsk Congress, one can say that biosphere reserves now appear to be widely accepted as new tools for environmental conservation and management. Although some ambiguities have still to be cleared up, the concept has been considerably clarified in the light of experience. However, a good deal of effort must be made to specify the needs for systematically covering the different areas of the world and for ensuring effective functioning of a truly global network.

The Minsk Congress will provide for a widescale international exchange of information and a critical analysis of the current situation. It therefore comes at an opportune moment to mark out the directions to be taken in developing the international biosphere reserve movement. Field study of the very interesting example of the Berezinsky Biosphere Reserve (Parfenov 1983) will usefully clarify the concrete problems which are faced by everyone.

This Congress brings together a very large group of scientists, managers and specialists in the study of representative ecological areas and the protection of their genetic resources and therefore has the authority to propose recommendations which are both pertinent and realistic for the future and which will be drawn up in a draft action plan. The International Co-ordinating Council of the MAB Programme at its next session in late 1984 will then examine the draft and officially adopt the action plan for biosphere reserves at the intergovernmental level. Indeed it is necessary that, on the basis of the work of the Minsk Congress, such an action plan enables every country, in co-operation with the relevant international organisations particularly UNEP, FAO, IUCN and Unesco, to strengthen and further develop the international biosphere reserve network and endow it with the necessary force and dynamism in order to fulfill its essential functions in the best interests of all countries and all mankind.

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PART ONE: CONSERVATION

BIOSPHERE RESERVES AND THE GLOBAL NETWORK OF PROTECTED AREAS

By

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ABSTRACT. The 226 biosphere reserves in 121 countries contain some 115 million ha. Most biosphere reserves have been based upon pre-existing national parks or other types of protected areas, and most are relatively small (less than 25,000 ha). After 10 years of the MAB programmme, biosphere reserves have been established in only about half the world's biogeographic provinces. However, the majority of the remaining provinces could be covered by linkage with existing protected areas of various types. Since 82 percent of the existing biosphere reserves are already based upon other protected areas, this opportunity is consistent with past practice. Given that the goals of the biosphere reserve project are closely associated with those of other types of protected areas, present investments by peoples and governments could be further amortized through close integration with the Man and Biosphere Programme. Furthermore, these investments in protected areas, talent and institutions could support sound rural development and show the way for the sustainable society of the future.

1. INTRODUCTION

People have established reserves for a wide array of purposes throughout human history. Particular land and water areas have received special treatment to meet needs for firewood, animal cover, fishing, water, religious and cultural solace and identity, and buffering from adjacent human groups.

Different types of management systems have been devised to meet various needs. National parks, for example, have been designed primarily for the maintenance of wild nature and the provision of opportunities for the public to visit and appreciate it. Other types of reserves focus upon the sustainable flow of material goods and services from renewable resources, including timber, water, fodder, thatch, wild fauna and recreation. While some types of reserves include cultural aspects of human history, others are limited to wild lands generally free of human impact. Most reserves of all categories include provisions for watershed protection, recreation, research, species preservation and the maintenance of scenery. All of these management categories give consideration to the question of resource sustainability; they differ in their design to offer various kinds of benefits.

As of September 1983, according to the data base of IUCN's Conservation Monitoring Centre there are 3081 protected areas. These areas cover 404,788,909 ha in 121 countries. They have been classified into ten management categories:

I	Scientific Reserve	VI	Resource Reserve
II	National Park	VII	Anthropological Reserve
III	National Monument	VIII	Multiple-use Reserve
IV	Managed Nature Reserve	IX	Biosphere Reserve
V	Protected Landscape	X	World Heritage Site

The relationship among the 10 categories has been examined by IUCN's Commission on National Parks and Protected Areas (IUCN, 1978). A revised version is presented in this volume. Significantly, these studies suggest that each category can be formalized as a management system designed to meet specific objectives. No single category can meet a nation's needs, yet by employing several categories simultaneously, a wide set of needs can be met. This approach is progressing in many countries, and protected areas are increasing on all continents (Harrison, Miller, and McNeely, 1982).

All of this sounds optimistic and idealized. Lest we get complacent, however, it is important to keep in mind the information presented elsewhere on the rates at which wildlands are being converted to other purposes, and the problems of soil loss, desertification and species extinction (Myers, 1980; Ehrlich and Ehrlich, 1981; Eckholm, 1982; Dourojeanni, 1983).

Furthermore, the policies, attitudes and procedures of protected area management are plagued with major problems which are considered to be relatively universal (Miller, 1982). These include:

(a) Island Mentality. The management of national parks and other types of protected areas has focused upon matters internal to the boundaries of individual reserves. This "island mentality" has led to a general lack of interaction with surrounding lands, peoples and institutions. A notable exception to this has been the forest reserve system of many countries which have been influential in overall rural development.

(b) Narrowly-viewed Benefits. The benefits provided by protected area management have been viewed narrowly and have shown little relation to basic needs of people. Management activities and public information have generally dealt with relatively few benefits, such as recreation and wilderness preservation in the case of parks, or timber in the case of forest; only passing reference has been made to the vast role of protected areas in watershed maintenance for downstream food production, and research on agricultural, pharmaceutical and medical properties of wild flora and fauna, among other key values to people. In other words, reserves have been sold short.

(c) Out-of-date Management. Management has often been conceived and implemented based upon conventional wisdom and dogma not reflecting the expanding knowledge base available from science and technology. Inappropriate practices and policies, or at least highly controversial ones, continue to be used beyond the point at which they can be justified. Examples include the role of fire, the handling of locally overabundant large mammals, laissez-faire attitudes toward recreation in protected areas, and tight restrictions on research and the collection of genetic materials.

(d) Inappropriate Public Information. Information provided to the public on the role and values of wildland and natural resources have been restricted to popular, often sentimental items with little reference to vital linkages between people and their natural resources. Thus while the public has been able to gain an appreciation of the "birds and the bees", they have missed the connection between the work of protected areas and their water faucet, dinner table, fireplace, doctor's office, home, school and place of worship.

(e) Weak Scientific Foundation. The long-term biological viability of parks and other reserves is in serious doubt (Soulé and Wilcox, 1980; Frankel and Soulé, 1981). Most existing protected areas were established before

the emergence of the science of conservation biology and other ecological benefits from scientific support. Recent reserves, including the major new areas in the Brazilian Amazon (Lovejoy, Prance and Wetterberg, 1981) have employed scientific guidelines from biology and ecology in the procedures for the identification and selection of over 10,000,000 ha of national parks and other protected areas. Most parks are biologically too small, have irregular shapes and jagged edges, and have population sizes which may be too small to ensure the genetic viability of key species. The basic integrity of ecosystems, including important ecological processes, and the habitat requirements of species often require territory outside the areas under protection. Imbalances or antagonistic influences can be anticipated to increase in the near future.

2. THE BIOSPHERE RESERVE

The biosphere reserve was introduced into this context. The pioneers of the idea laboured to design a programme which would build upon existing resource management and conservation efforts while focusing specifically on biological conservation, scientific management and the relationship between natural resources and people.

What is the current status from a global point of view?

(a) There are 226 biosphere reserves in 62 countries, covering 115,482,876 ha (Unesco, 1983).

(b) However, these hectares require careful examination to determine their role and contribution to conservation. Based upon calculations of the data in MAB (1983), it can be noted that of the total 115 million ha in biosphere reserve status, some 82.5 percent (or 95 million ha) are protected under law as national parks or other type of protected area; only 1.6 percent (or 1.7 million ha) are new hectares added to the total protected area estate due to the establishment of biosphere reserves.

(c) The mean size of biosphere reserves is 510,000 ha. However, on removing Greenland Biosphere Reserve (70 million ha) from the statistic, the mean becomes 202,000 ha.

(d) The median, or most common size class, equals 10,000-25,000 ha. The mode, or middle of distribution (number 113), is also 10,000-25,000 ha.

Thus, most biosphere reserves are relatively small. Studies of the biological significance of small size (Soulé and Wilcox, 1980; Soulé and Frankel, 1982) suggest that the long-term viability of small reserves for many species and communities is questionable.

Therefore, it appears valid to question how much the biosphere reserve effort has contributed to the protected area estate of the world, and also to be concerned about the biological viability of many biosphere reserves. There are outstanding exceptions which warrant special mention in this regard -- the Montes Azules (331,200 ha) and La Michilia (42,000 ha) biosphere reserves of Mexico have contributed entirely additional hectares and have been established under law. Similarly, the Rio Platano biosphere reserve (500,000 ha) of Honduras has contributed a vast new conservation area and is protected de jure. Still pending legal establishment, but already under de facto management, are Mt. Kulal biosphere reserve (700,000 ha) in Kenya, and the Mapimi biosphere reserve, also in Mexico.

A significant recent trend has been the study of the biosphere reserve by professional resource managers. It is argued by McFarland et al. (this volume) that the biosphere reserve can actually be approached as a "management category".

A key feature of the biosphere reserve concept is the establishment of a network of areas which can provide for the "...in situ long-term conservation of representative ecosystems of the world and of their component plants, animals, micro-organisms, etc." (Di Castri and Robertson, 1982). Thus central to the question of representative areas is the need for a common classification system.

Employing the biogeographical classification system prepared for IUCN and Unesco (Udvardy, 1975) to gain a global perspective for conservation purposes, let us examine present coverage:

(a) Of the 193 biogeographic provinces of Udvardy, 102 lack established biosphere reserves (that is, 52.84 percent are without representation).

(b) Of the 193 provinces, there are only 16 which lack one or more protected areas designated and managed under categories I through V of the IUCN classification. That is, only 8.29 percent of all provinces lack protected areas of other protection-oriented categories such as national parks and scientific reserves.

Therefore, the problem of low coverage comes with its accompanying opportunity; while over half of the world's biogeographic provinces do not have biosphere reserves, there are existing protected areas of other designations in as many as 86 additional provinces which could be useful in meeting the objectives of biosphere reserves. Were at least one of the protected areas in each of the remaining provinces to serve MAB objectives, then less than 10 percent of the world's provinces would remain uncovered.

The gaps in biosphere reserve coverage, at the large scale of the Udvardy analysis, are shown in Table 1. This presentation, accepting its over-simplification due to its global scale, serves as a basis for assigning priorities for the establishment of additional biosphere reserves.

3. SOME GUIDELINES FOR FUTURE ACTION

Looking over this entire situation, the World Congress on National Parks (Bali, Indonesia, October 1982) offered several principles or guidelines of interest here:

(a) The management of protected areas has become a complex scientific and technical enterprise requiring professional preparation and dedication. Far from the still-too-common perspective of management being limited to the simple activities of administration and field implementation, the task now must involve planning, policy formulation, and inter-disciplinary team leadership. Protected area managers are held responsible for the custodianship of the planet's most outstanding and ultimately significant resources. Training, salaries, responsibility and authority must be provided in an appropriate fashion.

(b) New demands upon protected areas require study and careful incorporation into management practices and procedures. Examples include environmental monitoring and conservation of genetic resources. These and other demands

for nature's goods and services require managerial analysis, policy development and regulatory measures both to permit the benefits to be obtained and to avoid conflicts with other objectives.

(c) The management of protected areas varies from place to place in response to local factors. Far from following monolithic practices, management must be adapted to the local context. This variability warrants universal respect and understanding.

(d) In spite of this necessary variation in management approaches, there is great benefit to be derived from a universal framework for protected areas management. Nations and peoples are spending considerable effort in intellectual and financial resources, and have dedicated more than 400 million ha to receive benefits from their protected areas. While the objectives and institutions of management will vary, all protected areas form part of a global network. The biosphere reserve must be taken in context with the other, far more numerous, existing areas.

(e) The global network of protected areas should be focused on a common mission to support the achievement of a sustainable society. It is recognized that development to provide all peoples with basic human dignity depends in great part upon the careful nurturing of natural resources. Protected areas, where selected and managed on the basis of modern conservation technology, are central to food production, human health, energy and water supplies, and the spiritual, ethical and moral dimensions of mankind. Thus, while protected areas need necessarily to deal with primary objectives for resource management, overall efforts must focus explicitly upon the linkages with sustainable development.

(f) International cooperation must be fostered to achieve the conservation objectives of the global network of protected areas and deliver the benefits to people. Ensuring adequate biogeographic coverage suggests the need for universal classification systems and opportunities for regional analysis. Management categories and management plans must be coordinated and compared where resources and goals are shared. Research data must be based upon common methods and techniques to ensure comparability and usefulness. And wasteful expenditures on overlap and needless repetition must be avoided.

The Declaration and Action Plan from the Bali Congress are important contributions to this examination of biosphere reserves (see Appendix for text of the Declaration). Those responsible for leadership, planning, administration, research and other tasks in the protected areas network of a country are generally the same individuals who are in charge of biosphere reserves. While the scientific component of the biosphere reserve programme often tends to overshadow managerial aspects it is vital that recognition be given to the important role of practical implementation and delivery of conservation results.

4. CONCLUSIONS

Several conclusions can be offered from this general overview:

(a) There are 226 biosphere reserves in 121 countries which contain some 115 million ha. The most common-sized reserve is between 10,000 and 25,000 ha. The majority of present biosphere reserves have been based upon pre-existing national parks or other types of protected areas. Thus, the MAB programme to date has contributed only limited additional hectares to

meet conservation objectives, and the small size of many reserves raises the question of the long-term viability so critical to the maintenance of genetic materials.

(b) While coverage is somewhat less than 50 percent of the world's biogeographic provinces, the majority of the remaining provinces could be covered by linkage with existing protected areas of various types. Since 82 percent of the existing biosphere reserves are already based upon other protected areas, this opportunity is consistent with past practice.

(c) The question remains open as to whether the resource management profession and the responsible resource agencies will treat the biosphere reserve as a "management category" (at the same status as the national park, scientific reserve, etc.) or whether it will be considered as a concept for international cooperation and the promotion of research in particular environments.

(d) Given that the goals of the biosphere reserve project are closely associated with those of other types of protected areas (education, research, conservation, recreation, training, monitoring, genetic resources protection), present investments by peoples and governments could be further amortized through close integration with the Man and Biosphere Programme. Furthermore, these investments in protected areas, talent and institutions could support sound rural development and show the way for the sustainable society of the future.

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Table 1. Biogeographic Provinces Lacking Biosphere Reserves

Nearctic Realm

Sitkan
Canadian Taiga
Tamaulipan
Canadian Tundra
Arctic Archipelago
Greenland Tundra

Palaearctic Realm

West Eurasian Taiga
East Siberian Taiga
Icelandian
Subarctic Birchwoods
Kamchatkan
West Anatolian
Arabian Desert
Takla-Makan-Gobi Desert
Tibetan
Higharctic Tundra
Lowarctic Tundra
Mongolian-Manchurian Steppe
Altai Highlands
Hindu Kush Highlands
Himalayan Highlands
Szechwan Highlands
Ryukyu Islands
Lake Ladoga
Aral Sea
Lake Baikal

Afrotropical Realm

Malagasy Rain Forest
Congo Woodland/Savanna
Miombo Woodland/Savanna
South African Woodland/Savanna
Malagasy Woodland/Savanna
Malagasy Thorn Forest
Cape Sclerophyll
Namib
Kalahari
Karro
Ethiopian Highlands
Guinean Highlands
South African Highlands
Ascension and St. Helena Islands
Comores Islands and Aldabra
Lake Rudolf
Lake Ukerewe (Victoria)
Lake Tanganyika
Lake Malawi (Nyasa)

Indomalayan Realm

Malabar Rainforest
Bengalian Rainforest
Burman Rainforest
Indochinese Rainforest
Malayan Rainforest
Indus-Ganges Monsoon Forest
Burma Monsoon Forest

Indomalayan Realm (cont'd)

Mahanadian
Coromandel
Deccan Thorn Forest
Seychelles and Amirantes Islands
Laccadives Islands
Maldives and Chagos Islands
Cocos-Keeling and Christmas Islands
Andaman and Nicobar Islands
Taiwan

Oceanian Realm

Papuan
Micronesian
Central Polynesian
New Caledonian
East Melanesian

Australian Realm

Queensland Coastal
Western Sclerophyll
Eastern Sclerophyll
Brigalow
Northern Savanna
Northern Grasslands

Antarctic Realm

Neozealandia
Maudlandia
Marielandia

Neotropical Realm

Colombian Coastal
Guyanan
Serro Do Mar
Brazilian Rain Forest
Brazilian Planalto
Valdivian Forest
Sinaloan
Guerreran
Yucatecan
Venezuelan Deciduous Forest
Caatinga
Gran Chaco
Pacific Desert
Patagonian
Campos Limpos
Babacu
Campos Cerrados
Argentinian Pampas
Colombian Montane
Yungas
Bahamas-Bermudean
Cuban
Revilla Gigedo Island
Cocos Island
Galapagos Islands
Fernando De Noronja Island
South Trinidade Island
Lake Titicaca

DECLARATION OF THE WORLD NATIONAL PARKS CONGRESS

BALI, INDONESIA, 11-22 OCTOBER 1982

WE, the participants in the World National Parks Congress, BELIEVE that:

People are a part of nature. Their spiritual and material wellbeing depends upon the wisdom applied to the protection and use of living resources. Development needed for the betterment of the human condition requires conservation of living resources for it to be sustainable.

Earth is the only place in the universe known to sustain life, yet as species are lost and ecosystems degraded, its capacity to do so is rapidly reduced, because of rising populations, excessive consumption and misuse of natural resources, pollution, careless development, and failure to establish an appropriate economic order among peoples and among States. The benefits of nature and living resources that will be enjoyed by future generations will be determined by the decisions of today. Ours may be the last generation able to choose large natural areas to protect.

Experience has shown that protected areas are an indispensable element of living resource conservation because:

they maintain those essential ecological processes that depend on natural ecosystems;

they preserve the diversity of species and the genetic variation within them, thereby preventing irreversible damage to our natural heritage;

they maintain the productive capacities of ecosystems and safeguard habitats critical for the sustainable use of species;

they provide opportunities for scientific research and for education and training.

By so doing, and by providing places for recreation and tourism, protected areas make an essential contribution to sustainable development.

At the same time protected areas serve the spiritual and cultural needs of people by securing the wilderness and sacred areas on which so many draw for aesthetic, emotional, and religious nourishment. They provide a vital link between us, our past, and our future, confirming the oneness of humanity and nature.

To these ends, therefore, WE DECLARE the following actions as fundamental:

1. Expand and strengthen the global and regional networks of national parks and other protected areas to give lasting security to: representative and unique ecosystems; as full a range as possible of Earth's biotic diversity including wild genetic resources; natural areas important for scientific research; natural areas of spiritual and cultural value.

2. Support the establishment and management of protected areas through national commitment and international development assistance.

3. Provide permanent status for protected areas in legislation securing their objectives against compromise.

4. Plan and manage protected areas using the best available scientific information; increase scientific knowledge through research and monitoring programmes; and make it readily available to scientists, managers, and the general public throughout the world.

5. Recognize the economic, cultural, and political contexts of protected areas; increase local support for protected areas through such measures as education, revenue sharing, participation in decisions, complementary development schemes adjacent to the protected area, and, where compatible with the protected area's objectives, access to resources.

6. Implement fully the existing international conventions concerning protected areas, and adopt such new conventions as may be required.

WE PLEDGE ourselves to these actions as a contribution to sustainable development and hence to the spiritual and material welfare of all people; and

CALL UPON all governments, singly and collectively, to take these actions with due despatch, bearing in mind their responsibility for the whole of life and their accountability to present and future generations.

CHAPTER 1

THE BIOGEOGRAPHICAL COVERAGE OF BIOSPHERE RESERVES

THE IUCN/UNESCO SYSTEM OF BIOGEOGRAPHIC PROVINCES IN RELATION TO THE BIOSPHERE RESERVES

By

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ABSTRACT. The combination of major ecosystems and biogeographic areas into a unified system is a logical continuation of a century-old systematizing effort of early biogeographers. Oceans and climatic zones are great geographic dividers of land. Eight land divisions (realms) and fourteen, mainly climatically controlled zones of life (biomes), are combined and yield 227 biogeographical provinces to form a basis of global conservation efforts. An overview is provided showing the coverage by biosphere reserves of each realm and each biome, and the major required future actions are emphasized. Suggestions are made toward increasing the coverage of wetlands and migratory animal habitats, and to assess, map and study the conservation needs of soil organisms.

1. INTRODUCTION

Biogeographers have long used the two sets of natural zonations found on the surface of the globe for major divisions of distribution of life. These are the vertical divisions (Sclater, 1858) by alternating world oceans with continents: Pacific, the Americas, Atlantic, the Old World continents, Indian Ocean, and Australia. The other is formed by the circumpolar climatic zones (Allen, 1878). While each climatic zone allows a great number of well-adapted animals and plants to thrive and form typical biomes and ecosystems, the stands of these biomes, extending widely in east-west directions as far as topography and vicinity of the world ocean allows it, form the very barrier for the distribution of member biota of other zonal biomes. Yet, the north-south or equatorward to poleward movement of biotas has been made possible by the great shifts of climates through time, in terms of tens of thousands to millions of years. In even longer time periods, continental drift has carried inhabitants back and forth.

Considering only the present geography of life, the outcome of all these major influencial factors is that biogeographical divisions can be made on a two-axis coordinate system. If north is above us (for New Zealanders, South Americans and Australians, below us) then the mainly vertical divisions delimit biogeographic realms, and the mainly horizontal climatic zones arrange the biomes mainly horizontally.

As I see it, the resulting mosaic comprises 227 biogeographic provinces. It comprises 8 major geographic entitities ("biogeographic realms"), 12 major biomes and two azonal, biome-composite units, totalling 14 on the "horizontal axis". The possible combinations of these two 'variables' total 112 entities. However, few of the realms contain all of the biomes; the Antarctic realm, for example, only comprises two biomes. Others, such as the Neotropic one, cuts across from the Equator to the Subarctic.

2. THE DISTRIBUTION OF LIFE ON EARTH

Ecosystems have been recognized in the second quarter of this century (Sukachev, Tansley) as communities of life dependent on and influencing their lifeless environment, thereby forming a basic unit of the biosphere. Biome is the term, now widespread, for groups of biotic communities (hence, of ecosystems) which under similar climatic influence consist of physiognomically similar plants and animals. The most permanent, since immobile, living components of an ecosystem are the rooted plants, providing not only food but cover and shelter for the animal community. Therefore, we most conveniently observe, measure, and map ecosystems and biomes by their conspicuous plant components, the units of vegetation. Thus it is justified to speak of a stand of ecosystem, just as the forester talks about a stand of mature fir forest or eucalyptus forest. For the conservationist with a zoological background this sounds strange, but not stranger than for the botanist when we talk about a population of yuccas on a desert wash.

Though the realms are well delimited by topographic or climatic and biotic barriers in their delimitation, the unique or endemic taxa have also been considered. Conversely, in the recognition of the biome the most common elements, i.e. the quantitative dominance factor, was decisive.

The elevational (altitudinal) differences on land -- mountain chains, massifs, plateaux, rift valleys, plains -- proximity to ocean, sea, lake, etc. alter the environment within each climatic zone so that instead of the zonal characteristic biome, extrazonal biomes may dominate. Azonal ecosystems thrive in environments widespread across several climatic zones, most important of them are the wetlands under the mediating influence of the water, on both the soil and the air. The system devised for terrestrial biogeographic provinces -- basic units -- encompasses the extensive extrazonal ecosystem stands -- e.g. mountain chains and high plateaux -- but not the wetlands, which is a basic deficiency of the system as it stands today (coastal and marine provinces are already under conservation scrutiny). A most urgent task of IUCN and Unesco, is to catalogue the wetlands (lakes, marshes, swamplands, rivers, watersheds with their drainage areas, and riparine ecosystems) of the world and to assess their needs for conservation measures.

3. BIOGEOGRAPHIC PROVINCES AND BIOSPHERE RESERVES

There is an interesting coincidence of numbers when we consider terrestrial biogeographic provinces and existing biosphere reserves. I have recognized 227 provinces on land, with one more about which I am still undecided, and when I submit, later this year, my revision to expert criticism, one or two may be cancelled again. There were 226 designated biosphere reserves as of May 1983. Finally in 1973, Unesco's expert panel drew up the units of vegetation, listing 225 types of vegetation, including wetland and freshwater vegetation. This coincidence is a reminder that only 226 biosphere reserves exist today -- evenly distributed, it would barely allow one reserve per biogeographical province and one reserve for each vegetation entity (which may equal ecosystems). Yet, a major aim of biosphere reserves is to preserve nature's diversity, a diversity so marvelous that nobody has yet attempted to quantify it. Let us make a simple speculation. If each realm would have, on the average, one area displaying each vegetation type, that would make 1,800 entities of vegetation units on land. But, add to these the azonal areas of life -- wetlands, caves, and geological formations -- and we may then set our goal as 2,000 biologically meaningful biosphere reserves. Finally, add those which contain valuable genetic diversity following centuries of cultivation -- it is not within my expertise to estimate their number.

To provide a basis for more realistic planning of areas in immediate need of biosphere reserves, we may use the tabulations presented (Fig. 1 and 2). Numerically, there is the greatest need to establish more biosphere reserves in the Neotropical and Afrotropical realms. Among the biomes, those represented with many biogeographic provinces have about the same need to expand the biosphere reserve system, but I find it more important, for the time being, to focus on those biomes which occur in few provinces. Within these provinces are few, if any, biosphere reserves, such as the system of ancient and large lakes, tropical grasslands, and coniferous forests (Fig 3).

Up to this point, the above treatment was concerned with preservation of ecosystem stands on land. However, biosphere reserves serving to maintain nature's diversity may also aim at populations of single endangered species, or groups of ecologically related species. I am thinking here about migratory animals, which carry out their annual life cycles alternating between two or several biogeographic provinces as their seasonal domicile. I could not discuss here, in detail, the seasonally important staging or resting and feeding areas of migratory birds and mammals, but attention toward their existence is part of IUCN's ten year plan of activities (McNeely and Miller, 1983).

Finally, study of the ecological and conservation literature of scientists in the USSR made me aware of that important branch of biological conservation which deals with maintaining the diversity of soil organisms. The microfauna, microflora, and the bacteria of the soil have so far not been considered, to my knowledge, neither by the biosphere reserve planners, nor by IUCN's master plans. Let us devote some discussion to this point, and perchance reach some conclusions about this important portion of the biota during the workshops of this Congress.

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Figure 1. BIOSPHERE RESERVES IN THE TERRESTRIAL REALMS IN 1983

Explanations: BP = Biogeographic Province
BR = Biosphere Reserve

No. & Name or Realm	No. of BP in realm	Total No.BR in realm	No. BP with BR	No. BP without BR
1) NEARCTIC	24	40	15	9
2) PALAEARCTIC	57	104	23	34
3) AFROTROPICAL	35	31	11	24
4) INDOMALAYAN	28	13	9	19
5) OCEANIAN	8	3	2	6
6) AUSTRALIAN	16	12	7	9
7) ANTARCTIC	4	1	1	3
8) NEOTROPICAL	55	22	17	38
TOTALS	227	226	85	142

Figure 2. BIOSPHERE RESERVES IN THE TERRESTRIAL BIOMES IN 1983

Explanations: BP = Biogeographic Province; BR = Biosphere Reserve

Biome Type	No. of BP in biome	Total No.BR in biome	No. BP with BR	NO. BP without BR
TROPICAL HUMID FORESTS	32	25	9	23
TEMPERATE SUBTROPICAL RAINFORESTS	10	9	5	5
TROPICAL DRY FORESTS & WOODLANDS	27	20	9	18
WARM DESERTS/SEMIDESERTS	19	33	13	6
TUNDRA & ARCTIC DESERT	13	5	5	8
TROPICAL GRASSLANDS & SAVANNAS	11	1	1	10
TEMPERATE GRASSLANDS	11	9	4	7
MIXED MOUNTAIN SYSTEMS	34	54	12	22
MIXED ISLAND SYSTEMS	29	8	6	23

Figure 3. BIOSPHERE RESERVES IN THE TERRESTRIAL BIOMES IN 1983

Biome Type	No. of BP in biome	Total No.BR in biome	No. BP with BR	NO. BP without BR
NEEDLE-LEAF FORESTS/ WOODLANDS	10	2	2	8
TEMPERATE BROAD-LEAVED FORESTS/WOODLANDS	8	44	7	1
EVERGREEN SCLEROPHYLOUS	9	11	7	2
LAKE SYSTEMS	9	0	0	9
COLD DESERTS/SEMIDESERTS	5	5	3	2
TOTALS	240	277	93	137

PREREQUISITES FOR A REPRESENTATIVE NETWORK OF BIOSPHERE RESERVES FOR EUROPE

By

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ABSTRACT. Since European countries tend to be densely populated and highly industrialized, 'natural areas' suitable for biosphere reserves can seldom be established. Therefore, it has to be questioned whether a representative network of such reserves can be implemented in Europe. The recommended priority assigned to a particular ecosystem complex for the selection of biosphere reserves -- such as wetlands, islands, coastal areas, etc. -- constitutes an additional problem. Areas in less need of protection are being neglected despite their similar importance as benchmark areas. Cooperation between the European countries is urgently needed in order to meet the objectives of the biosphere reserve concept.

1. INTRODUCTION

The biosphere reserve concept of the MAB Programme is already well developed in some countries and in several instances its objectives are close to realization. In most cases, success in creating a viable biosphere reserve programme is based on existing reserve systems where research has been carried out for some time. For example, the "interdisciplinary exchange of information for the improvement of management in natural reserves", which is a major objective for the US MAB Programme, would not have been possible if minimum baseline resource inventories, monitoring and research programmes were not already available for all areas nominated as biosphere reserves (Mack et al., 1983).

In contrast, involvement in the biosphere reserve concept is still in an early phase in many other countries, especially in Western and Northern Europe. A number of highly developed countries, where all land uses including agriculture are pursued as an industry, have thus far hesitated to participate in the programme due to the fact that large areas suitable as biosphere reserves can no longer be found within their territory; some countries have designated individual areas which are unique areas rather than representative examples of commonly existing ecosystems in that country. It appears that the original objective of a well-balanced representative system of biosphere reserves for all biogeographical provinces can hardly be achieved in the densely populated parts of Europe (Poore, 1981).

2. CAUSES OF THE LACK OF REPRESENTATIVENESS

The Federal Republic of Germany has only one biosphere reserve: the Bavarian Forest National Park. In order to make further nominations the Federal Republic has been systematically surveyed suitable natural areas of larger size which fulfil at least some of the criteria of a biosphere reserve. For this purpose it has been necessary to "adapt to local conditions and opportunities" (von Droste, 1981) and abandon the idea of equally fulfilling the originally developed set of criteria as established by Unesco (1974). A list has been prepared on the outcome of this survey, including six areas of first priority and seven areas of second priority. They are primarily

protected areas of various categories, but some as yet do not have protective status. Several conditions have to be met before their designation can be realized, including a coordinated approach in the European context.

The areas have been entered on a simple vegetation map of the Federal Repulic of Germany in order to show the distribution of the potential biosphere reserves with regard to the vegetation units. It is obvious that several biogeographical areas (characterized by vegetation units), especially mountains and alpine mountains, will be over-represented by biosphere reserves with others under-represented or not covered at all. In the latter case, fertile areas in the lowlands are noticeable; they are intensively used for agriculture and only very rarely contain relatively large natural sites.

A similar situation occurs elsewhere in Western Europe as demonstrated by the distribution of established biosphere reserves with regard to the vegetation map of the Council of Europe. The same conclusion can probably be drawn for Eastern Europe (where a comparable vegetation map is not yet available). These comparisons show that a representative system of biosphere reserves does not yet exist in which all the main ecosystems are adequately represented. So far the criterion of representativeness has played a subordinate role in the selection and establishment of biosphere reserves. It is mainly those already-existing protected areas, such as national parks and national nature reserves, with all their advantages and disadvantages of fixed boundaries and allocation in a given country, that have been selected as biosphere reserves.

3. PRIORITIES FOR THE SELECTION OF BIOSPHERE RESERVES

In the same context the question has to be raised whether the request for the setting aside of particular priority ecosystems is consistent with the objective for a representative system of biosphere reserves. In the presentations for Session A.I. of this Congress, such priorities are suggested for 6 ecosystem complexes: tropical rainforest ecosystems; savanna ecosystems; wetlands; mountain ecosystems; island ecosystems; coastal areas.

Under predominent nature conservation considerations, such areas undoubtedly deserve special attention due to their diversity of species and communities, high degree of threat, high naturalness and other particular features valuable for protection. However, there are other ecosystems worth protecting even though they do not contain rare or threatened species; examples include Atlantic oak-birch woodlands and acidophilous beech woodlands. They are characteristic of large biogeographic regions, but only a few relatively natural remnants remain. They have been given little attention by nature conservationists.

If the criterion of "nature conservation value" for the selection of biosphere reserve continues to be given as much emphasis as in the past, the establishment of a protected area system that is balanced and equally covers the entire surface of the earth will become even more difficult than at present where the situation is based on the unavailability of suitable natural areas in many biogeographical regions. Inevitably, this will leave large areas -- if not the greatest proportion of the earth's land surface -- not covered by biosphere reserves and will have the effect that long-term monitoring data is only of local relevance and of very limited use for comparison. The same applies to long-term ecological research. However, for the assessment and prediction of future human impacts, monitoring areas are particularly needed in the regions which are strongly affected by man and result in the alteration of ecological systems. Biosphere reserves as benchmark areas should also contribute to this need.

4. PROPOSED COOPERATION AMONG EUROPEAN COUNTRIES

An additional aspect has to be considered in Europe with its many countries. Each country in Europe has both selected and nominated its biosphere reserves according to its own judgement, without considering neighbouring countries (di Castri & Robertson, 1982). To overcome this lack of coordination, it is necessary to develop means for coordinating plans for future biosphere reserves. The highly industrialized countries should also agree upon minimum standards for reserves; for example, size of the core area and the ratio of natural, semi-natural and intensively managed areas. Another productive field of cooperation will be baseline inventories, including their standardization as well as long-term environmental monitoring and long-term biological research. European data pools for the comparison of biosphere reserves and their alterations through human impacts can only be provided when the mentioned requirements are met, which is indeed a difficult task. With such cooperation an important objective of the biosphere reserve concept can be met.

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A SYSTEM OF TERRESTRIAL BIOSPHERE RESERVES FOR THE MEDITERRANEAN

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ABSTRACT. With its wealth of plant and animal life and extreme ecological heterogeneity, the Mediterranean region is one of the areas in the world whose natural ecosystems are the most highly diversified, but at the same time most at risk, primarily as a result of increased human interference of all kinds, particularly during the past century. It would thus appear to constitute an ideal model for the organization and creation of a system of biosphere reserves.

1. INTRODUCTION

1.1. GEOLOGICAL AND GEOGRAPHICAL HETEROGENEITY

The Mediterranean region is a veritable enigma, because its surface relief is extremely jagged, and also because its geological structure is one of the most complex in the world. Abrupt relief, often highly fragmented mountain masses, deep valleys, high plateaux, vast sedimentary basins, steeply-banked and winding rivers and an abundance of islands, are prominent geographical features which characterize the region. Geologically, virtually all types of substrata may be found, although sedimentary rock is predominent. These characteristics clearly have played an important role in the creation of diverse habitats, and have actively encouraged the diversification of the region's flora.

1.2. Climatic and bioclimatic heterogeneity

Characterized by a broad range of temperature and precipitation, the Mediterranean region today may be considered to be a remarkable microcosm of the non-tropical world. Precipitation ranges from very low figures in pre-desert zones, to over 3,000 mm in certain mountain masses, while mean annual temperatures may vary from 5°C to 18°C.

1.2.1. Altitude zoning. Following the work of Flahault (1897), Gaussen (1926), Schmidt (1966), Ozenda (1975) and Quezel (1974-76), it has become standard practice to establish an altitude zoning classification of species and types of vegetation in the Mediterranean region, based essentially on thermal criteria, but difficult to relate directly to the thermal variants set out above (Achhal et al., 1979). Schematically, it is possible to distinguish the following zones:

-- an infra-Mediterranean zone, corresponding exclusively to the Atlantic Moroccan, Macaronesian region, characterized by Argania spinosa and Acacia gummifera;

-- a thermo-Mediterranean zone, developed throughout the Mediterranean basin, and chiefly characterized by the sclerophyllous formations Olea-Ceratonia, Pistacia lentiscus, together with Pinus halepensis, Pinus brutia and Tatraclinis articulata, according to region;

-- a meso-Mediterranean zone, which is primarily the zone of sclerophyllous forests of Quercus ilex in the western and central Mediterranean, and of Quercus calliprinos in the eastern Mediterranean;

-- a supra-Mediterranean zone, which supports Mediterranean deciduous forests in a humid bioclimatic environment and which is replaced, in a sub-humid or semi-arid bioclimate, and in the southern Mediterranean zone, by a higher Mediterranean zone, where sclerophyllous oaks are predominant;

-- a mountain Mediterranean zone, essentially characterized by high altitude coniferous formations such as Cedrus, Pinus nigra and Mediterranean firs;

-- an oro-Mediterranean zone, most often comprising scorched grassland or spiny xerophilous garrigue, where scattered formations of arborescent junipers may occur; and

-- an alti-Mediterranean zone, mainly confined to the higher Atlas and Taurus ranges, consisting of sparse dwarf chamaephytes.

The above descriptions are only indicative; while they may generally serve to distinguish the different zones, the boundaries between the zones themselves vary according to latitude and ecological features.

2. BIOLOGICAL WEALTH OF THE MEDITERRANEAN REGION

The Mediterranean flora and fauna are remarkably varied. The author's specific concern with flora is reflected in this study, but it is clear that the analysis and listing of the animal groups represented would lead to similar conclusions.

2.1. Floristic variety

The floristic variety of the Mediterranean region alone, as pointed out by many authors, is extensive. This may be seen from the comparative table below:

	(area sq km)	number of species (approx.)
Mediterranean region	2,300,000	20,000
California floristic province (Raven and Axelrod, 1978)	324,000	4,400
Australia (Specht, et al., 1974)	7,716,000	15,000
Southern Africa (Goldblatt, 1978)	2,500,000	18,500
West Tropical Africa (Hepper, 1971)	4,500,000	7,500
Tropical Africa (Brenan, 1978)	20,000,000	30,000
Eastern North America (Raven and Axelrod, 1978)	3,200,000	4,400

Floristic variety becomes even more evident when we compare the Mediterranean region with non-Mediterranean Europe, which, for an area of 9,000,000 sq km, probably has no more than 6,000 species (the British Isles, with an area of 308,000 sq km, has 1,400 species).

This variety reflects, of course, an appreciable degree of endemicity. In fact, the country-by-country listing, which is that most frequently employed, gives only a distorted impression of this variety, since the actual zones of species distribution do not take political frontiers into consideration. Thus, Mediterranean North Africa (Quezel, 1978) has 1,100 endemic species among the overall total of some 4,000 species; over 3,000 of the species belong exclusively to the Mediterranean world. It would appear that of the approximately 20,000 species found in the Mediterranean, more than half are native to the region.

These figures, moreover, can only be considered as tentative, since they are based on the Linnean system of taxonomy, and ignore the innumerable macromorphs, ecotypes and geographical and genetic races whose number is infinitely larger.

3. HUMAN IMPACT ON THE ENVIRONMENT

Despite its duration and importance, man's past influence on the flora and vegetation of the Mediterranean, which dates back to the beginning of recorded history, would not appear to have produced catastrophic changes; it is even possible that the agricultural methods employed throughout the Mediterranean basin resulted in a certain equilibrium, reflected in the classic concept of "sylva-saltus-ager" (Kunholtz-Lordat, 1946).

This situation changed completely, however, during the first half of the 19th Century, under the impact of a number of factors related primarily to the break with traditional farming methods, but also to the population explosion and to the new types of human behaviour which accompanied the development of modern society.

Indeed, an appreciable increase in the population, combined with the progressive mechanization of agriculture, has, in less than a century, resulted in a radical transformation of a considerable part of the Mediterranean region, with extensive damage both to vegetation structures and to their floristic composition.

These changes may be attributed either to direct intervention by man on the environment, or to the indirect influence of human activities, such as grazing practices, fires, the use of herbicides and pesticides, or various forms of pollution.

3.1. Direct human impact on the Mediterranean environment

This section deals primarily with the more recent impact of human activity on the major natural vegetation structures, and on the climax forest formations of the Mediterranean region in particular.

3.1.1. Recent human impact on forest formations. We shall consider this impact as it affects the different zones of vegetation.

a) Thermo-Mediterranean sclerophyllous formations: The olive and carob forests of the coastal fringe have virtually disappeared in Lebanon and Syria, as a result of unchecked urban development along the littoral (Abi-Saleh, 1978). In North Africa, the search for arable land is most often responsible for the disappearance of these formations, which generally only survive in the form of isolated trees or small plantations, preserved locally for religious reasons.

b) Sclerophyllous oak formations: Over-exploitation of these forests for firewood or charcoal is responsible for their degeneration into non-productive coppice. The aging of stumps, or their exploitation, contribute to the transformation of these forests into intensely eroded, frequently over-grazed maquis or garrigue. The Mogods mountain range in northern Tunisia offers a striking example in this connection. Its cork oak forest has been completely destroyed, and replaced by a landscape of degraded garrigue and grass, cut through by numerous erosion rills and gulleys. In Morocco, the tree cover in the Mamora forest appears to have been reduced by over half in the course of the past 20 years. In southern Greece and Anatolia, it has now become virtually impossible to find sclerophyllous oak forests in relatively good condition (Barbero and Quezel, 1976).

c) Mediterranean conifer formations: Despite their hardiness, neither the Alep pine nor Pinus brutia have been spared the consequences of human activity; the former has clearly suffered most in North Africa, especially in the semi-arid zone. The magnificent stands of this species once found on the upper slopes of the high plateaux in the Saharan Algerian Atlas, and on the Tunisian backbone range, were decimated in some areas during the wars of independence and have been still further damaged by unchecked felling.

d) Deciduous oak formations: These formations have undoubtedly suffered the most as a result of human activity, particularly in the Near East. In North Africa, on the other hand, the Zeen oak forests, which have been protected for many years (often owing to their remoteness) do not appear to have suffered much over the last few decades. Conversely, in the Near East and especially in southern Anatolia, the search for new arable land has been largely responsible for the virtual disappearance of this type of formation, which is almost always found on deep soils. Thus, oaks of the aegylops group in western Anatolia and Quercus pseudocerris in southern Anatolia, have only survived in the form of isolated specimens preserved intentionally by local people, sometimes in the form of plantations protected for religious reasons. On the high Anatolian plateaux of the semi-arid zone, intensive grazing has been responsible for ruining the Quercus pubescens subspecies anatolica forests, now replaced by vast tracts of steppe land or reduced to creeping brush which almost never exceeds one metre in height (Akman, Barbero and Quezel, 1978).

e) Mountain conifers: The prospects for these forests, which comprise some of the most valuable tree species, vary from region to region, but are extremely uncertain in some localities. The Mauritanian black pine is now only found in Morocco in small stands not exceeding 20 ha; and in Algeria, in the form of a few hundred fire-damaged specimens.

Cedar forests present a major problem in North Africa, especially those plantations situated furthest to the south. On the upper eastern Atlas range in Morocco, the retreat or -- in some areas -- disappearance of high altitude cedars has been dramatic, and regeneration is virtually impossible under present conditions. Thus, in the Anemzi-Agoudim region, thousands of hectares have been transformed into veritable tree cemeteries in less than 30 years. In Algeria, the cedar forests of Bou Thaleb and Cheliah have probably been reduced by half during the same period.

The fir forests of North Africa have also suffered heavily in recent decades. For example, part of the Jebel Tazzaote forests of Abies maroccana on the Rif was destroyed by fire 4 years ago. Despite the creation of a national park, the Numidian firs of the Babors have been decimated, particularly as a result of uncontrolled felling, during the past few decades.

In Anatolia and the Near East (Akman, Barbero and Quezel, 1979; Chalabi, 1980; Avi-Saleh, 1978), the threat to mountain conifers is fortunately less serious. Although these forests have obviously been over-exploited for centuries, an extremely effective national forestry service now ensures their protection, and in some areas, in Turkey in particular, extension. Natural regeneration remains doubtful, however, and the harmful effects of over-grazing may be observed locally. It should also be noted (Chouchani, Khouzami, and Quezel, 1974) that during the Second World War, the magnificent fir forest of Khamoua'h in northern Lebanon was practically razed by the English, who used the wood for the ties needed to build a railway in the region.

3.1.2. Recent human impact on other vegetation structures. Among the most striking examples in this connection, we shall consider the clearing of certain steppe formations, and human impact on aquatic ecosystems, permanent or transitory lakes and coastal ecosystems.

a) The clearing of steppes: A noteworthy case is that of the disappearance, in North Africa and the Near East, of vast areas of steppe vegetation, the clearing and cultivation of which (usually for grain) has been made possible through the use of mechanized equipment. Thus, in less than 20 years, thousands of hectares of remarkable floristic structures have disappeared, in Anatolia in particular, without measures of any kind being taken to ensure their protection. Although a precise assessment has not yet been made, it is nevertheless very likely that several dozen species have disappeared from these areas, or are rapidly dying out.

b) Aquatic ecosystems and permanent or transitory lakes: The recovery, drainage and cultivation of aquatic biotopes have been in progress for the past hundred years or so throughout the Mediterranean basin, and have resulted in the virtual disappearance of these ecosystems, with their outstanding wealth of flora. The examples of the Pontine marshes in Italy, and the Rharb marshes and La Calle lakes in North Africa come to mind, from which, in less than a century, more than a hundred species have disappeared. Similarly, the transitory lakes which constituted such an exceptional habitat for Isoetes have survived in only a few scattered localities in the Mediterranean region, and many of the species they contained are now extinct.

c) Coastal ecosystems: The gradual and irreparable destruction of this environment, rich in rare or endemic species, is mainly due to the influx of tourists, urbanization and the construction of holiday homes, and to the intensive summer use of beaches, dunes, and rocky shores of the Mediterranean.

3.2. Indirect human impact on the Mediterranean environment

The indirect impact of human activity on the environment is already considerable, and will undoubtedly increase still further in the coming years. We shall limit ourselves here to a few examples.

a) The role of grazing: Many authors (Le Houerou, 1971, in particular) have studied the impact of grazing on the flora and vegetation of the Mediterranean. Although this influence is as old as the civilizations of the region themselves, only during the past century, and the most recent decades in particular, has a certain balance been upset, resulting in considerable damage to different vegetation structures.

In North Africa and the Near East in particular, the unchecked increase in the number of sheep and goat flocks, combined with a refusal to observe rational methods of pasture use, often lead to a catastrophic degradation not only of the available pasture but also of the steppe, radically changing vegetation structures, provoking the proliferation of toxic or non-browsed species and seriously inhibiting the regeneration of the forests. This activity is largely responsible for the phenomena of steppification and desertification (Le Floch and Floret, 1972; Le Herou, 1968-69) which are, indeed, gaining momentum.

Conversely, in countries to the north of the Mediterranean, the reduction or total disappearance of this livestock are jeopardizing the continued diversity of flora and vegetation; the progressive spread of brush in forests and pastures not only reduces the variety of vegetation structures, but also increases the risk of fire.

b) Increased forest fires: The disastrous increase in forest or brush fires is also a phenomenon whose importance continues to grow in the Mediterranean region (Seigue, 1972; Chautrand, 1972; Le Houerou, 1973). Although forest fires occur under natural conditions, it would appear that the significant extension of the surfaces destroyed is more or less directly linked to an increase in the number of individuals (especially tourists) frequenting unspoiled, natural areas. The effects of these recurrent fires on plant species and vegetation are too widely known to need recalling here; the consequences are invariably a reduction in the variety of vegetation structure, and the propogation of particularly fire-prone common species (Trabaud, 1974; Naveh, 1974).

c) The effects of herbicides and pesticides: The widespread use of these substances in farming over the last decades has provoked a radical change in the wild flora associated with crops and with man-influenced environments. Many species which were common 30 years ago have gradually declined, and can no longer be found. This phenomenon, reported by numerous authors (Aymorin, 1965, 1976; Guillerm and Trabaud, 1980), has been serious enough to warrant the adoption of protective measures in various countries, in order to guarantee the survival of various grainland species in particular.

d) Different forms of pollution: Although the influence of pollution on vegetation structures and ground species remains limited in time and space, it merits at least a brief mention here. The effects of pollution are particularly significant, on the other hand, where aquatic eocsystems are concerned and especially the consequences of eutrophication, which results in the radical transformation, if not disappearance, of many aquatic plant groups, promoting the propagation of common species and contributing to the extinction of other, valuable species.

3.3. Conclusions

From the above remarks it should be clear that by virtue of its biological variety, and also because of the increased risk to which its flora and fauna are exposed as a result of substantially increased human activity of all kinds, and because of changes in the methods and techniques of utilization of the major natural ecosystems, the region corresponding to the ancient Mediterranean world cries out, more than any other, for a well-established network of biosphere reserves.

This claim is, however, by no means generally recognized as yet, and an assessment of the presnt situation seems to be called for at this point.

4. THE CURRENT SITUATION

The rational organization of a comprehensive biosphere reserve network involves two essential stages: an inventory of major ecosystems; and planning for the creation of biosphere reserves, taking account of progress achieved already.

4.1. Inventory of the major Mediterranean ecosystems

It is hardly necessary to return to this question, which was discussed at great length at the Side meeting. Moreover, MAB Report No. 45 (Unesco, 1979) includes an annex comprising three summary tables establishing preliminary classification systems for natural forest ecosystems, degradation stages and agro-ecosystems.

While the tables referred to are doubtless incomplete or over-simplified, they nevertheless provide a sound working hypothesis, and at the same time illustrate the complexity of the Mediterranean world, particularly as far as its forest ecosystems are concerned. Their contents should be expanded to include permanent and transitory hygrophilic ecosystems and coastal ecosystems, the specific features of which are also examined in Report No. 45 (pp. 26-28, Table I).

4.2. Planning

Some 14 biosphere reserves have been established in the Mediterranean region:

France: The Camargue National Reserve, the national forest of Fango (Corsica)

Italy: Collemeluccio - Montedimezzo, Circeo National Park, Miramare marine park

Spain: Ordesa-Vinamala reserve, Grazalema reserve, Montseny natural park

Tunisia: Djebel Bou-Hedma National Park, Djebel Chambi national park, Ichkeul national park, Zembra and Zembretta Islands national park

Yugoslavia: Tara river basin; Velebit mountain.

This list is, however, only one on paper as the effective existence of some of the reserves mentioned is not certain. In France, for example, none of the established biosphere reserves is functioning as such, the planned addition of the Ventoux reserve remains to be approved by the Ministry of the Environment and the Quality of Life.

An attempt was also made at the Side meeting to assess major gaps in this system and an outline was distributed to the various countries of the Mediterranean with the aim of securing adequate coverage of all major ecosystems through the establishment of a relatively limited number of biosphere reserves. In this connection, we can do no better than to refer to the conclusions of the Side workshop:

The following were identified as the major types of ecosystems not represented in biosphere reserves:

a)	Thermo-Mediterranean:	Argania spinosa Acacia gummifera Pistacia atlantica Tetraclinis articulata Pinus halepensis Juniperus (littoralis formation) Quercus suber
b)	Eu-Mediterranean	The ecosystems of deciduous oaks (Quercus pubescens, Q. aegilops, Q. faginea)
c)	Supra-Mediterranean	Juniperus thurifera Quercus pubescens Quercus infectoria Abies alba (Mediterranean)
d)	Mountain-Mediterranean	Cedrus atlantica Abies marocana Abies numidica Abies cilicica

The following proposals were made with a view to the creation of comprehensive reserves:

North west Africa. Three or four well chosen reserves (Sous, Rif, Middle Atlas, Babors, Aures) would give a valuable representation of the forest ecosystems.

South east Spain. There should be at least one reserve for Juniperus thurifera, Pinus nigra spp, P. clusii and P. silvestris (Mediterranean race).

France. The forests of Quercus pubescens, Pinus silvestris, Abies and Fagus should be covered; and on Corsica P. nigra laricio. The Mont Ventoux area would be valuable in filling most of these gaps.

Turkey. The establishment of reserves in Amanos (for the deciduous oaks, P. nigra spp, pallasiana, Abies cilicica, Ostrya) and on the Ayas mountains (Quercus pubescens anatolica, steppes) would be desirable.

Syria and Lebanon. Reserves for the protection of the Q. calliprinos and Q. infectoria would be desirable.

Existing and planned reserves in Greece, Italy and Yugoslavia appear to provide adequate representation of forest ecosystems in these countries.

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APPROACHES TO CREATION OF AN EFFECTIVE NETWORK OF RESERVES IN THE USSR

By

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ABSTRACT. At present there are no clear-cut general principles for establishing a scientifically-based network of reserves in the USSR. Experience has proved that this problem should be solved on the basis of physiogeographic zoning, landscape maps and satellite survey. The "principle of representation" is the most important one, stating that more reserves should be set up in the regions with a great diversity of physiogeographic conditions. Thus, it is recommended to create at least one reserve in each physiogeographic province in such regions as the Carpathians, the Crimea, the Caucasus, Central Asia, the Kazakh SSR, the Altai, the Sayans, the Baikal area, the Far East, the Urals, and all steppe and forest-steppe regions. Methods are recommended for designating protected areas by ecological criteria, with due regard to economic characteristics of a specific region. It is neceessary to evolve a balanced strategy of exploiting and reproducing living natural resources that should envisage a timely reservation of areas in order to protect them from irreversible changes. A set of workable approaches to the problem is proposed.

1. INTRODUCTION

The first "Long-term Plan of a Geographic Network of Reserves in the USSR" was prepared and formulated by E.M. Gheptner, S.V. Kirikov, and A.N. Kormozov. This vital document, still valid today, substantiated the need to set up reserves in all geographic zones of this country. The Central Laboratory of Reserves and Hunting of the Central Hunting Board of the RSFSR has drafted a long-range project for a network of reserves in the Russian Soviet Federative Socialist Republic to be created according to the same zoning principle. A number of other similar attempts have been made to solve this problem. Nevertheless, clear-cut scientifically based unified principles to be applied in setting up a network of reserves have not yet been elaborated. It is for this reason that none of these projects has been converted into reality.

Proceeding from the experience gained in this field we have decided that this problem should be solved on the basis of physiogeographic zoning of the area, landscape maps and satellite survey. Within the framework of this problem one can outline two principal tasks: to develop a general system for the siting of reserves in this country as whole; and to select specific areas deserving conservation.

The State reserves of the USSR serve as natural banks for the genepool of organizisms and also as samples of natural complexes needed as sources of scientific information indispensible in studying the organization of natural complexes in order to plan the most efficient use of renewable resources in adjacent areas. In this connection, each region that differs from another (a physiogeographic province or sometimes a physiogeographic district or area) should have at least one reserve. In southern and mountainous areas where natural life is more diverse and physiogeographic zoning is more fragmentary, it is advisable to organize more reserves, as well as to duplicate them. This has already been done in several regions in the Causcasus.

As we see it, the long-range network of reserves in the Soviet Union should be based on the system of physiogeographic zoning. The zoning proposed by N.A. Gvozdetsky and others (1967) rather fully meets these requirements. According to it, within the USSR there should be 18 physiogeographic countries, 88 regions and 305 provinces. Thus, in order to protect the genepool of plants and animals adapted to various natural conditions, at least one reserve should be created in the future in each physiogeographic province of the USSR.

It follows from the foregoing that the most important factor in organizing and distributing reserves in the USSR is the principal of their representation in terms of physiogeographic zoning -- the more diverse the conditions in each particular area, the more detailed the zoning. We recommend to designate at least one reserve in each physiogeographic province in such southern regions of the USSR as the Carpathians, the Crimea, the Caucasus, Central Asia, the Kazakh SSR, the Altai, the Sayans, the Baikal area, the Far East, in all steppe and forest-steppe zones, and in the Urals.

2. BIOGEOGRAPHICAL AND PROTECTED AREAS

The biogeographic province system of IUCN (Udvardy, 1975), may be used in this country, but with certain corrections which will allow us, first to fit into the international system of protected areas and second, to differentiate within this system the smaller territorial units within this country.

Within each physiogeographic province it is possible to outline, by an analysis of landscape maps and satellite pictures, several repesentative sites that would on the whole meet the requirements for reservation. However, only one of them should be selected for reservation and its area must be strictly limited as unwarranted withdrawal of land from economic use is certainly wasteful. For ths reason in choosing a required site within a physiogeographic province, an effort should be made to use the comprehensive system analysis of the territory. Moreover, the following factors should be taken into account: a combination of typical and unique features of natural complexes in the landscape structure of a prospective reserve; maximum structural, functional and species diversity; availability of most favourable life conditions for rare, valuable and endemic plant and animal species; absence of extreme anthropogenic disturbances in a natural complex; a possibility for complete restoration of natural conditions; resistance of a natural and territorial complex to direct and indirect man-induced effects; autonomy of a natural complex and its self-regulation capacity; minimum grievances on behalf of economic and industrial organizations and the local population; and absence of serious contradictions between the need to set up a reserve and the prospects for economic development of the area.

It is also desirable that the natural boundaries of a prospective reserve should run along mountain ridges or other watersheds. The area designated for a reserve should differ in its biotic landscape characteristic from the reserves in an adjacent physiogeographic region. Although the aesthetic factor is less important than representativeness, it is necessary to take into consideration the degree of "appeal" and an emotional effect of a given natural site on a human being.

It is no less important to determine a specific site within a physiogeographic region or province where a reserve is to be established, and its size.

To this, end one can apply the method of overlapping habitats of plants elaborated by S. Koulchinsky (Isayeva-Petrova, 1977) or habitats of rare animal populations (Filonov, 1977). Defining the outline of protected areas (Yazan, 1977) is based on projecting habitats of valuable and rare species of

plants and animals and a number of economic characteristics of a region on transparent maps. Since several competitive localities proposed by experts should be compared, there is no need to identify completely habitats of the species of plants and animals concerned; it is sufficient to have information on the availability in designated places. All other factors being equal, preference is given to a site where there is a combination of habitats with the greatest number of biological features to be protected. It is also stipulated that it is not only plants and animals that should be protected but also their communities forming a part of the biogeocenosis. As it is impossible to plot habitats of all the plant and animal species on transparent maps, the search may be confined to the background species of higher vascular plants and vertebrates, among them the most valuable but endangered species, both rare and typical for a given region, should be selected. After preliminary plotting of lands and waters by this method, it becomes possible to analyse habitats of other animals and plants and their communities for further delineation of the boundaries of an area to be chosen.

If several sites necessary for setting up a reserve are outlined by the above method, preference is given to the one that is most representative and may be excluded from economic use at a smaller cost. It is desirable, though not obligatory, that the area selected by such a method should match unique landscape features, e.g. water reservoirs, picturesque rocks, dunes, rare soils, minerals, etc.

The approach described above, combined with the use of geobotanical maps and detailed atlases of different regions, will allow to strictly limit the number of reserves, to verify their location, and establish approximate size for various physiogeographic regions and provinces.

One of the primary functions of the reserve network is to protect the whole diversity of flora and fauna, but first of all endangered species. By applying the method of projecting animal and plant habitats it is possible, for example, to establish centres of overlapping habitats of rare plant and animal species included in the "Red Data Book of the USSR".

These centres reveal an increase in the species diversity from the north to the south; the most favourable, in this respect, are natural complexes of the southern mountains where the diversity of natural conditions provides the species diversity of flora and fauna.

As far as the centres of overlapping habitats of rare animal species recorded in the "Red Data Book of the USSR" are concerned, it should be noted that in the USSR they are concentrated mainly to the south of latitude 50° north. An increase in the number of overlapping habitats in northern regions is observed only in three areas along latitude 70° north: in the inland part of the Gydansky and Yamal Peninsulas; in the interfluvial area of the lower reaches of the Yana and the Kolyma rivers; and in the north-eastern part of the Choukotsky peninsula coast. The following regions may stand out among the others in terms of a relative diversity of species: Vakhsh-Pyanjsky, Copetdagsky, Murgab-Tyejensky, Aral-Amu-Daryinsky, Pribalkhashsky, Tarbagataisky, Ust-Dnie-Stovsky, West CAucasus, Yergeninsky, Minor caucasus, and the Far East.

Not all the overlapping habitat centres are included in the existing network of the Soviet reserves. As far as fauna is concerned, these centres are to be found in the southern Aral Sea area, the Lower Dniester, the Balkhash Lake area; as far as flora is concerned, these are the southen parts of the Kuril Islands, the southern Sakhalin, and the Carpathians.

The foregoing permits us to compile a forecast map of centres of overlapping habitats of rare species, with due regard to the general characteristics of natural conditions over the USSR territory. Such a map will be helpful in earmarking not only sites for future reserves but also in determining a sequence of their creation. However, it refers to the next stage of research.

Existing reserves vary greatly in their size, as their dimensions have never been determined in accordance with research findings. Now that technogenic pressures leading to disturbances of landscapes and natural complexes are becoming more valuable, this practice can no longer be tolerated. Therefore, it is necessary to evolve a balanced strategy of exploiting and reproducing natural resources that will provide for timely reservation of areas in order to safeguard them against irreversible changes. Thus, it is always necessary to convincingly substantiate the need for turning a part of land or a water body into a reserve and to carefully choose the form of reservation (national park, reserve, sanctuary, natural monument); it is also vital to define criteria for determining the minimum size of an area to be reserved. This will ensure conservation of the overall sufficiently full genepool of biota and will provide necessary conditions for normal life of plants and animals.

When defining the boundaries and size of a future reserve, it is very important to find an area capable to provide normal living conditions for the most valuable beasts of prey and ungulate animals that cover long distances.

3. CONCLUSION

Summing up national and international experience in the selection of natural areas to be protected, we would propose the following pattern of approaches:

-- Collecting information on proposals for organization of natural protected areas (from literature, state institutions, public and scientific organizations, individual scientists).

-- Drafting a scientifically-based long-range project to create a network of natural protected areas; discussing, finalizing the draft and obtaining the approval for it from a relevant body or organization.

-- Drafting a preliminary plan for siting of protected areas in various regions in accordance with the scientifically based-project and the card file of proposals received at the first and second stages.

-- Reaching agreement with interested local organizations and institutions; in situ studies of selected and agreed-upon plots of land and water areas to be possibly reserved.

-- of regional plans of siting of protected areas by the appropriate government agencies.

-- Drawing up a summary general plan for siting of natural protected areas, agreed upon and approved of locally, for this country as a whole for the period ending in 2005. Approval of the plan by the State Planning Committee of the USSR.

-- Preparing relevant projects with due regard to social and economic development of each particular land and water area to be reserved.

-- Drafting decrees on organization of specific natural protected areas to be adopted the the Councils of Ministers of the Union Republics after their approval by the USSR State Planning Committee.

CONSERVING TROPICAL RAINFOREST ECOSYSTEMS: ASSESSING COVERAGE AND ASSIGNING PRIORITIES

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ABSTRACT. The main thesis of this paper is that conservation of natural ecosystems can only be achieved through a total commitment of society. Through enlightened management, yield can be enhanced to the limits of natural energy laws but not further if renewability of natural resources is to be maintained. Conservation goals cannot be attained either through needless exploitation of ecosystems (which generally ignores natural limits) nor through forced preservation (which generally ignores human needs). The rates and causes of tropical deforestation are reviewed and because some forests are being cleared to satisfy the needs of landless people, it is considered imperative to incorporate people's needs in plans to conserve the tropical forest resource. The paper suggests that MAB's priority in the tropics should be toward the development of model land uses in biosphere reserves and the promotion of the conservation ethic into the social fabric.

1. INTRODUCTION

Global awareness of the need for conservation of natural resources has increased dramatically since the 1972 Stockholm Conference. With increased attention to conservation by governments and by the public in general, conservation ideas are now more likely to affect the way people live. Nowhere is this scenario more applicable than in the area of tropical forest conservation. Millions of people depend on the goods and services from tropical forests while millions more are concerned that tropical forests are being destroyed too rapidly and the climatic and biotic balance of the planet may be in jeopardy as a result.

Government officials responsible for the management of tropical forests are in a difficult position because, on the one hand, they must respond to the needs of the public and at the same time have a responsibility to future generations. In what state will forest lands be in fifty or a hundred years from now? What is their current status? What are the possible uses of tropical forests? How should we proceed in the coming decades? Should policies be guided by the notion that tropical forests may be gone by the year 2,000 or is there more time to develop a balance between human needs and the capacity of natural ecosystems to provide those needs? These are the difficult questions that the global society must answer and for which conservationists must develop ready answers.

Some organizations, such as the International Union for Conservation of Nature and the US National Academy of Sciences (Myers, 1980) have raised a strong voice of concern about the future of tropical forests. Others have questioned these forecasts and gone as far as to say that the problems are not anywhere as serious as suggested (Simon, 1983). As it should be with issues of global

concern, credibility is the most important commodity in a debate where so much is at stake. In the midst of the debate for technical credibility, however, people's needs and the concerns of their government are probably lost.

The Man and the Biosphere Programme (MAB) is in a unique position to balance the extreme points of view because this programme was created precisely to function at the interface between humans and their environments with due concern for both. In this paper we present information on the status of tropical forests with suggestions for management strategies open to us. Our main concern is that policies must be based on sound analyses of available information; when adequate information is lacking strong ecological principles must be used. Policy makers and conservationists must accept the enormous diversity of conditions that exist in the tropics as a base from which equally diverse policies are developed. Generalizations over broad regions are very dangerous in tropical environments and this makes policy making even more difficult. Errors will be made but an effort to err on the conservative side is a must.

Maintaining the renewability of natural resources is a fundamental guiding principle of conservation. To accomplish this, one has to understand that living resources are renewable within certain limits of use. Non-use cannot always be the alternative given by conservationists when human needs demand satisfaction. A conservation policy that takes into consideration human needs must be ready to accept intensive as well as extensive use of forest lands. Indeed, the main thesis of this paper is that conservation of natural ecosystems can only be achieved through a total commitment of society. Society must decide whether its use of resources will impinge on natural resource renewability. Through enlightened management, yields can be enhanced to the natural limits set by the energy laws, but no more if renewability is to be maintained. It is obvious that conservation goals cannot be attained either through needless exploitation of ecosystems nor through forced preservation.

Because we know so little about the tropics, much of the decision making is going to be different at best. Integrating a conservation ethic into day to day living will require several generations and hard work. Time and a commitment to research and sound management will be needed before an acceptable balance between people and natural ecosystems can be reached. The MAB Programme should spearhead such an effort and help the world bridge the gap that exists today between the fervour of preservation and the unsupported optimism of endless growth advocates.

2. ASSESSING THE RESOURCE

The tropical region of the world encompasses an area of approximately 4,814 million ha and about 76 countries in tropical America, tropical Africa and tropical Asia. Many small islands in the Pacific and Caribbean are not included in this estimate but they account for less than 2% of the total land area. Most of the countries in this region of the world are regarded as developing nations and most have high population growth rates.

The tropical region has more climate and soil types than any other region of the world. Some tropical areas have as little as 500 mm/yr of rainfall while others have as much as 10,000 mm/yr. This rainfall can be seasonally distributed with one or two dry seasons a year or it can be distributed fairly evenly thoughout the year. Mean annual temperature varies from about 25°C in the lowlands to almost freezing on the high mountains. In fact, using

temperature and rainfall values, Holdridge (1967) classified the world into 120 life zones or plant formations, of which 66 are tropical compared to only 37 for the temperate region.

All ten of the soil orders are found in the tropical region. The potential number of combinations of soil and climate types is so large that an equally high number of possible ecosystems or plant associations exist. Species richness is the product of environmental richness, and it is no wonder that the tropics are reputed to contain the most number of plant and animal species in the world.

If we consider forests only, 32 of the 66 tropical life zones support forests, but because of the diversity in soils and topography, the actual number of forest associations is much higher. These tropical forests are not all "rainforests" as most people think because almost half of them grow in arid environments.

The most up-to-date assessment (for 1980) of the tropical forest resource was made by the Food and Agriculture Organization (FAO) of the United Nations (Lanly, 1982). Two basic forest formations are recognized: closed forests in which the various storeys of the forest cover a high proportion of the ground without a continuous dense grasslayer; and open broadleaf tree formations, which contain a dense grass layer. The former type includes broadleaf, coniferous and bamboo species which may be evergreen, semi-deciduous or deciduous, wet, moist or dry, i.e., many types of forest life zones. The closed forest formation covers an area of about 1,200 million ha or 25% of the tropical land area, and the open forest formation covers an area of 734 million ha or 15% of the land. Most of the closed forests are undisturbed or late secondary (82%); the remainder are logged (14%) or intensively managed (4%). Most of the open forest formations are disturbed by human activities.

Other estimates of the areas of tropical forests have been made as far back as the 1920s by Zon and Sparhawk (1923) for the US government with at least three major independent assessments between then and 1980. The difference between the 1920 and 1980 surveys of tropical closed forest amounts to about +15%. Because of the differences in methods among the surveys we cannot use them to determine rates of deforestation with much confidence, but they do tell us that in terms of the total resource we have more forests now than we thought we had in the last decade.

Areas of tropical forests are changing every year due to their clearing for agricultural activities. To determine the future status of these forests, we must know how fast and why they are being cleared. Concern for tropical deforestation centres on the moist forests, the "closed" broadleaf forest formation designated by FAO (97% of the total closed forests). We have concern about the fate of open forests too because they are also intensively used, they have slower rates of recovery, and millions of people depend on them for many goods and services. However, these forests are not gaining as much attention as the closed forests.

The problem of tropical deforestation is not new, it has been going on for centuries in many parts of the tropical world. Examples of this are the invasion by forests of the ancient temples in Cambodia, Mexico and Guatemala; the cyclical nature of forest cover in the Venezuelan llanos; evidence of charcoal and pottery chards in the soil under many forests of tropical America; the devastation of forests in parts of S.E. Asia for many centuries by people resulting in the same problems as today, such as filling of river beds and subsequent flooding; and the clearing of forests in much of the Caribbean Basin by the various colonialists to make way for plantations of

bananas, coconuts and sugar. What makes deforestation a serious problem now, and for some countries a critical problem, is that the world is losing forests at an unprecedented rate at a time when high human populations have great need for their products and services.

A report by the US National Academy of Sciences (Myers, 1980) and the Global 2000 report have suggested a rate of deforestation as high as 20 million ha/yr while FAO's report suggests a low of about 7 million ha/yr. This difference in reported rates of deforestation is the main issue surrounding the tropical deforestation debate. People who support the high rate go as far as predicting that, except for a few remnant forest patches, all tropical forests will be gone by the end of the century.

Part of the reason for such a disagreement rests with the interpretation of the word "deforestation" and part of it is due to unreasonable extrapolations. We have reviewed the National Academy of Science report elsewhere (Lugo and Brown, 1982) and it is not necessary to discuss again its many shortcomings. We believe that the detailed country by country report by Lanly (1982) is the most comprehensive analysis available at present and we will refer to it often in the following discussion.

Less than half of the 7 million ha of the deforestation takes place in the undisturbed closed forests; the rest comes from logged forests. The highest rate of deforestation occurs in tropical America (greater than 4 million ha/yr) but because this region has the greatest amount of tropical forests its percent loss is the same as the other two regions. Although the percent rate of loss for the whole tropical region is low (0.61%), some countries have much higher rates of loss. For example, countries with small areas of tropical forests such as Costa Rica, Thailand, Ivory Coast and Nigeria are losing their forests at a rapid rate (3-6 %/yr) and if allowed to continue their forest resources will be virtually gone in a few years. These values can not be extrapolated to all the tropics because countries with the largest forest areas such as Brazil and the Cameroon-Congolese forests of Africa are experiencing relatively low deforestation rates of 0.2-0.4%/yr. Another danger of global extrapolation is the underlying assumption that national boundaries do not exist. Predictions about the future status of tropical forests have to be made country by country.

By far the greatest cause of deforestation is the practice of shifting cultivation. This form of agriculture has been going on for centuries and until recently it had minimal impact on the forests. Now however, human populations are higher and many of them are landless and eke out a living by illegally clearing and cultivating forest areas, particularly the logged forests. Other causes of deforestation are planned colonization programmes such as those in tropical Asia. Conversion to pastures is another important cause of deforestation, particularly in tropical America; in some cases the pastures are overgrazed resulting in badly denuded and degraded lands.

Other human activities often lead to a general degradation of forest lands. Fuelwood collecting, grazing, and repeated fires tend to be the most important causes, but these are generally restricted to open formations or closed conifer forests. Logging can also lead to degradation, particularly in natural monocultures (e.g., mangrove and dipterocarp forests) where logging is more intensive.

Many countries faced with high rates of forest loss are developing a variety of programmes to reverse the trend. Their emphasis is on stabilizing the shifting cultivators through the establishment of community forestry programmes, agroforestry, and better soil conservation techniques. Many of

these programmes are still in the early stages and their success has yet to be determined. However, to be successful in the long run, they must provide the opportunity for the people to produce food, fuel and fodder and to provide incentives for increasing their standard of living.

What else can be done to resolve one of the most serious problems facing civilization? Beyond understanding the situation of the resource, humans must also try to understand how the resource functions. For this, research in tropical forestry in needed. Research results must be interpreted from the point of view of management application. Management prescriptions must then be applied in the field taking into consideration cultural, social and political factors. This process requires social enlightenment and funding. It is obvious that deforestation and its solution is as much a social and political problem as it is a strictly biological or technical issue. All sectors of society must pool efforts to solve a problem that affects them all equally.

3. ASSIGNING PRIORITIES

Tropical biosphere reserves cover an area of about 20 million ha (or 17% of all biosphere reserves) of which 14.8 million ha (74% of all tropical biosphere reserves) are forested. In a global survey that we conducted, we found that most of the biosphere reserves are not under any kind of intensive use, or at least policy so dictates. Most of the biosphere reserves are used for environmental protection, research, and the preservation of resources. Because tropical environments are so much more diverse than all other regions of the earth combined, it is obvious that many more tropical reserves need to be declared if the system is to contain representative areas of all possible biogeographic regions. However, achieving such a balance, which we support strongly, should not be the only priority of the MAB programme during the coming decades. Instead, we believe that MAB's priority should include the development of model land uses in the resources, and promotion of a conservation ethic into the social fabric of the tropics. The main justification for this is that the future state of tropical forest lands will depend on how people relate to the land and its natural resources. The programme in the biosphere reserves in Mexico could be used as a model for tropical America (Halffter, 1980) and similar models should be developed in tropical Africa and tropical Asia.

Only a brief suggestion for an approach to the management of tropical forest lands can be given here. Figure 1 contains a series of decisions that have proven useful in the management of forest lands in some parts of the world. The idea of the scheme is to optimize the full work of the natural ecosystem while at the same time seeking useful yields for people. This to us is the essence of the implementation of conservation principles into forest management.

Some forest lands are needed for agriculture and those with gentle slopes on the best soils should be used for this purpose to assure high yields. The remaining forest lands can be used either for protection or production of timber and other forest products. Forest lands on steep slopes and those in high rainfall areas should be preserved as natural forest because they protect water, soil and wildlife resources. In addition, they can be used for recreation, tourism and research. Forest lands of low production potential could also be allocated for these uses. Forest lands that have a high production potential, and if they are already forested, can be managed for timber and other forest products using practices that are consistent with good soil and water conservation. Non-forested areas can either be allowed to

regenerate naturally or reforested with plantations. The rate at which natural regeneration occurs depends upon the life zone in which the land is found. Regeneration is faster in humid climates than in arid ones, which must be considered in this decision-making process. The use of tree plantations has been the most popular way to reforest lands, but even plantation species are constrained by the type of life zone the land occurs in (Lugo et al., 1981). Selection of suitable species that are compatible with the climate, soils and desired end-use is very critical to ensure success of the venture.

In short, the highest priority of the MAB programme should be finding ways to integrate people with a land-use ethic based on conservation of ecosystems. We propose that biosphere reserves can be used to develop land use models that incorporate the principles of conservation that the MAB programme as a whole is trying to communicate. This would be a function of biosphere reserves that would be compatible with their many other uses in terms of preservation, research, and monitoring. Our belief is, however, that if the principles of conservation are not incorporated into the day-to-day activities of people in the tropics, tropical forests will continue to experience wide oscilations of use and abuse.

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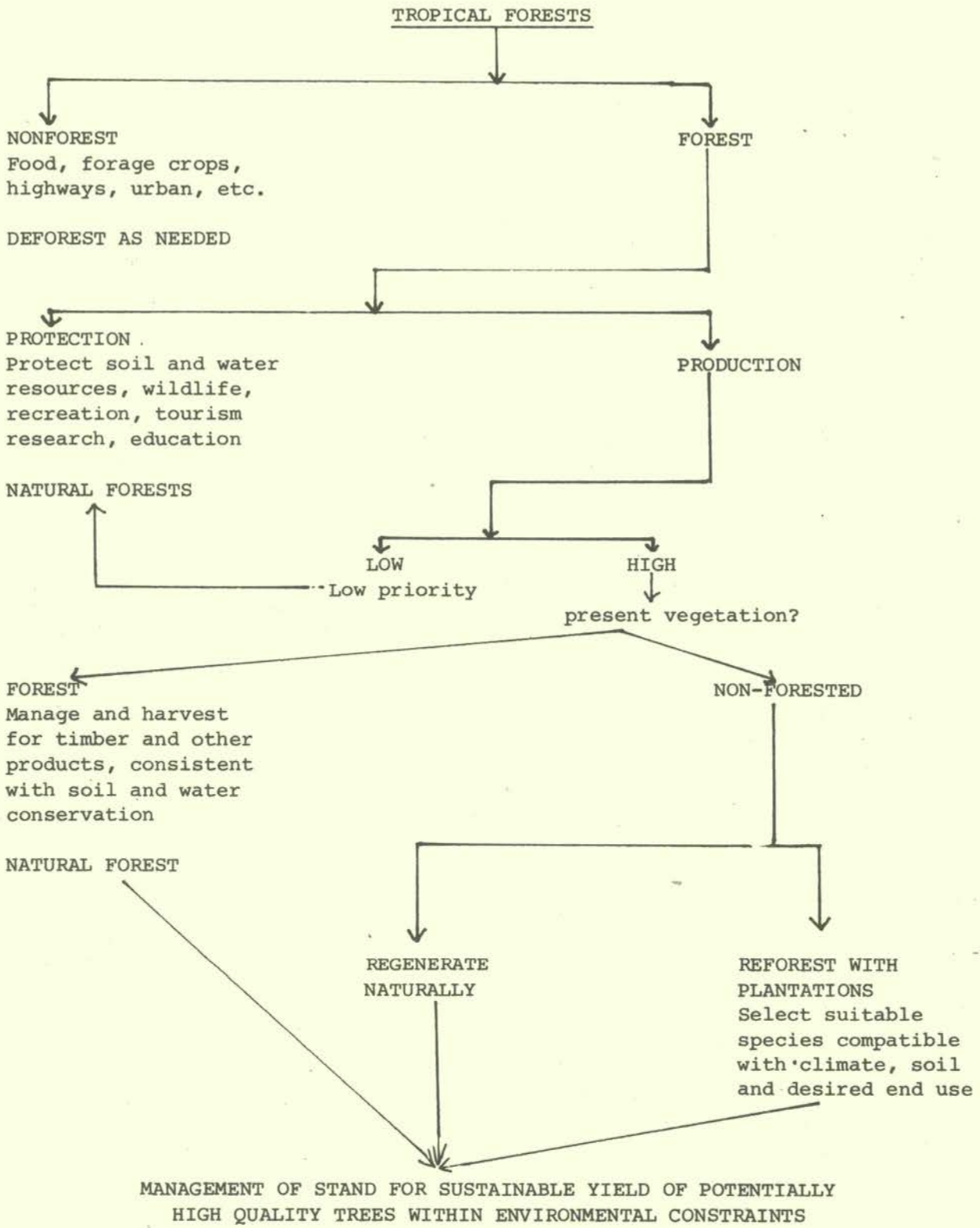
Fig 1: Suggested scheme for the allocation of tropical forest lands (adapted from Wadsworth, 1978)



BIOSPHERE RESERVES IN SAVANNA REGIONS: BUILDING THE RESEARCH-CONSERVATION CONNECTION

By

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ABSTRACT. Although the term "savanna" is of limited value in a precise classificatory sense, the term is widely used to identify an array of wooded grasslands and grassy woodlands that lie between the equatorial rainforests and the deserts and semi-deserts of the tropical regions. There is great variation in the physiognomy of savannas and in their water, fire and soil nutrient status. But it seems possible to recognize a small number of functional groupings of savanna types with characteristic differences in energy flow and ecosystem dynamics. The three major types are moist savannas, dry savannas, and cold-season savannas. Two major land use problems in areas unsuitable for agriculture are poor quality forage for livestock and (in Africa) presence of tsetse flies. Relatively low densities of human populations and the presence of spectacular numbers of large herbivores help explain the well-developed systems of national parks in certain savanna regions. Of the 11 biosphere reserves established in savanna zones, 10 are in Africa, only one in South America, and none in the Australasian region. All but one reserve is over 100,000 ha in area. Conservation rather than research has been the main stimulus for their designation as biosphere reserves. Among the proposals for future action are: extension of the geographical coverage of biosphere reserves in savanna regions; and development among groups of research sites of comparative studies designed to test working hypotheses on the functioning of these ecosystems, their stability in time and the possibilites for their improved use by man.

1. INTRODUCTION: TROPICAL SAVANNA ECOSYSTEMS

1.1. Definition, types, distribution

The word "savanna" has long been used to refer to a certain type of tropical landscape, but there has been, and still is, much controversy over the exact meaning of the term (Bourlière, 1983; Bourlière and Hadley, 1970). In this contribution, the term is used to describe a tropical formation where the herbaceous stratum is continuous and important, interrupted to a greater or lesser extent by fire-tolerant trees and shrubs. Bush fires often occur annually and the main growth patterns are closely associated with alternating wet and dry seasons. In most situations, there is one dry and one wet season per year, but there may be two dry seasons (always unequal to each other) and two wet ones. The seasonal aspect of the climate directly determines the vegetation cycle, and constitutes the principal characteristic of these herbaceous formations; the modalities of this seasonal change determine the diversity of the structure and phenology of the plant cover in the savanna zones.

Non-scientific in its origin, the term "savanna" covers a large range of different types of vegetation. Physiognomy is variable, involving two principal elements: first, the height of the herbaceous layer, which can vary from several decimeters in low-lying savannas on iron crusts, to several metres in Pennisetum savannas; and second, the structure of the shrub and tree layers, which span the range from total absence (some edaphic grass savannas) to presence of stands of quite tall trees (woodlands), passing through various intermediate stages of shrub and tree savannas. At the wet and dry ends of the climatic spectrum, these mixed forest-grassland and grassland formations grade into closed forest and steppes.

Given the overriding importance of the climatic factor in the life and functioning of savannas, it would seem rational to group the principal types of savannas according to climatic factors, independent of their physiognomy. Though there are of course intermediary gradations, three major types can be identified:

-- moist savannas, with tall perennial herbs, high rainfall and a relatively weak and short dry season during which plant growth can still take place. The woody stratum can be very diverse but is often reduced in wetter areas, doubtless because the effect of fire on high biomass of the herbaceous layer can be a particularly destructive force. Annual regrowth after fire is, on the other hand, rapid and vigorous (Lamotte, 1977; 1978; 1979).

-- dry savannas, with perennial herbs (as in moist savannas), but which attain a much lower biomass, and which are subject to a much longer dry season. In these areas, the bush fires are less intense, given the lower biomass, and cause less damage to the trees. Regrowth after fire is more limited and often delayed.

-- savannas with cold season, which also have a relatively arid appearance because they are nearer to the limits of the tropics than to the equator. The cold slows down plant growth but compensates for part of the dryness in reducing transpiration and thus the needs of vegetation for water. Increasing altitude trends to accentuate the cold period.

Together these systems cover considerable proportions of the southern continents -- some 65% of Africa, 60% of Australia and 45% of South America according to Huntley and Walker (1982). A slightly different, but still considerable, extension of savannas is shown in Figure 1 (from Bourlière, 1983).

1.2. Role of fire and influence of man

Independent of type, the savanna seems to be stable during the course of time, in a similar way to the tropical forest. "Elders" in western Africa villages have no recollection of forest in areas where savannas are found today. This "stability" is without doubt linked to the bush fires, which typically occur each year (in some cases more irregularly). Apparently inevitable, they can be considered as natural phenomena, even though they might be induced by man. In effect, in the memory of the local people they have always existed and they constitute one of the key elements of the seasonal rhythm of the vegetation. The woody and herbaceous plants of the savanna, by all their anatomical and phenological characteristics, are adapted to such fires.

Experimentally, it is possible to prevent the passage of bush fires over a period of years. Such experiments lead to modification of the environment. At Kokoundékro, near Bouaké in the Ivory Coast, total protection from fire for more than 35 years has resulted in reconstitution of a dense dry forest

completely devoid of a herbaceous layer (Monnier, 1981). In an adjacent plot burned each year, the woody savanna facies has been maintained without change. With precocious fires, woody materials do develop, but are not able to strangle completely the herbaceous strata. A second experiment in the Ivory Coast, at Lamto, has been underway for more than 20 years, and here the initial changes in vegetation have been monitored with greater precision than at Kokoundékro (Menaut, 1977; Vuattoux, 1976). Other long-term observations include the 30-year fire experiment in semi-humid savanna in northwestern Ghana (Brookman-Amissah et al., 1980) and observations at Olokemji in southwestern Nigeria, where 50 years of fire protection have resulted in the regrowth of forest and thicket with no undercover of grass (data reported by Sanford, 1982).

Two situations are therefore possible. The first, linked to regular annual bush fires, induces a savanna with greater or lesser shrub or tree cover. The second, in the absence of fire, leads to the reconstitution of a dense dry forest without herb layer. Complete protection can thus lead to change from savanna to dry forest in a period of 30-40 years. Inversely, fire during a dry period can rapidly destroy a dense dry forest and result in a savanna rich in herbs. In other words, in many areas the savanna is a stable formation only in the presence of fire.

Fire, however, is often considered as a man-made perturbation and most present-day savannas as secondary formations, attributable to the action of man; they would have replaced a climax forest formation. For some authors, fire is not a strictly anthropogenic factor. It can also be induced by lightning in favourable circumstances and would undoubtedly have always existed, but would have been a less frequent occurrence, certainly not an annual one. It is, however, known that fires induced by lightning and acting on several years' accumulated vegetation can have a particularly violent and disruptive effect.

It should not be forgotten that savanna occupation by man is very ancient, particularly in those zones where the forest is not unduly oppressive by its density and humidity. Fire induced by man in a regular way dates back at least several thousand years, and this gives substance to the saying that these areas which have been shaped by man are in fact "natural". Moreover, there exists a large mammal fauna adapted to these environments which testifies to their age.

The problem of the anthropogenic origin of savannas remains open therefore, like that of the exact role of fire. One of the main reasons for this uncertainty is the diversity of situations, which is itself linked to the heterogeneity of the plant formations encompassed by the term "savannas". Thus, certain herbaceous savannas are linked to soil characteristics, such as the flooded or swamp savannas found in very wet climates or topographical situations. In forest zones, there exist "islands" (sometimes large) of savanna-type formations that can be attributed to the action of man, such as the savanna-type Imperata systems found extensively in Indonesia, Thailand and other parts of Asia formerly covered by evergreen forest.

Sometimes, savannas are truly grasslands sown by man in areas of dense forests cut for cultivation and then abandoned. Such formations are found increasingly in the equatorial regions, particularly in Mexico and all of the humid tropical zones of Central America. These totally anthropogenic herbaceous formations are the equivalent of the pastures and hayfields of temperate zones, which were also induced in regions with a forest climax. In Venezuela, where several types of savannas coexist, it is possible to

distinguish primary savannas as well as savannas whose existence can be traced almost certainly to the action of man. The natural savannas are characterized by typically Neotropical species of Gramineae, while the anthropogenic savannas are populated by grasses belonging to recently imported African species.

1.3. Ecosystem functioning

Tropical savannas show marked variability, and this variability is perhaps their most important feature. In spatial terms, there is no such thing as a typical savanna ecosystem, but rather a gradient of related ecosystems ranging from open woodland to treeless or almost treeless savanna grassland. In temporal terms savannas are not only adapted to survive variations over time but many in all probability require such changes to maintain their resilience (Walker and Noy-Meir, 1982). In spite of this variability, some generalized features of tropical savannas can be identified: alternating wet and dry phases; structure primarily determined by competition between woody and grass plants for available soil moisture; fire, herbivores and soil nutrients as principal modifying factors (Walker and Noy-Meir, 1982, and Figure 2).

The moist savannas are characterized by high biological productivity. The main limiting factor is the low fertility of the leached soils (water is abundant). After their juvenile stage the low-protein herbs provide poor forage. Large wildlife is rare and domestic stock raising restricted. The presence of gallery forests has a marked effect in increasing the health hazards (particularly through trypanosomiasis) but on the other hand tends to favour agricultural development because of the more favourable forest soils. High relative humidity often contributes to the presence of major endemic diseases in these tropical regions, resulting in the past in high levels of human mortality. Many of the moist savanna zones have remained underpopulated and continue to pose difficult management problems.

In the drier savannas, which cover large expanses between the moist preforest savannas and the Sahelian steppes, rainfall is in contrast a factor limiting production. The growing season is shorter and biomass is lower than in the moist savannas. On the other hand, bush fires are less violent and thus less damaging to the trees, which are favoured in their competition with herbs. One remarkable feature is that the wetter years are those when bush fires are most violent, the biomass being higher. Due in part to the richer herb layer, wildlife is more abundant and stockraising relatively easier. Relatively unfavourable for agriculture, these dry savanna areas are also sparsely populated in the main. With the appearance of a cold season, the dry savannas lose (at a given rainfall level) part of the rigour of their water regime in relation to the vegetation, since transpiration is reduced. The cold however -- like aridity -- inhibits primary production. In the drier types, annuals partially replace perennial herbs, leading to a more steppe-like landscape. Fire is rarely an annual event, owing to lack of combustible material.

2. THE CONSERVATION CONTEXT

The functional characteristics of savanna ecosystems are of key importance in affecting the conservation status of this biome type. Outside certain favourable zones, soils and climate make agriculture difficult. Industrialized crops are mainly confined to irrigated zones, and the major form of land use in the drier areas is livestock management. The effect of livestock on the savanna landscape is not fundamentally dissimilar to that of wild ungulates, apart from differences in intensity of grazing and browsing attributable to the absence of predators. Problems associated with

agricultural and pastoral development, together with human diseases such as trypanosomiasis and onchocercosis, have tended to keep human populations at relatively low levels in many savanna areas. At the same time a principal characteristic of the wildlife of savannas is not so much the presence of endemic species, but rather the abundance of a large mammal fauna: antelope, buffalo, zebra, elephant, rhinoceros, are but five major types of herbivore found in Africa; carnivores include lions, hyenas and wild dogs. It is the conjunction of relatively low densities of human populations -- linked to the paucity and inhospitality of the environment -- and the abundance of a "spectacular" and readily visible fauna that has led to the creation of a relatively large number of national parks, particularly in Africa, many of which are very large.

Figures for protected areas in the African "tropical dry forest and woodland" biome of Udvardy (1975) includes many "savanna" sites. In this biome, 216 national parks and other protected areas cover a total surface area of 60 million ha (Harrison, Miller and McNeely, 1982; IUCN, 1982), an average of 277,000 ha for each protected area. These are impressive figures, even though the long-term conservation prospects for some of these areas -- as originally planned and currently managed -- are more problematic. In effect, in the last few years it has become increasingly recognized that some national park policies, particularly in tourist savanna zones in Africa, may be ill-adapted to the social and economic needs of local people and to their culture and traditions, and that new approaches are required to ensure the continued existence of these conservation units (see for example Lusigi, 1981). In this respect, the multiple function and research perspectives of the biosphere reserve concept have an especially important role to play in the savanna zones, in helping conservation policies to adapt to present-day conditions and needs.

In the moist savanna areas, the context and problems of conservation are somewhat different. These savannas are often intimately linked with gallery forest, and the landscape may take the form of a savanna-forest mosaic, where soils may often be more favourable to agriculture, and thus tend to support higher densities of human populations. On the other hand, the presence of tsetse flies and the low-protein content of forage are major constraints on the use of these areas by livestock and other herbivores. Large ungulates are much less abundant and less visible than in drier savannas, and thus are much less of a tourist attraction. For these reasons, reserves are not as common in moist savanna and savanna-forest mosaic areas. Nonetheless, though large mammals are not abundant, these areas do support a very varied and often richer fauna than the drier savannas, particularly in respect to small or medium-sized animals (invertebrates, birds, small mammals). It is also in these zones that those species are found that are not strictly savanna forms, but which make use of both savanna and forest (the chimpanzee is a good example).

3. STATUS AND PROSPECTS OF SAVANNA BIOSPHERE RESERVES

3.1. Biogeographical framework

Imprecision in definition and differences in the use of the word "savanna" are, not surprisingly, reflected in shortcomings in the frameworks for planning and assessing conservation action at the international scale, such as Udvardy's (1975) system of biogeographical classification. All who have worked with this system agree on the necessity for the system to be adapted to particular biogeographical and ecological regions. Such adaptation would appear to be especially needed for the tropical regions in general, and

tropical savannas in particular. Thus, while "tropical grasslands and savannas" are one of 14 types recognized in Udvardy's system, in the 1975 world map based on the system, there is no indication or delimitation of this biome type in the African region. Areas intuitively considered as savannas are shown as "tropical dry or deciduous forest (including monsoon forests) or woodland".

One consequence is that in the most recent published compilation on biosphere reserves (dated July 1981) in the MAB Information System, only two of the 193 biosphere reserves established at that time (one in Columbia, one in Australia) are listed under the "tropical grasslands and savannas" biome (Unesco, 1981). Other savanna-type sites are subsumed under other biome headings, including those on "tropical dry or deciduous forest" (e.g. Serengeti-Ngorongoro), or "warm desert and semi-desert" (e.g. Waza) or "mixed mountain and island systems" (e.g. Rwenzori).

3.2. Location of biosphere reserves

Given these inadequacies in available conceptual frameworks, a balance sheet of biosphere reserves in savanna regions cannot be derived from simple interrogation of entries in the MAB Information System. Rather, descriptions of individual biosphere reserves in tropical regions have to be reviewed in the light of the working definition of savannas proposed under Section 1 above. Such review leads to the listing of biosphere reserves in savanna regions given as Table 1. This listing is confined to biosphere reserves whose predominant physiognomy is savanna in form, and which to a greater or lesser extent are representative of a widely distributed ecosystem type. Excluded are biosphere reserves in azonal or interface areas, where savanna-type ecosystems constitute only a relatively small proportion of the total biosphere reserve; examples that do not figure in this table are individual biosphere reserves that encompass a large altitudinal range of ecsoystem types, of which one is savanna (e.g. Rio Platano in Honduras or Mont Nimba in Guinea) or which include savanna-type formations as a relatively small part of an aquatic-terrestrial environment (e.g. Lake Manyara National Park in Tanzania or Prince Regent River Nature Reserve in Australia).

The 11 biosphere reserves in savanna areas listed in Table 1 include a range of physiographic types, from thorn bush savanna in the Dinder National Park in Sudan to miombo woodland at Lufira in Zaire and wooded savanna at Serengeti-Ngorongoro in Tanzania. With the exception of the Colombian llanos site, mean annual rainfall ranges from 600 to 1300 mm. Almost all the reserves are large in surface area. In some cases, a detailed management plan has been formulated and is in operation.

In comparing the location of the 11 biosphere reserves with the global distribution of tropical savannas, the most striking fact is that all but one of the reserves are in Africa. There is one in the llanos of South America but none in the Australasian-Asian region. Major gaps include the Venezuelan llanos, the Brazilian cerrados, the woodland savannas of northern Australia and ecosystems having a savanna-type physiognomy in South Asia. In Africa, there are no biosphere reserves in southern Africa savannas. In the more humid savanna zones of Africa, the continued protection of some sites -- often relatively small in surface area -- might usefully be reinforced through their designation as biosphere reserves (in an analogous way to certain research sites in the tropical forest biome). The cluster concept for biosphere reserves (Johnson, Olson and Reichle, 1977) has been mostly developed and applied in temperate zones, but would appear to be of considerable potential importance for the humid savanna zones, in enabling relatively small non-contiguous areas devoted to strict conservation, research, restoration, etc., to be brought within the biosphere reserve network.

3.3. The "research-conservation" relation

At least 20 of the 60 or so biosphere reserves in the intertropical belt as a a whole are closely associated with MAB research projects. For several, the impetus for establishment as a biosphere reserve would appear to be suitability as a site for long-term ecosystem research rather than interest as an area for conservation of genetic diversity. Examples are; Dinghu (China), Sakaerat (Thailand), Luquillo (USA), Puerto Galera (Philippines), I' Passa-Makokou (Gabon), Omo (Nigeria), and Mount Kulal (Kenya). In other cases, conservation interest and ongoing MAB research would both appear to have been important in the designation of an area as a biosphere reserve; examples are Taï (Ivory Coast), Yangambi (Zaire), Basse Lobaye (Central African Republic), and Sinharaja (Sri Lanka). Significantly, perhaps, these various reserves are located towards the ends of the dry-wet moisture spectrum in the tropics (mean annual rainfall less than 500 mm or more than 1500 mm). None of those mentioned are found in the semi-arid and subhumid zones whose characteristic vegetation is savanna and woodland. Of the 11 biosphere reserves in the savanna biome, only a small number, e.g. Serengeti-Ngorongoro and Rwenzori, have been the focus of a sustained reseach effort, and this research has not been initiated as a result of MAB or indeed closely associated with the Programme.

Several authors (e.g. Golley, 1984; Lugo and Brown, 1984) have remarked on the relatively low number of MAB field projects in the subhumid and semi-arid regions of the tropics, compared to wetter and drier areas, and this is reflected in the status of research in most existing biosphere reserves in the savanna biome; the research function has either not been developed, or has largely been undertaken outside the framework of MAB.

In contrast to the humid tropical forest biome, in savanna areas conservation and tourism objectives would appear to have been paramount in the identification and establishment of biosphere reserves. This is further reflected in the fact that 9 of the 11 biosphere reserves in savanna areas are also, in part or wholly, national parks. The comparable proportion for humid tropical forests is much lower: of the 13 biosphere reserves listed under the tropical forest biome in the July 1981 compilation of biosphere reserves, only 4 are also national parks (Unesco, 1981).

In the savanna biome, at least, it would appear that the biosphere reserve "label" has been usually added to an already well-established national park or other type of protected area. It remains to be demonstrated that designation of any of the 11 areas as a biosphere reserve has, as yet, substantially altered its conservation status or contributed markedly to changing the management strategy and its implementation or shaped the type of research that is undertaken.

The fact that MAB research is little developed in biosphere reserves in savanna areas has advantages. In the absence of well-defined research projects, there is opportunity to develop from scratch comparative studies among groups of research sites in the savannas regions, and to consider the location of new biosphere reserves as a function of the needs of testing working hypotheses on the functioning of these ecosystems, framed in scientific and/or practical terms.

3.4. Research directions

The numerous problems posed by the origin and stability of savannas on the one hand, and by the diversity of climatic, edaphic and topographic situations to which they correspond on the other, underline the importance of developing a

cooperative network of savanna research sites at the world level. At least three dimensions should be borne in mind in the organization of such research: time scale; comparative studies among groups of research sites; and links between research and management.

First, information on how ecosystem components change over time is crucial for formulating hypotheses and in clarifying the variables and parameters of systems which most significantly determine their dynamics. Such records are virtually non-existent for savanna regions, but are especially important for enabling understanding of how the system behaves under various conditions. For instance, perhaps the observed "stability" of savannas is illusory, linked to insufficiently precise observations over too short a time period. In several decades, perhaps there will be a shift toward more forest-like conditions or conversely toward a certain degradation linked to abusive use of fire or overgrazing or excessive collection of firewood. All of these phenomena merit long-term study.

Second, the spatial structural heterogeneity of savannas makes it important to identify the characteristics of a small number of functional groupings of savanna ecosystems, and so provide a basis for extrapolation of scientific information and transfer of technology. Comparative studies among groups of biosphere reserves and other research sites have therefore importance for defining and testing hypotheses on the functioning and dynamics of the ecosystems of these zones.

Third, within a problem-oriented programme of scientific coooperation such as MAB, working hypotheses framed principally in scientific terms can be usefully formulated within the context of priority problems affecting land use in savanna areas. In turn, part of the results of the research effort should be potentially applicable and have implications for management. Some of the sorts of priority issues that might be tackled in savanna regions within this continuum from general land use problems to scientific observation, experimentation and testing of hypotheses to management guidelines are shown in Table 2. More comprehensive and substantive recommendations on research needs in savanna areas are provided in such works as Bourlière (1983), Huntley and Walker (1982) and Unesco (1979).

Unfortunately, research has too often been viewed as something apart from, and incidental to, management for the maintenance of ecological systems within reserves (Siegfried and Davies, 1982). In most national parks and reserves, it was -- and often still is -- rare for management practices to be designed so that biologists can compare the effects with control areas and follow up long-term consequences; the result is that much wildlife and reserve management may still rest on untested myths (Sinclair, 1979). These attitudes now seem to be changing. There is increasing recognition that much can be gained from using management as part of the research programme -- for example, in using deliberate experimental management of a system to gain knowledge and understanding of ecosystem processes that can aid in the formulation of optimal policies for management, including management for conservation. Both researchers and reserve managers should be encouraged to reinforce efforts for considering research as an integral part of management and management as an integral part of research.

4. CONCLUSIONS AND RECOMMENDATIONS

This contribution has been based on three underlying premises. First, savanna ecosystems, though highly variable, share a number of important functional characteristics. Second, an understanding of these functional characteristics and how savanna ecosystems work can contribute to improved land use and

management practices, including conservation. But research in these zones has tended to be neglected in comparison with more humid and more arid regions of the intertropical belt, perhaps in part because of the heterogeneity of savannas and of the secondary origin that is often attributed to them. Third, quantitative indications of the numbers and surface areas of protected areas (mainly national parks) may give a deceptive impression about the status of genetic conservation in savanna zones. The underlying concerns and perspectives of the biosphere reserve concept have a contribution to make to the long-term prospects of conservation in these areas, particularly in respect to relations with local pople and in developing a sounder scientific basis for conservation planning and action.

In conclusion, suggestions for the further development of the biosphere reserve network in the tropical savanna region can be made as follows:

-- to extend the present coverage of biosphere reserves through identification and designation of reserves in the Brazilian cerrado, cold-season and other savanna zones in southern Africa, humid savannas of West Africa, the savannas of northern Australia and savanna-type formations of South Asia;

-- to encourage the development of conservation-related research activities in existing biosphere reserves;

-- to seek the assistance of the international scientific community in the design and execution of comparative studies on the functional characteristics of different savanna ecosystems, through the planning, convening and follow-up of such symposia as those on "Savanna and woodland ecosystems in Tropical America and Africa" (Brazil, October 1983) and on the "Management of the World's Savannas" (Australia, May 1984).

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Figure 1. World distribution of tropical savannas and savanna-like formations (from Bourlière, 1983)

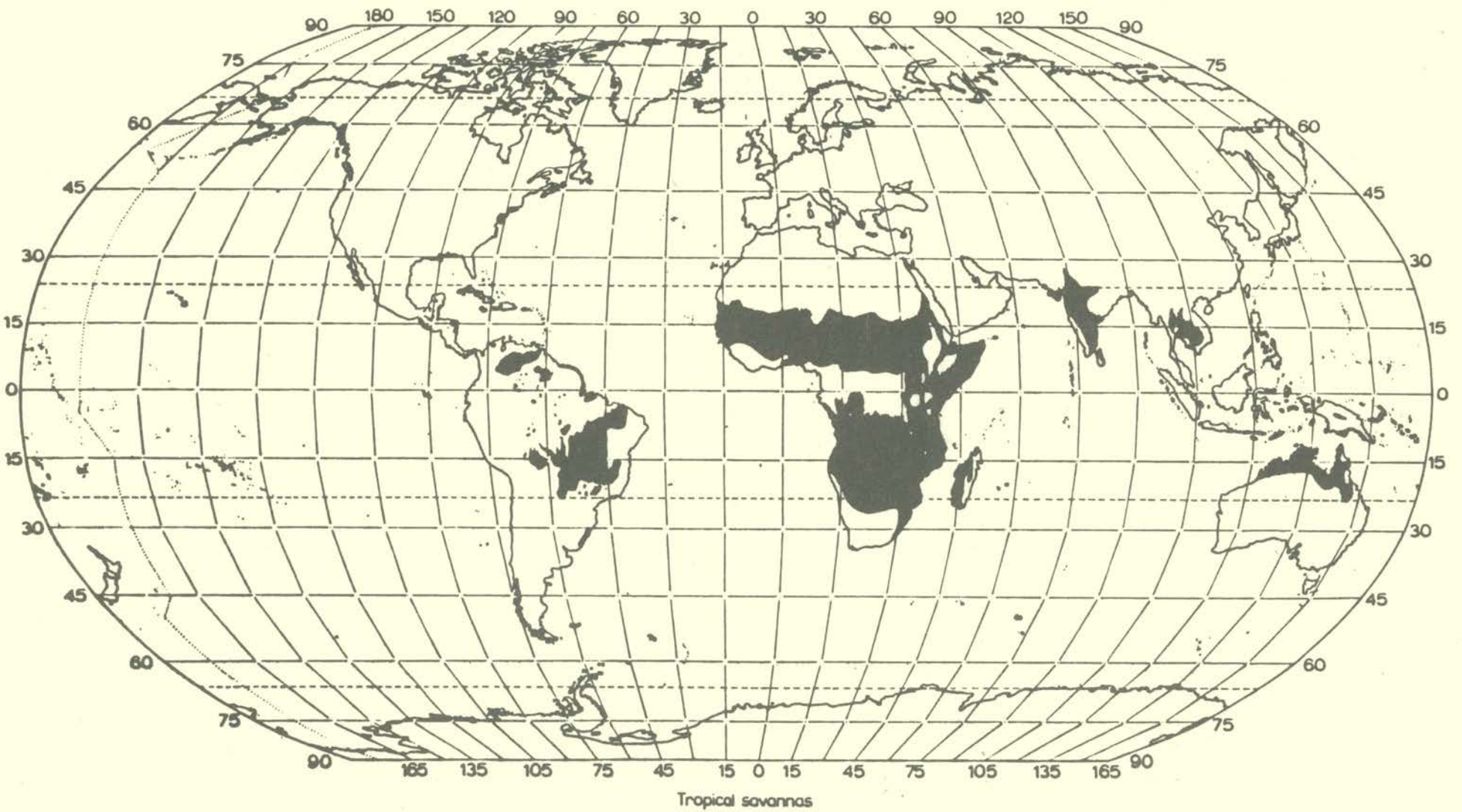
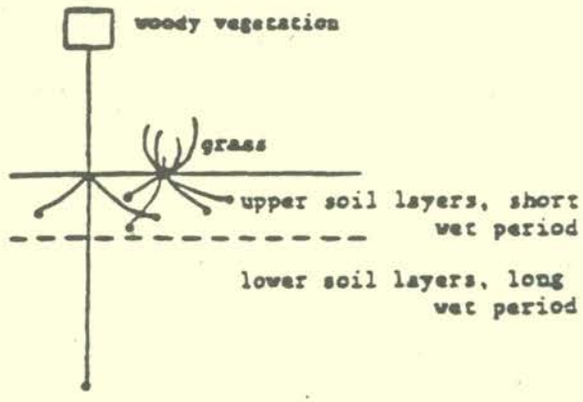


Figure 2. Summary description of a "generalized" savanna ecosystem (adapted from Walker and Noy-Meir, 1982)

Minimum savanna model



Structure

- woody vegetation comprised of established, mature trees (W_t) and shrubs and saplings (W_s)
- herbaceous vegetation, dominated by perennial grasses occurring in open areas between trees (G_o) and in sub-canopy areas (G_u)
- herbivores - predominantly grazing animals (H), or predominantly browsing animals (B)

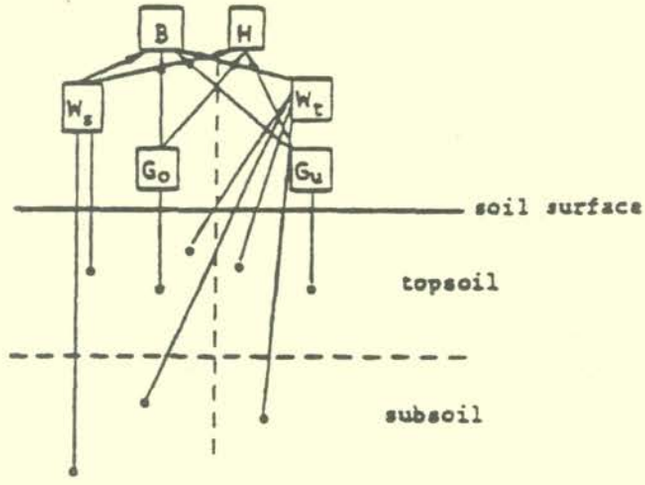
Dynamics

- woody vegetation produces major leaf flush some months apart from grasses, which only begin significant growth after rains start
- owing to nature of root systems, grasses out-compete woody plants for water in topsoil
- on heavy-textured soils, infiltration rate of water into soil function of grass cover
- during early season grass growth, most herbivores graze. During period when woody vegetation in leaf flush and until fresh grass, most herbivores browse or migrate to other areas where can still graze

Environment

- rainfall over relatively short period
- rainfall often irregular in time and space, with bulk of rain in relatively few, heavy downpours
- intra-seasonal droughts, during which topsoil water drops below wilting point
- topsoil dries out soon after end of rains
- soil nitrogen limiting for plant growth, but less important than water

Extended savanna model



Examples of hypotheses regarding determinants of savanna structure and dynamics

- savannas increasingly 'sensitive' or 'fragile' with increasing aridity
- in savanna regions, 'pure' grassland unstable and requires regular fires or other interference by man
- removal of all woody vegetation lowers long-term resilience of system
- for any particular savanna, density of trees below which no further increase in grass growth
- with regard to available food for larger herbivores, production of total usable grass and browse maximum at given low tree density

Table 1. Biosphere reserves in savanna areas (as of September 1983)

Site	Country	Biogeographical Province (Udvardy 1975)	Surface area (ha)	Mean annual rainfall (mm)	Principal Vegetation types
Niokolo Koba National Park	Senegal	3.4.4. (West African woodland savanna)	913.000	1100	Sudano-type vegetation, Andropogon gayanus savanna
Dinder National Park	Sudan	3.13.7. (Eastern Sahel)	650.000	600-800	Acacia-Balanites thornbush savanna, Combretum woodland
Boucle du Baoulé National Park	Mali	3.4.4. (West African savanna/woodland)	771.000	950	Includes (a) Sudano-Guinean (Isobelina), (b) Sudano and (c) Sahelian areas
Baninguy-Bangoran Conservation Area	Central African Republic	3.4.4. (West African woodland/savanna)	1.622.000	1300	Sudano-Guinean vegetation, with dense dry forests, wooded savannas, edaphic savannas
Waza National Park	Cameroon	3.4.4. (West African savanna/woodland)	170.000	600	Woodland, woodland savannas grass plains
Comoé National Park	Ivory Coast	3.4.4. (West African savanna/woodland)	1.150.000	1200	Range of grass and woody savanna types
Benoue National Park	Cameroon	3.19.12 (Guinean Highlands)	180.000	1000-1250	Wooded savanna and dry open woodland
Luifra	Zaire	3.6.4. (Zaire woodland/ savanna)	14.700 (2.800 ha core area)	950	Miombo woodland
Rwenzori National Park	Uganda	3.20.12. (Central African Highlands) and 3.5.4(East-African woodland/savanna)	220.000	600-	Varied. Includes Acacia savanna, undulating grasslands
Ngorongoro-Serengeti Biosphere Reserve	Tanzania	3.5.4. (East-African woodland/savanna)	2.305.100	1210	Varied. Grassland, woodlands, montane forests
El Tuparro Nature Reserve	Colombia	8.27.10. (llanos)	928.000 (600.000 ha core area)	2200	Natural (Andropogon) grassland, with woodlands along river courses and mirity palm groves

Table 2. Towards identification of unifying scientific hypotheses for improved management in savanna areas

General management problem	Scientific hypothesis/observation	Management implications
Whether or not to eliminate all woody plants in order to achieve maximum grass yield	Vegetation structure determined by soil moisture conditions (c.f. floristic composition determined by soil nutrient conditions) (Cole 1982)	Major changes in vegetation structure and composition effected by relatively minor manipulations in soil moisture conditions (Tinley, 1982, based on data on southern African savannas) and in soil nutrient content
	Light, high tree canopy leads to greater production of grasses (in Nigerian Guinea savanna) than either full exposure or dense canopy (Sanford et al., 1982)	Desirability of maintaining low density of large trees, preferably legumes
How to improve production while protecting against soil erosion and loss in soil fertility	Soil organic carbon (humus) is a key factor in assuring continued production and is positively related to water holding capacity, soil aeration, cation exchange capacity and content of nitrogen; significant positive correlation between soil carbon content and tree density (see Sanford, Wangari and di Castri, 1983)	Maximum humus formation favoured by management techniques which favour maximum biomass production. On slopes, maintenance of both tree and grass cover important for control of wind and water erosion
Whether and how to manage ungulate populations in extensive savanna areas set aside as National Parks	Strong interactions exist between a few components of savanna ecosystems, e.g. in the Serengeti, between the dominant herbivore (Wildebeest) and perennial grasses, between giraffe-elephant and trees. Natural negative feedback mechanisms operate between some components of system. Provided negative feedbacks strong enough, system able to absorb disturbance and perturbation (Sinclair, 1979)	Changes in a few major components can have far-reaching effects on other components (e.g. removal of wildebeest would probably result in major changes in all trophic levels, in contrast to likely minimal effects on system of disappearance of impala or buffalo). System should be maintained in as natural state as possible to fulfil function as national park and ecological baseline area
Presence, timing, frequency and intensity of burning, and its relation to soil fertility and primary production	Effects of annual burning vary with geographical position, climate and vegetation; great caution required in interpretating data. In Nigerian Guinea savanna, burning may reduce tree canopy; with less canopy more grass produced, except in drier warmer regions (Sanford, 1982)	Burning should be controlled as to time (intensity) which should vary with vegetation, climate, soil and management goal. For highest primary production, early (light) burning beneficial in drier savannas; in moist savannas, late (intense) burning probably more satisfactory

PROBLEMS AND PROGRESS IN ESTABLISHING BIOSPHERE RESERVES IN NORTHERN REGIONS

By

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ABSTRACT. Finland, Greenland, Norway, Sweden, the United States of America and Canada formed the Northern Science Network in 1982 to foster the exchange of information, development of training opportunities, and education in socially relevant fields pertaining to the circumpolar north. One of the themes for network activities is "Biosphere reserves and other protected areas". The Theme Coordinator will initially focus on creation of biosphere reserves in the Canadian Arctic, and then use this experience as a basis for a dialogue with other network nations on the establishment and management of reserves elsewhere in the circumpolar north. Experience with the International Biological Programme in the Canadian North shows that Territorial Government administrators and politicians must participate in early planning stages for biosphere reserves. The perceptions and aspirations of community residents must also be reflected in reserve planning and operation, and scientists must be seen to contribute to community welfare. Changes in attitudes on the part of industry, support of the principles of conservation by aboriginal residents and new land use planning initiatives by the federal government will facilitate the acceptance of the biosphere reserve concept in the north. Network-sponsored meetings on the biosphere reserve theme are planned for 1984 and 1985.

1. INTRODUCTION

In late May 1974, MAB Expert Panel 8 (biosphere reserves) met in Paris to draw up international guidelines for establishing biosphere reserves. With some excitement and optimism, I attended as Canada's representative. My optimism was shared by many participants. Since then, however, I learned that my confidence in the success of biosphere reserves was not justified, at least in my own country. Since 1974, only two biosphere reserves have been established in Canada, and until recently at least one was a reserve in name only (Eidsvik, 1983). But my optimism has been renewed by recent events.

One of the recent harbingers of renewed activity in the biosphere reserve programme was the formation of the Northern Science Network. In view of the inadequate coverage of the Arctic by biosphere reserves (Unesco, 1982), this MAB programme was chosen as one theme for the circumpolar network.

1.1. The Northern Science Network

In September 1981, the Canadian delegation to the MAB International Coordinating Council proposed the "establishment of a network for cooperation among peoples engaged in problems peculiar to the circumpolar north" (Freeman, 1983). The proposal was adopted and in October 1982, delegates from Finland, Greenland, Norway, Sweden, USA and Canada met in Edmonton, Alberta, Canada to establish the Northern Science Network (the Soviet Union was invited but was unable to send a representative). A secretariat was established with offices in Edmonton.

The purpose of the network is to "strengthen scientific activities by the exchange of relevant information and by providing training opportunities, as well as facilitating the creation of knowledge syntheses of an interdisciplinary nature" (Freeman, 1983). The network is especially concerned with socially-relevant science -- studies related to policy issues and the management of the human environment (Canada/MAB, 1983).

Participants agreed to limit the specific scientific work of the network to three themes at the onset:

> studies of the ecology and land use of subarctic birch forests; development of, monitoring and research in biosphere reserves and other protected areas; and land use practices and grazing animals: socio-economic, biological and environmental effects.

Coordinators have been appointed for each theme, with responsibility for the exchange of information among members and for assuring leadership in strengthening network objectives. The Coordinators are the contact persons for the network secretariat, National MAB Committees and others seeking participation in the themes.

1.2. Biosphere reserves and other protected areas

There are few biosphere reserves in the circumpolar north, yet biosphere reserves are a main concern of at least four of the circumpolar MAB members (Norway, the USSR, Canada and the USA). This Congress therefore, presents network members represented here with an outstanding opportunity to begin planning activities as part of its biosphere reserves theme.

Theme activities will not be confined to biosphere reserves alone, but will include such protected areas as national parks, ecological reserves and national wildlife areas. Overall objectives give special emphasis in Canada on informing the public of the benefits of conservation and assisting in the education of students and the general public in the conservation ethic.

2. CREATING RESERVES IN CANADA'S NORTHLAND

More than nine years after the MAB Panel 8 meeting in Paris, Canada has only two active biosphere reserves, neither of which are in Arctic and subarctic Canada. Clearly the challenge is to demonstrate the usefulness of biosphere reserves to Canadians and to other member countries.

2.1. Building blocks for biosphere reserves in northern Canada

Northern Canada is a potentially fertile ground for the man-oriented biosphere reserve theme. The main reason for the past failure of the programme in the north is the lack of proper forum for consideration of the biosphere reserve format rather than any rejection of the concept itself. Large areas of the Northwest Territories (NWT) and the Yukon Territory enjoy a measure of protection as national parks, migratory bird sanctuaries, national wildlife areas and numerous sites designated under the old International Biological Programme, Conservation Terrestrial (IBP/CT). These protected areas, especially the IBP/CT sites in the NWT, should serve as building blocks for biosphere reserves in the north (Figs. 1 and 2).

2.2. Problems and issues

Most of Canada north of 60° north latitude is Crown land under the administrative control of the federal Department of Indian Affairs and

Northern Development. The aboriginal people of the north have for years been negotiating vigorously with the federal government for recognition of aboriginal rights, including the right to own and manage what they regard as their lands. They have demanded that the government refrain from disposing of more Crown land before this issue is settled. The Canadian government, on the other hand, is anxious to quickly develop petroleum and mineral resources in the north, even in the face of unsettled aboriginal claims. Federal administrators react negatively to the term biosphere reserve as implying a static, closed unit and an impediment to development. Torn between these two forces is the conservation movement which is occasionally identified in the north as the domain of southern "experts" supporting the alienation of land for reserves and other protected areas.

This oversimplified scenario, when added to problems posed by a depressed economy and a resident population that regards scientists and their research as irrelevant and insensitive (Canada/MAB, 1982) is enough to indicate an unhealthy climate for spawning biosphere reserves. Indeed, it will take time and considerable diplomacy to gain acceptance of the MAB programme in the Canadian north.

2.3. Signs of hope

Biosphere reserves are intended to teach man how to better manage and live in harmony with his own environment. The World Conservation Strategy proposes this as a common goal for mankind. Elements of this concept include long-range land-use planning, research, public participation and public information and education programmes. For this reason, the biosphere reserve programme is timely for the north. It offers a structure within which oilman, hunter and scientist can research and plan the north's development and conservation together. Indeed, there are a few hopeful signs to suggest that the biosphere reserve programme may succeed.

The aboriginal peoples of the NWT have expressed their belief in the need for conservation and research by championing the creation of ecological reserves under the International Biological Programme. They ask for even greater protection of IBP sites in their negotiations with the federal government. I predict that the man-oriented biosphere reserve programme, which can build on IBP, will be even more compatible with these plans for a new northern society.

Industry, buffeted by public response to what is seen as careless husbandry of the north's resources, impeded by native rights negotiations and perceiving mercurial government policies for the north, has been trying to polish its conservation image. Industry representatives acknowledge the value of the "development with conservation" aspect of the programme (an element of the World Conservation Strategy), of reserves as "background sites" for monitoring man's impact on the environment and vice-versa (Unesco, 1982), and of the great flexibility of application of the MAB programme.

The federal Department of Indian Affairs and Northern Development has recently announced its intention to embark with northern residents on a public process of integrated land use planning. An element of this process is a conservation strategy for the north (Inglis, this volume). The Department has endorsed the biosphere reserve concept as complementary to their land use planning and management strategies, thereby providing the forum for presentation of the MAB programme that was lacking in the past.

The biosphere reserve programme and its "development with conservation" principle may now offer solutions to recent international concerns in the rest of the circumpolar north. The United Statse and Canada share a major Arctic caribou herd upon which the needs of the petroleum and recreation industries

are now impinging. Greenland and Canada share populations of marine mammals that may now be threatened by coastal and offshore industrial development. The Northern Science Network can serve as a forum for discussion of these common concerns and the role international biosphere reserves might play in effecting solutions.

2.4. Suggestions for strategy

The situations described above suggest an improving environment for the creation of biosphere reserves in the north. However, success in the face of the problems I have listed will come only if the people of the north participate fully in the MAB programme. The starting point is with the two Territorial governments. Though the federal government is the landlord, the Territorial governments consist of elected representatives of the northern population and therefore must be invited to take part in the earliest stages of planning for biosphere reserves.

There are also three Territories-wide and several regional aboriginal rights organizations. These organizations must also be encouraged by the Territorial governments to participate in the very first stages of planning biosphere reserves. To the uninitiated, there appears to be a Gordian knot of overlapping claims to representation of NWTS residents which would doom any negotiating effort. However, if both groups of representatives participate, and the real benefits of the biosphere reserve programme to northerners are clearly laid out in practical terms of northern economic development, I am confident of success.

The Yukon presents a simpler political problem than the NWT as the Territorial Government and the aboriginal rights organizations are close to unity on settlement of claims with the federal government. Nevertheless, regional opposition to a proposed reserve would be a barrier in the Yukon as in the NWT. I believe the establishment of the first northern reserve, which would serve as a demonstration project, would facilitate the establishment of other reserves. I envision this pioneer Arctic reserve as having the following characteristics:

a) Covering an area with potential for several major uses of the land such as mineral extraction, subsistence hunting, recreation and critical wildlife habitat protection. The experimental approach to land use management, and the training of northerners in research and management would be practical projects for the core and buffer zones of such an area. No other system such as parks, IBP sites or wildlife management areas would serve these needs as well as biosphere reserves.

b) Managed by a committee representing major resource uses, as well as regional government and having decision-making authority over the reserve. Sharing land-use decision-making authority with the federal government in an area of national importance because of mineral or petroleum production potential is one of the most challenging issues in the north today. Nevertheless, a committee managing an area for regional as well as national and international benefit must indeed be delegated the authority to manage or it will not be seen as credible and deserving of popular support.

c) Providing a basis for long-term research as part of a network of field stations.

d) Research governed by the management committees which is in turn responsive to public needs and perceptions.

e) Encompassing one or more IBP sites and other protected areas which are used as core zones. The good work of IBP/CT, which received broad support in the north, as well as established parks and wildlife reserves, would serve the need for continuity in land use management.

f) Tailored to regional needs and perceptions.

Di Castri and Glaser (1979) recommended that the following principle be adopted by biosphere reserve managers:

> "Perception of environmental quality and the aspirations of the local population and of tourists (be) taken into consideration in planning the research, as well as in the evaluation of the study, with a view to applying its results".

Local populations should be encouraged to work with scientists in identifying priority problems for research and to help apply the research results. They suggested that feedback mechanisms be established at an early planning stage between scientists, local populations and decision-makers. They stressed that work with decision-makers, even to the point of interacting with them in research design, be accepted as a code for reserve research managers.

The characteristics described above must be adopted as policy for future reserves in Canada's north or the programme will not succeed. Only thus will the barriers between natural scientists, human and social scientists and decision-makers be broken down and a problem-oriented interdisciplinary approach to studies of natural and man-modified ecosystems be introduced in the north (Glaser, 1981).

3. PLANS FOR ACTION

I have been speaking as the Coordinator of the Northern Science Network's biosphere reserves theme. As such, I have proposed the creation of biosphere reserves in the Canadian Arctic as a basis for a dialogue on complementary work on biosphere reserves with member countries. Theme activities in Canada would, at the same time, be aided by a launching conference of network nations and by subsequent meetings to mark progress and coordinate biosphere reserve work, especially in the areas of research and training.

3.1. Theme activities in Canada

Meetings with Canada/MAB, Territorial Governments and aboriginal rights organizations will take place this winter to discuss the feasibility of establishing one or two Arctic reserves in the Territories. The network, being non-government and independent, will serve as a catalyst for discussion and an aid in establishing the reserves. I anticipate that federal agencies will be invited to join the planning team at an early date as administrators of the senior resource management legislation in the two Territories.

3.2. International theme activities

As discussions between the United States and Canada about the creation of Waterton-Glacier International Biosphere Reserve are now in progress, so should bilateral discussions about international or complementary Arctic reserves take place between network nations. I believe there is potential for discussions between Canada and the United States, and Canada and Greenland, a potential I hope to exploit during the coming months.

With good fortune, there will be progress with the biosphere reserves theme to report when the Northern Science Network holds its next meeting in Greenland in 1984.

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MARINE BIOSPHERE RESERVES IN KENYA

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ABSTRACT. The biosphere reserves concept is a recent development, nevertheless the programme is gaining popularity worldwide. Of the group of protected areas under this, marine biosphere reserves have had the least coverage. In this paper a case study of Kenya's Malindi and Kiunga Marine Reserves is presented as a model in management planning. The role of research in investigating the problem of siltation by the Sabaki River, involving measurement of sediment load and pattern of current flow and tide action using aerial photographs and satellite images, is emphasized. Other activities include tourism development, fishing, and coral and shell collection, which are all seen as contributing to the decay of the reef at Malindi. Action is urged to halt this state of affairs and restore the marine parks before they become seriously degraded as has often happened to their terrestrial counterparts.

1. INTRODUCTION

The International Union for Conservation of Nature and Natural Resources (IUCN, 1982), have categorized biosphere reserves as the 9th type of conservation areas. The fundamental requirement for a biosphere reserve is that the area must have legal status and must embrace a complete ecosystem for it to be accepted by the Man and Biosphere International Coordinating Council of Unesco. In my discussion I shall deal with one category of biosphere reserve, namely marine biosphere reserves which have limited distribution throughout the tropics.

2. KENYA'S MARINE BIOSPHERE RESERVES

As an illustration of the functioning of marine biosphere reserves the example of Kenya is provided, which has four marine protected areas and of which two have been accorded biosphere reserve status: Malindi/Watamu Marine National Park and Kiunga National Reserve (Fig. 1).

2.1. Malindi/Watamu National Park

Located north of Mombasa, the park complex comprises a 5 km wide strip of sea and its associated beach extending from Malindi in the north to Mida Creek 30 km to the south. The marine complex serves to conserve a major marine ecosystem consisting of the coral reef and tidal lagoons together with their associated fauna and flora that are typical examples of the Kenyan coastline. The reef itself contains a variety of corals which, together with the marine vegetation provide an excellent habitat for a large number of colourful reef fish, molluscs and other sea animals including sponges, sea urchins and sea anemones. The beach is an ideal nesting ground for sea turtles; the area is also frequented by migratory fish such as sardines and kingfish.

2.2. Kiunga Marine Biosphere Reserve

Kiunga is situated on the northernmost point of the country, adjacent to the Dadori National Reserve near the Somali border. It serves to protect large

nesting colonies of migratory seabirds on the offshore islands as well as superb and as yet unspoiled coral reefs. In addition mangrove thickets fringing the marine reserve harbour a wealth of birds, and the few creeks in the reserve are frequented by the rare dugong (Pertet, 1982). Kiunga is the least developed of Kenya's marine reserves.

3. ECONOMIC IMPORTANCE

The two marine biosphere reserves and particularly Malindi/Watamu are important to Kenya in a variety of ways, including:

3.1. Income generation

Tourism ranks second to agriculture in foreign exchange earnings, amounting to US $110 million in 1982. Of the 500,000 visitors who visited Kenya about 50,000 or 10%, visited Malindi Marine Park.

3.2. Kenyan identity

National parks, including marine parks, not only contribute to the economic well-being of Kenya, but also help to enhance the national image both locally and internationally. By attracting overseas visitors Kenya is able to feel a sense of satisfaction as a nation among the world community.

3.3. Protection of genetic resources

By virture of their conservation status, marine reserves serve as reservoirs for genetic resources. Unregulated exploitation of fish populations outside the protected areas may often result in selection of exploitation-resistant species.

4. MANAGEMENT GUIDELINES

The information provided herein comes from a review of work in areas throughout the world and from personal experiences gained from Kenya's marine reserves. In short, the management guidelines provide a series of long- and short-term recommendations for the improved management of marine biosphere reserves in order to achieve their established goals. In the case of Malindi and Kiunga Marine Biosphere Reserves, the primary objective is to preserve and maintain a representative area of the coral reef ecosystem together with the beaches and mangrove communities which typify the Kenya Coast. Other objectives are as follows:

- -- to encourage public understanding, appreciation and enjoyment of the natural resources through interpretation/education and the provision of recreational opportunities;
- -- to undertake the development of these natural resources in a manner which generates revenue and therefore provides an econommic justification for the use of scarce resources and land to fulfil the conservation objective and;
- -- to promote research on the coral reef and mangrove ecosystems for the purpose of enhancing their management and education programmes.

In aiming for the attainment of the above objectives three major categories of guidelines have been proposed concerning management, tourism and administration.

4.1. Environmental management

Guidelines may cover research requirements including specific actions in relation to key management issues such as siltation, pollution, shell and coral collection, visitor-related damage and endangered species. In addition, two major activities are proposed as part of environmental management:

4.1.1. Monitoring. The objective is to carry out systematic observation and measurement of the occurrence, impact or level of natural phenomena and human activities related to the marine biosphere reserve; and

4.1.2. Surveillance. The objective is to patrol the marine reserve by sea and where posssible by air or from the land to give a means for visitor contact and education, including emergency operations.

4.2. Visitor use

Guidelines should include proposals for improving visitor facilities, zoning activites, improving visitor orientation and setting up interpretation and education programmes.

4.3. Administration and operations

Guidelines should deal with a wide range of issues which include recommendations for the acquisition of land; transport, boats and other equipment; staff organization and training; control of commercial enterprises; revenue collection; and law enforcement.

5. PLANNING CONSIDERATIONS

The main object of planning is to interpret park/reserve policy through the accomplishment of established goals. The management plan aims at setting a balance between the resources and their utilization. The management plan has three main functions: to ensure that clear objectives for the resource exist to develop objectives for resource use and identify potential uses of the resources.

6. ZONING CONCEPT

Zoning is a recognized planning tool which is utilized to organize and allocate land uses. The primary determinant of a zoning plan is the distribution and character of the natural and cultural resources of the reserve in question. The plan is developed in order to classify areas of the biosphere reserve according to type and intensity of visitor use desired. In this context certain areas may be singled out for zoning, basic examples being:

6.1. Over-use areas

Visitor activities may result in damage to corals, as in the case of an underwater trail. One remedy would be to restrict visitor use to allow for coral regeneration.

6.2. Critical nesting/feeding grounds

The isolated off-shore islands in Kiunga Marine Biosphere Reserve support nesting congregations of sea birds totalling over 30,000; in addition, turtle nesting grounds and feeding areas for dugongs may also require special protection from people within a framework of zoning.

7. THREATS TO THE MARINE BIOSPHERE RESERVES

Basically, threats to the marine reserves emanate from land and are often induced by man's activities. In the case of Kenya we may recognize the following activities:

7.1. Hydropower dams and irrigation schemes

Kenya has embarked on an ambitious programme to develop her own electricity supply through the construction of hydropower dams along the Tana River, which is the country's largest and longest river. In addition, irrigation schemes are being established along the Tana as part of the plan to make the country self-sufficient in food and to settle the growing rural population to lessen the problem of landlessness. The hydropower dams and irrigation schemes in themselves are not a problem, but the agricultural activities further afield in the catchment region involve cultivation on the steep slopes of Mt. Kenya along with cultivation and overgrazing in the marginal areas and are causing serious soil erosion. The impact of this is the siltation of the hydropower dams which may result in the reduction of their life-span as well as causing pollution to the marine reserves, particularly Malindi/Watamu Marine Park.

In addition, it is now believed that these dams did not provide for fish-ladders in the designing stages and final construction (Pertet, 1982). Two fish species, Labeo and Anguilla are known to travel upstream from the Indian Ocean for spawning purposes; in the absence of fish-ladders it is not known what the long-term impact on the survival of these fish will be. With regard to the irrigation schemes the immediate concern is the removal of the forest, especially on the lower Tana River, for fuelwood.

Hydrological changes resulting from such development may impact on the forest and ultimately the habitat of animals living in those affected areas and ultimately the marine reserves (Pertet, 1982). In addition the mangrove forest is being exploited for timber which is exported to the Middle East. The ecological interdependence of the mangrove ecosystem with the marine fauna such as fish, molluscs and crabs is of special significance in the food chain link of marine reserves. Thus changes in the mangrove ecosystems could have far-reaching implications.

7.2. Pollution

Pollutants may come from agricultural sources such as chemical fertilizers and pesticides, all of which may kill the coral reef and associated fauna as well as marine vegetation. Sewage disposal by nearby coastal cities and oil pollution also pose potential dangers to marine reserves.

8. RESEARCH AND MANAGEMENT

Ideally, research should form the backbone of management planning for marine biosphere reserve. The problems can all be a subject of investigation. Broadly speaking, research could take place along the following lines:

8.1. Ecological studies

The first step is to inventory marine park resources leading to preparation of checklists and guide manuals for education/interpretative purposes. In the case of Malindi/Watamu serious gaps exist on the information of two endangered taxa, i.e. the dugong and all of the sea turtle. Information on the numbers and

distribution of these two marine species are lacking at present. Problem species such as the crown-of-thorns starfish and its interaction with the coral gardens would also be of interest.

8.2. Monitoring and remote sensing

Use of remote sensing is becoming increasingly important in the management of Marine Parks such as the Great Barrier Reef in Australia (Great Barrier Reef Marine Authority, 1982). The technique has also been applied in the monitoring of reef condition and to provide an inexpensive broad-scale survey of bathymetry surrounding reefs.

8.3. Oceanographic and topographic studies

The ocean currents play a significant role in marine ecosystems as the transport medium and in circulating food materials. Such surface current movements can be studied by means of drift card drops to ascertain their pattern. The coral reef section can be mapped using the inkjet topographic and bathymetric technique (a coloured non-photographic production of LANDSAT imagery).

8.4. Economic research

Fisheries are an important activity as far as marine biosphere reserves are concerned. It would therefore be desirable to undertake an economic study of this activity as a management problem. Scientific investigation should be extended to cover the economic impact of major marine reserve uses such as tourism including research activities themselves.

9. CONCLUSIONS AND RECOMMENDATIONS

The value of marine protection areas ranges from recreation to tourism to research benefits. In order to conserve these marine protected areas we need to understand how they function, which is only possible through research. Hence, the concept of biosphere reserves is most relevant for marine areas. We in Kenya are at a great disadvantage because, unlike the Caribbean and the Great Barrier Reef of Australia where much research has been carried out, we have to begin from scratch. Perhaps the only aspect of research that is nearly complete in Kenya is an inventory of the coral genera (Bock, 1979). At this stage research is needed to set us off on a developmental path. The two major problems facing Malindi/Watamu Marine Parks are probably siltation by the Sabaki River and impacts of tourism.

The problem of siltation can perhaps better be investigated through remote sensing. Aerial photographs taken by the Survey of Kenya satellite imagery would be useful in analyzing the silt load and its seasonality; apart from investigating silt distribution patterns and seasonal aspects of this phenomenon, aerial photographs and satellite images may be used to register current flow patterns of the coastal waters.

This forms an important aid in pin-pointing sampling sites (silt accumulations, etc;) for determining the rate of silt accumulation. One item of significance at Malindi is the sandbar which developed at the mouth of the Sabaki River in 1961 following heavy floods. Unfortunately the only area photograph available dates from 1962 and the satellite images, of course, are much younger still.

Mechanical damage caused by human activities includes trampling and boat anchoring as well as sheer vandalism. Investigations could be carried out to ascertain the extent and type of damage and the measure the rate of coral recovery. Findings from such investigations would go a long way toward assisting in preparation of management guidelines.

10. ACKNOWLEDGEMENTS

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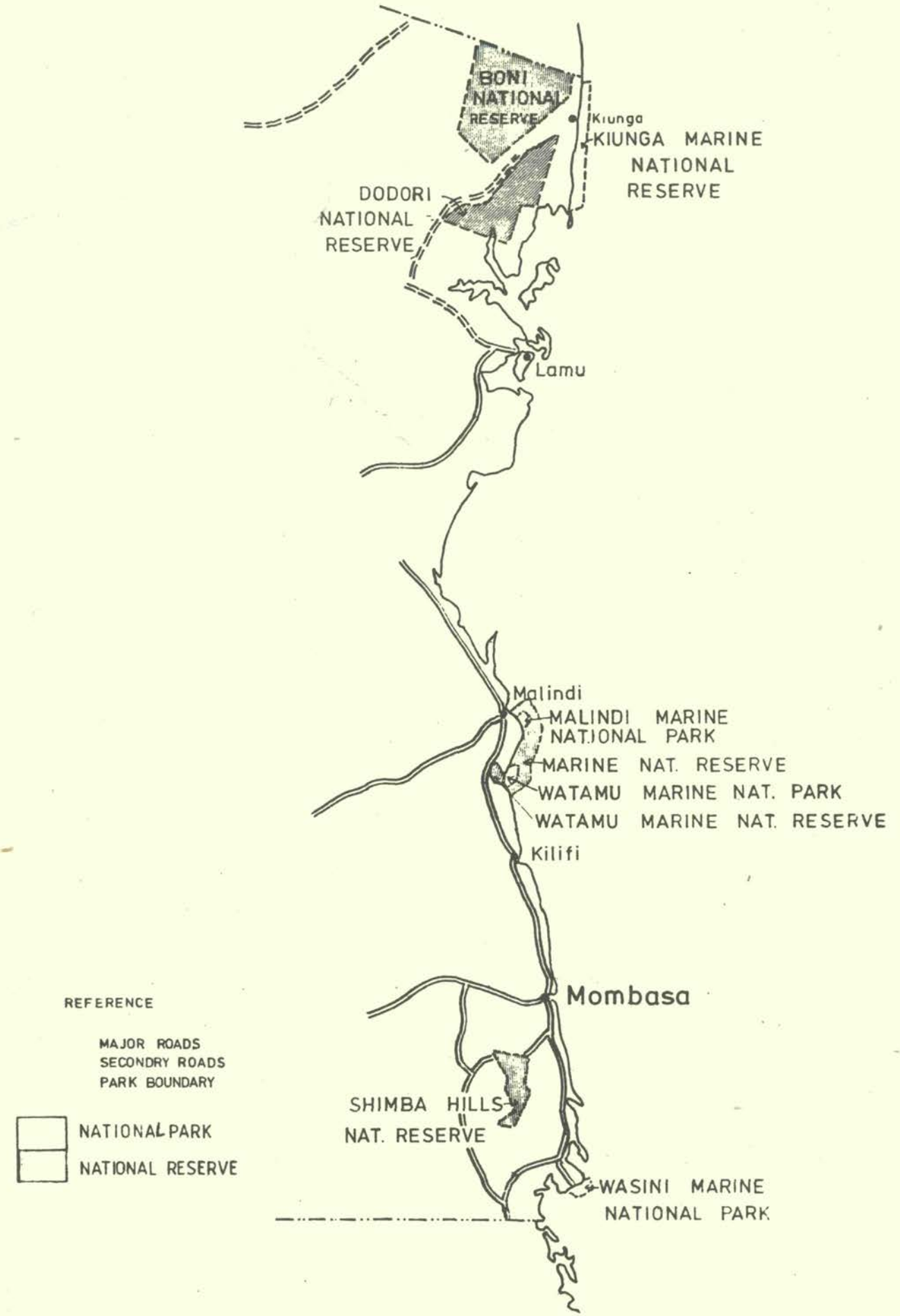
FIGURE 1. Coastal and marine parks in Kenya



CHAPTER 2

THE ESTABLISHMENT AND MANAGEMENT OF BIOSPHERE RESERVES

EVOLVING A NEW APPROACH TO BIOSPHERE RESERVES

By

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ABSTRACT. Biosphere reserves are examined as a mechanism to assist countries in implementing the philosophy of the World Conservation Strategy. The paper discusses integrating conservation with development, in recognition of the dependency of development on conservation, and the important question of "What's in it for me?" A re-evaluation of the functions of existing biosphere reserves is recommended and new procedures for establishment of biosphere reserves and their funding are suggested. The value and importance of the biosphere reserve concept are endorsed, provided that current practices are improved.

1. INTRODUCTION

This paper discusses New concepts in Biosphere Reserve Management. As has been pointed out by Dr. Batisse of Unesco, "During the last few years, a new term has crept into the vocabulary of conservation, namely 'biosphere reserve'. Yet few people know what it really means, and many have confused, or even conflicting ideas about what it actually covers. This situation results from the fact that the concept is relatively new, that it is multifaceted, and that it has already undergone some evolution as theory has been translated into practice" (Batisse, 1982).

In assessing biosphere reserves from a management perspective, we need to look at pre-established "objectives" to see whether these have been achieved and whether biosphere reserves in fact exist.

2. EXISTING OBJECTIVES

2.1. Biosphere Reserves as a Conservation System

The first objective of a biosphere reserve is "to conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural and semi-natural ecosystems, and to safeguard the genetic diversity of species on which their continuing evolution depends" (Batisse, 1982).

An attempt has been made to achieve this objective through the establishment of 226 biosphere reserves in 62 countries (Unesco, 1983); a growing network of protected areas of land and coastal environments. However, as the first biosphere reserves designated in 1976 were already national parks, the impression given was that the term "biosphere reserve" was only a new label. But in a short time we have seen the evolution of the biosphere reserve concept grow to incorporate core areas, buffer zones, agricultural areas and the harmonious and sometimes discordant relationships between these lands. Today, we see national parks as theoretical core areas of larger reserves which involve a diversity of management approaches.

Nevertheless, as conservationists, we could be faulted for our enthusiasm in pursuing this new concept too rapidly. Hindsight suggests that we should have proceeded with more pilot projects to test our theories. For example, at least 84% of the biosphere reserves are other types of protected areas which existed prior to the creation of the new term, "biosphere reserve". While this was occurring, theory said, "In some cases biosphere reserves will coincide with or incorporate, existing or proposed protected areas ..." (Batisse 1982). Our over-enthusiasm in effect built a credibility barrier that we must now overcome. We should not hesitate to re-state the principle to read, "In most cases biosphere reserves will coincide with or incorporate some form of existing protected area". Such a statement would be more precise and would extend credibility to the programme and to some protected areas.

The challenge in the search for future achievement is to build on those biosphere reserves which have done well and to modify those reserves not in step with current concepts. There are many special values that can be assigned to biosphere reserves as areas for interdisciplinary and non-bureaucratic communication, for cross-frontier research and for education.

Where the more traditional protected area concept has not been extremely effective, the biosphere reserve concept provides a new approach to achieving conservation. Outstanding examples are Mapimi and La Michilia in Mexico, the Rio Platano in Honduras, the Gurgler Kam in Austria, as well as Mt. Kulal in Kenya (the latter two biosphere reserves are cited as having provided the foundation for much more extensive conservation achievements than the biosphere reserve itself).

The use of the biosphere reserve as a new administrative device to achieve conservation objectives remains viable and vital. For example, the preparation of draft legislation to provide a legal foundation for biosphere reserves in India is a demonstration of positive new direction which will aid conservation in the sub-continent, as well as demonstrate positive new directions for biosphere reserves.

Where the protected area concept was well established and "biosphere reserves" became labels applied to existing national parks, there is a need to modify the boundaries of existing reserves. Administrative changes in these biosphere reserves are now essential if they are to reflect current concepts. These changes will require the incorporation of additional land to complement the "core areas" of national parks.

2.2. Research

The second primary objective for biosphere reserves is "to provide areas for ecological and environmental research, including baseline studies, both within and adjacent to such reserves" (Batisse, 1982).

Noting that nearly all biosphere reserves carry additional "labels" as existing protected areas, the key question for most managers is, how can the biosphere reserve concept facilitate a conservation programme? It is sometimes very difficult to analyze what changes were caused by the biosphere reserve designation. This difficulty I would suggest is a frustration for the MAB Secretariat. Fundamentally, the problem is obtaining accurate and timely information from reporting institutions. For example, it can readily be seen from submitted reports that the Andrews Experimental Forest engages 238 people in 79 research projects and that there are 69 projects involving 153 people at Yellowstone National Park, but it must be wondered how much of this was happening before the designation of these areas as biosphere reserves and how much the designation has influenced the research programmes? I believe the

following statement by Dr. Francesco di Castri does a great deal to lend credibility to the biosphere programme (it should be noted he is addressing MAB as a whole, and not only the biosphere programme): "Among the field projects perhaps 30% would have existed regardless of MAB, 60% have been influenced by MAB and 10% owe their very existence to the approach and support of the MAB programme" (di Castri, 1981). I suggest that a similar statement could be made for research on biosphere reserves in general.

Further, in "compilation two" of the MAB Information System (Unesco, 1981), Biosphere Reserve No. 184 and Biosphere Reserve No. 136 fail to report any research projects. As a manager evaluating their programmes, I would begin to wonder what they do at the Michigan University Biological Station and at the Repetek Reserve in the Kara Kum? I have had the privilege of visiting the latter, and saw that there was indeed a research programme. As a student at Michigan, I am also sure they had a research programme at the Biological Station. Clearly, there is a reporting problem here.

On the other hand, in new reserves, there is no difficulty in recognizing the contribution of the biosphere reserve concept, e.g. at Mapimi and Michilia where 12 projects involve more than 50 individuals. As new "social institutions" these reserves demonstrate how the biosphere reserve programme can provide conservation leadership.

To ensure uniformity in reporting on research projects in the future, it would be useful to provide better guidance and improved criteria relating to project listings.

2.3. Training and education

From a protected area management perspective, the research objective is closely linked to the third primary objective of biosphere reserves: "to provide facilities for education and training" (Batisse, 1982).

The biosphere reserve reinforces the need for educational and training facilities and their linkage to the community at large. For example, this is one of the foundations upon which the Mont St. Hillaire Biosphere Reserve in Canada has built its programme.

3. THE BIOSPHERE RESERVE IN PERSPECTIVE

3.1. Conservation in perspective

Returning to New Approaches to Biosphere Management, let me reflect on Professor Sarasin's remarkable keynote address to the 1913 International Conference for the Protection of Nature (Eidsvik, 1980). In this address he advocated the conservation of whales, seals, penguins and genetic resources of which we hear so much today. In 1949, Unesco and IUCN advocated the study of human ecology in relation to dynamic ecological situations, including all possible factors such as soil, water, food, climate, plants, animals and the people concerned, with special emphasis on their interrelationships. In brief, there isn't much new in conservation philosophy. Nor have we done our job so well that we have put ourselves out of business. Biosphere reserves, however, provide a new approach which has a potential to provide effective results if certain strengthening considerations are adopted.

3.2. Main characteristics of biosphere reserves

As a starting point it is useful to review the main characteristics of biosphere reserves as summarized by Batisse (1982).

1) Biosphere reserves are protected areas of land and coastal environments; together they should constitute a worldwide network linked by international understanding on purposes, standards, and exchange of scientific information.

2) The network of biosphere reserves should include significant examples of biomes throughout the world.

3) Each biosphere reserve should include one or more of the following:

   i) Representative examples of natural biomes;
   ii) Unique communities or areas with unusual features of exceptional interest;
   iii) Examples of harmonious landscape resulting from traditional patterns of land-use; and/or
   iv) Examples of modified or degraded ecosystems that are capable of being restored to more-or-less natural conditions.

4) Each biosphere reserve should be large enough to be an effective conservation unit, and to accommodate different uses without conflict.

5) Biosphere reserves should provide opportunities for ecological research, education, and training; they will have particular value as benchmarks or standards for measurement of long-term changes in the biosphere as a whole.

6) Biosphere reserves must have adequate long-term legal protection.

7) In some cases biosphere reserves will coincide with, or incorporate, existing or proposed protected areas, such as national parks, sanctuaries, or nature reserves.

At the time of this writing, most of the above statements remain valid; the exception, as stated earlier is the last. Indeed at some time in the future the success of the programme could be measured by the number of reserves areas not under other existing protective designations.

Improving the management of biosphere reserves systems requires a review of existing biosphere reserves against these contemporary criteria. Such a review should be carried out by a technical assessement team, perhaps under the direction of the International Union for Conservation of Nature and Natural Resources (IUCN). The review could take as much as five years, so that each area is assessed. A fixed time period should be established for adaptation of those areas which do not currently meet established criteria, with a "sunset clause" being implemented to delete non-conforming areas from the list of biosphere reserves after a period of some years.

If not deleted, the inclusion of non-conforming sites would continue to lead to confusion and to a dilution of the biosphere reserve concept. There is no value in having a large register of areas of questionable value. In addition, the possibility of deleting areas not meeting current criteria may also lead to a renewed programme in some cases, resulting in sites being brought into the mainstream of a renewed biosphere reserve programme through special initiatives.

4. CHANGING PERSPECTIVES

4.1. Universal Programmes

As conservationists we have tried to implement programmes with universal application for national parks, strict nature sanctuaries, biosphere reserves and World Heritage sites. These programmes have worked with varying degrees of effectiveness related to their ability to recognize social, cultural and economic imbalances in the global society (e.g., Myers, 1972; Lusigi, 1982; Asibey, 1983). It seems clear that we are moving toward a reinforcement of traditional conservation philosophy and the biosphere reserve may have a key role to play in the future. Basically during the past century, we have moved (hopefully) from exploitation to preservation, to protection, to management, and finally to sustainable management for human society. However, the term "sustainable management for human society" has generated problems of perception for many managers. It may be that we have used the term without adequate consideration of its impact on different societies.

What is desirable is to retain the values of national parks where they are defensible and to introduce relatively new concepts such as the biosphere reserve as a mechanism for becoming more responsive to socio-economic needs.

4.2. Conservation with development -- Existing areas

National parks represent a widely accepted form of land use, providing conservation, recreation and educational services. To suggest that these parks should be "exploited" in some different form to provide for "sustainable development" is tantamount to heresy and has been so since the Yosemite National Park Hetch-Hetchy dispute of 1913.

For example, where national parks in North America become incorporated in biosphere reserves, it is essential from a conservation perspective that the national park contribute only to the protected core zone of the biosphere reserve. But the biosphere reserve must also be more than a core area if it is to contribute to development. The challenge for managers is to demonstrate how this is done, and the biosphere reserve is a new mechanism to facilitate this process.

To clarify the conservation position, we must demonstrate that "conservation with development" means reaching out from the protected core area to improve management in the surrounding area. We must emphasize again and again that it does not mean reaching into the protected area to reduce conservation values. Inside the fence (so to speak) we must produce the clean water which nourishes development outside. We must manage over-abundance to ensure benefits to surrounding peoples. We must develop research and education programmes which are meaningful to a broad cross-section of society. We must generate tourism which in spite of its many drawbacks can still generate revenue for national as well as local levels of society. Through such mechanisms, we must demonstrate that our management capabilities can ensure sustainable conservation and provide social and economic benefits through development.

4.3. Development with conservation -- New areas

Where the concept of "setting aside" new protected areas is now subject to extreme social and economic pressure, the concept of development with conservation may provide a valuable approach to establishing these areas as legal entities.

If we examine the concept of development with conservation related to biosphere reserves in Africa, for example, it would appear to provide a legal mechanism which would guarantee the viability of a core national park while meeting the needs of local peoples through the application of the biosphere reserve as a buffer or development zone. The core area would be under protection but the linkage to development programmes can be much more clearly enunciated through a total biosphere reserve.

If we examine the definition of a biosphere reserve, we find the need for a "conservation core" which is often a national park and an "external manipulative zone" which we could call the development zone. Thus by combining "development and conservation" we arrive at the biosphere reserve as it should be. It may appear that we are playing "word games" but the essence of it is that development programmes must be based on sound conservation practices.

5. FUNDING FOR THE FUTURE

It is illustrative to look at The World Heritage Convention along with the Man and the Biosphere Programme. The former is the mechanism for achieving protection of features of outstanding universal value. The second, through the use of biosphere reserves, could be a mechanism for implementing the World Conservation Strategy's philosophy, "Conservation with Development" (IUCN, 1980).

The World Heritage Fund supported by members of the World Heritage Convention provides a mechanism for supporting protection measures. It is time that biosphere reserves also had a mechanism for funding and I suggest that a concerted effort be made to this end by linking biosphere reserves with technical assistance programmes such as USAID, SIDA, NORAD, DANIDA, CIDA, etc. As these organizations are becoming more attuned to the World Conservation Strategy, conservation with development through "biosphere reserves" should become a core aspect of their programmes.

It is also apparent that the biosphere reserve programme is not receiving adequate financial support from Unesco's programmes. It would thus appear necessary to provide a legal framework for the biosphere reserve programme to which nations could financially contribute. To this end we should carefully examine the need for a new international convention which could provide for this possibility.

6. ACTION PROGRAMME

How do we achieve this new impetus for conservation?

1. Recognize that the "biosphere reserve" is more than an other designation for existing conservation areas.

2. Strengthen the selection, review and approval process of biosphere reserves. Here, lessons can be learned from effective World Heritage Committee procedures.

3. Re-emphasize the role of biosphere reserves as representative conservation areas delivering conservation with development in contrast to the role of World Heritage sites as protected areas of outstanding universal value.

4. In the longer term, work toward an international convention for protected areas which would incorporate biosphere reserves, and link international funding mechanisms which would equitably distribute the cost of protecting the "core" of biosphere reserves as well as supporting their role in development.

5. Develop management plans which integrate biosphere reserves in the planning of the region in which they are situated.

6. Ensure that benefits of the biosphere reserve are received, where appropriate, by the people living adjacent to the reserve, so that they will serve a biosphere reserve as well as having it serve them.

If we can achieve the above we will be able to guarantee a sacrosanct role for national parks as well as ensure a system of biosphere reserves which serve to sustain human societies through conservation and development.

To sum up, I see the new message for biosphere reserves simply to be "Conservation and Development". A simple message with a clearly identifiable objective: "There's something in it for everyone".

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PROPOSALS FOR IMPROVED MECHANISMS TO DEVELOP THE BIOSPHERE RESERVE SYSTEM AS AN INTEGRATED NETWORK

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ABSTRACT. This paper explains the need for a more coherent internationl system to guide countries in their proposals for the Biosphere Reserve programme, drawing on the experience of the Council of Europe in establishing the European Network of Biogenetic Reserves. Under these arrangements proposals are drawn up for each habitat type to enable member governments to offer biotopes that will contribute to an inter-related network for Europe, and to identify those biotopes which need further protection in order to secure a comprehensive network to reflect the European range of natural variation of habitat types.

Suggestions are made whereby this experience can be applied to the development of the world network of Biosphere Reserves. A role is suggested for IUCN's Commission on National Parks and Protected Areas.

1. INTRODUCTION

However important individual biosphere reserves might be, it is quite clear that from the outset it was intended that the system should be planned in order to achieve a coherent global network of reserves. So far general criteria have been developed to ensure that any proposed site is up to standard and action is well in hand to provide at a world scale a revised classification of the biogeographical zones as a framework within which the network can be developed. But adequate arrangements that would enable countries to determining the action each could most appropriately take to contribute toward an overall network is still lacking.

This means that even those countries which have established a number of biosphere reserves are quite unable to see whether yet further sites should be proposed. Some might argue that the answer is simple: there can never be too many protected areas, so establish more sites. But this argument has a serious defect -- there is no way of knowing whether any site being offered might be inferior to potential biosphere reserves of a similar type in other countries, with the overall risk of devaluation of the currency and consequent eventual and understandable disregard by politicians of the importance of this protective designation. Although this paper deals essentially with problems associated with the establishment of a network of sites, the same general comments apply to how these sites are subsequently managed.

What is lacking is a mechanism or set of institutional arrangements that will ensure that countries can offer sites which contribute in the most appropriate way to a coherent network. The 3rd World Congress on National Parks last year in Bali touched upon this in its Resolution No. 17 on biosphere reserves when it expressed the need for more such Reserves but considered that the present short-comings arise inter alia from insufficient understanding "of the criteria and methods for their selection, planning and management, and of the need to develop global, regional and national networks of reserves".

This paper suggests that the experience of the Council of Europe in establishing its European Network of Biogenetic Reserves may provide lessons for the biosphere reserve system. Indeed, this European Network is of considerable relevance because its rules specify that it "should constitute a contribution to Unesco's worldwide network of biosphere reserves".

Although the European Network has only been in operation for about 3 years there has been sufficient experience to have enabled the procedures to be codified, so that the network is now developing within an overall regional framework. I will describe the procedures in the Council of Europe in general terms, and then suggest the lessons that can be drawn from them. Some more specific suggestions will then be made on what might be done to improve arrangements for the biosphere reserve system. Some of the points may appear obvious, but nontheless need to be considered in order for the system of biosphere reserves to form a coherent network.

2. THE EUROPEAN NETWORK

First, under the European Network there has not been attempt to tackle all the biocenoses at once, but there has been a decision at senior level as to which of the biocenoses should receive priority.

A study is then carried out under the guidance of a committee of experts from the relevant countries, to identify the general geographical extent of the biocenosis, to assess the nature of the impacts on it and to suggest possible solutions, including general proposals on appropriate management.

This leads to the preparation by experts of an outline classification of the range of variation of types within the biocenosis. This classification provides a framework for the designation of sites for the network and makes it possible to indicate in which country each of the various habitat types occurs and is best represented.

It is then possible for experts to identify within each country the individual sites for that biocenosis which are most relevant to the European Network.

Information is then provided to enable the government of each country to see which already-protected sites are relevant to the network, to identify the gaps in the present network and to take appropriate action to fill such gaps.

2.1. The role of experts

Taken overall, the system enables experts to provide within a framework of priorities the information that will enable each government to propose sites that it knows will contribute to the network, in the knowledge that as other governments are in a similar position, its action will be complementary. It is important to stress that the role of the experts is to provide information, decisions on the basis of that information are, and must remain, the prerogative of each government.

Let me add a further comment on the role of the experts. Many countries are developing their own national networks of nature reserves. It is tempting for national experts to suggest which sites in their own national networks are of international importance. I am of the view that the recognition of international significance is more likely to be soundly based if it is the outcome of a group of experts drawn from all the relevant countries (or more widely if necessary to secure the required expertise) so that there can be international agreement on what is of international importance. It extends to the identification of sites of international importance the concept of "peer review" that has served the scientific community so well with scientific publications.

The Council of Europe also operates such a system of "peer review" in the examination of the applications for the award of the European Diploma to sites of special importance for conservation. Experts drawn from the various countries together identify whether the area is genuinely of European significance and whether the practical arrangements for the protection and mangement of the sites are appropriate to warrant the inter-governmental recognition entailed by the award of the Diploma. Again the final decision is made at the political level, but on the basis of the information and advice from the experts who take a broad European view.

2.2. The regional scale

There is one feature of the Council of Europe's system I have described which is a consequence of the nature of the organization responsible for the European network -- it is being handled (in world terms) at a regional or near-regional level. This scale is not too extensive for practical purposes; for a variety of reasons, both scientific and administrative, the scale is one that can be comprehended and handled fairly easily. It is largely because of the regional scale of the European Network that it has been able to devise workable procedures that have led to progress in developing a coherence that I feel has eluded the Biosphere Reserve Network.

3. CONCLUSIONS AND RECOMMENDATIONS

Based on this European experience some broad recommendations for the Biosphere Reserve system can be drawn.

Arangements which can be flexible and vary from region to region should be devised to approach the world network of biosphere reserves at regional level. Ideally the boundaries of the regions should be drawn to take account of biogeographic factors, and the work already being done on biogeographic provinces undoubtedly will be highly relevant. However, in some cases it may be possible or more appropriate to take advantage of existing relevant inter-governmental groupings to help in administrative arrangements and in promoting eventual implementation. Thus it will be sensible on occasion, to take account of political factors in deciding on the extent of the "region" concerned.

Priorities for action should also be determined at this regional level. This should take account primarily of what is desirable on ecological grounds, but in practice it will be sensible to be guided also by other factors such as whether there is sufficient information on some aspect that would enable action to be taken without undue delay.

Experts should be brought together at regional level so that it may be agreed, through a process of "peer review", which are the sites of international importance. This should result in information being made available to governments on how each country can most appropriately contribute to the network and help to ensure that, taken together, the sites are truly representative of the full range of variation of the world's biocenoses.

I have so far omitted any reference to how these various regional initiatives should be organized or welded together into a genuine world network. Much of this will be essentially a bringing together of the views of experts. We have a mechanism already in existence, even though it will require some elaboration. It is here that I suggest there is a role for IUCN and particularly its Commission on National Parks and Protected Areas. The Commission is well placed to take a world view of what is required for the

overall network and is now taking steps to strengthen the regional basis of its organizaiton. It has already used a regional approach to review possible World Heritage sites and could use similar means to help the more rapid development of the Biosphere Reserve system as a real network in a way that would meet the needs of all the participating countries of the world.

PLANNING A SYSTEM OF BIOSPHERE RESERVES

By

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ABSTRACT. Mexico has a rich tradition of appropriate and locally-adapted use of its diverse biological resources. Unfortunately, the development of modern agriculture and growing demographic pressures are quickly causing the replacement of traditional land use by modern crops. This has meant an increasing loss of Mexico's biotic richness as ecosystems are transformed by deforestation and tillage. There is an urgent need to protect the country's natural heritage.

National Parks and other conservation schemes have failed because they did not take into account the requirements of local populations. Biosphere reserves in Mexico, on the other hand contemplate the interests of local residents and include research for new rural development alternatives. Furthermore, they are conceived to protect representative parts of important biomes. Selection criteria for biosphere reserves can be grouped into four categories: political; biogeographical; ecological; and social. A system of biosphere reserves will help not only to conserve part of the biotic richness of Mexico, but will also help to generate new alternatives for the development of the country.

1. THE NEED FOR CONSERVATION

As the origin of most Mesoamerican agriculture, Mexico has had for centures a rich tradition of adequate and locally-adapted use of its diverse biological resources. A great number of cultivated plants have their centre of origin in Mexico, and the country has been for decades a paradise for naturalists, plant collectors, ethnobotanists, agronomists and anthropologists. The country's biogeographic location in the transition between two great realms (the Nearctic and the Neotropical), its pronounced topography which determines a complex mosaic of contrasting environments, and the great development of agriculture in prehispanic times, have all contributed to the high biotic richness of the country and to the diversity of traditional uses of these resources. Mexican varieties of maize and beans -- to mention only two of the most common crops -- form a significant portion of germplasm banks around the world.

Unfortunately, the situation has been rapidly changing in recent years. The development of modern agriculture on one hand, and growing demographic pressures on the other, are quickly causing the replacement of traditional land-use systems by modern crops. While traditional land-use involved procedures like the multiple use of forests and tropical orchards, the planting of mixed crops, the harvesting of water in arid lands, and the use of chinampas (Unesco, 1981) in floodable areas, modern crops are extremely homogeneous systems based on planting one or a few varieties which are genetically uniform and are used over large parts of the country. Thus, the development of modern agriculture has meant the growing loss of a great part of Mexico's biotic heritage as more and more ecosystems are transformed by deforestation and tillage.

There are many analogies between the destruction of a country's natural heritage and that of its cultural heritage. Both the cultural and the natural environments have formed the traditions and the present structure of the society, and represent its historical legacy. Hence, species and ecosystems represent not only potentially valuable resources, but are also an important part of a nation's identity, traditions and lore.

For a country like Mexico, facing great economic, social and demographic problems, the conservation of nature cannot be based on aesthetic or romantic arguments, but should be based instead on political and social considerations. More important is the need to conserve important biotic resources, to recover control over the natural heritage, and to stop technologies changing the country's lifestyle in unforeseen ways. To recover the adequate use of Mexico's natural heritage is to recover the means to decide the country's own future.

2. THE GENERAL STRATEGY

When discussing conservation policies in countries like Mexico, two important questions arise. Is it possible in a poorly developed country to protect ecosystems, plants and animals without involving actively local human populations? Is it politically and morally justifiable to keep large untouched areas away from direct food production when food deficiencies are a dramatic reality for most poor countries?

These questions hae been addressed by G. Halffter on various occasions (Halffter, 1980b, 1981a, 1981b; Halffter, et al., 1980). Their answer is not simple, and indeed there may not be a unique answer. What is clear is that both the problems involved in the conservation of nature and the possibilities of obtaining economic means to solve them are different in a non-industrialized and poor country as opposed to a rich industrialized nation. In the former, the high demographic increase, the growing demand for consumer products and the general situation of quick social and cultural change generate strong pressures on natural areas which have not yet been devoted to production. In addition, poor countries have a lower availability of qualified personnel and modern technology to face conservation and resource-management problems. Finally, it is important to note that most poor countries are located in the tropics, while most rich countries are in temperate areas. The ecological problems faced are radically different: the greater species richness in tropical ecosystems frequently masks their greater fragility and the enormous difficulties encountered for their appropriate management.

To get a comprehensive and politically meaningful conservation scheme for the poorer countries, these fundamental problems have to be taken into account. For the Mexican situation, we think there are definite answers to the questions posed earlier. It is not possible to protect natural ecosystems without actively involving the local populations. It is not justifiable, indeed it is not usually possible, to keep large untouched areas for conservation when the needs for more food and more land are pressing on the whole organization of society. It is our contention that the best (perhaps the only) way to conserve biotic resources in poor countries is by affording them importance for human development, and the whole philosophy of Mexican biosphere reserves has been based on this idea. Conservation and development, two concepts frequently opposed, should go together in countries which need more land and more food. A good, socially-oriented conservation scheme should not exclude rural development. Adequate development and proper management of biotic resources should include sustained production and long-term conservation as a main objective.

3. THE MEXICAN BIOSPHERE RESERVES

3.1. Biosphere reserves and other protected areas

The national parks system in Mexico has had a strong influence from the philosophy of US parks. Our parks have been conceived mainly as areas of great natural beauty for the recreation of the urban population. Unlike the case in the United States no previous ecological studies for the selection of sites and no management plans have been made. The ownership of the land is often not clear, and the interests of the local populations are not taken into account or are of secondary priority. The same situation prevails in many other Latin American countries.

Unfortunately, a conservation system based on this approach has little chance of success in the mammoth task of protecting our immensely diverse biotic resources. Demographic increase leads many peasants (campesinos) to the illegal occupation of protected areas. The pressure for food and resources is so strong that it is very difficult to control hunting and tree-felling in large protected areas. Tourism is poorly organized and frequently results in the littering and pollution of the parks.

The problem cannot be ascribed to the inefficient administration of national parks. We think that in Mexico the main problem lies in the philosophy of national parks itself, which does not correspond to our real needs for conservation but has been copied instead from that of the developed countries. This does not mean we are against national parks. If their administration is improved, they have an extremely important role to play in Mexico; but the question still remains, how shall we protect significant portions of our main biomes and their biotic richness?

A new system of conservation has to be implemented which should include the following characteristics:

a) It should be conceived to protect large and representative portions of our biotic resource and our natural heritage.

b) It should contemplate the interests of local residents.

c) It should include research for new rural development alternatives and for proper use of the natural resources.

d) It should include as an important objective of its organization, serious scientific research and high-level education.

e) The selection of conservation sites, their location and size should be based on ecological and scientific criteria.

MAB's proposals for the creation of biosphere reserves fit ideally into these characteristics. Biosphere reserves in Mexico do not compete with national parks. They represent instead a new system of conservation whose main objectives are the protection of biological heterogeneity, scientific research and high-level education. We think that the answer to many of Mexico's conservation problems lies in a parallel system of biosphere reserves which would be complementary to our national parks. The creation by the Instituto de Ecologia of the biosphere reserves of Mapimi and La Michilia has been a first and important step towards this (Halffter, 1978). The two biological research stations of the University of Mexico are based on a similar philosophy. The Center for Scientific Research of the State of Quintana Roo (CIQRO) and our own Institute have selected new areas for the potential

creation of more biosphere reserves at Quintana Roo, Sonora and Tamaulipas. A great research effort has been allocated to the selection and inventorying of these areas in order to locate the best sites and determine the optimum for the new reserves.

3.2. Selection criteria

When selecting a biosphere reserve, we take into account a complex set of criteria. These criteria can be grouped into four categories which I shall discuss in more detail.

3.2.1. Political criteria. Each potential area in Mexico for a biosphere reserve is related to different social, economic and management problems. In the humid tropics, for instance, the main problem is the constant increase of cattle ranching, usually for the export of beef, in detriment of multiple use of the forest and of traditional agriculture (Myers, 1981; Halffter, 1980). In the arid north of Mexico, on the other hand, range use and cattle ranching are not in direct competition with agriculture, as the latter can only occur under irrigation. Rather, they represent complementary activities. At a national level it is desirable to displace ranching from the tropics to the arid and semi-arid areas under an adequate range management policy. It is also important to restore proper multiple use of tropical forests and to encourage the development of an appropriate tropical agriculture. These important political considerations have to be incorporated into biosphere reserve selection procedures, and indeed they have played an important role in deciding the creation of Mapimi and La Michilia reserves.

3.2.2. Biogeographic criteria. Biosphere reserves must be representative of important biomes. Hence serious biogeographical studies at a regional level are of central importance in the selection of a new reserve. Exhaustive inventories have to be made in order to guarantee that the chosen areas include a sufficiently large number of species. Species-area curves and the comparison of inventory lists with published work and regional collections are important aids in this. Intra-area heterogeneity including habitat diversity, biogeographical barriers, and even the shape of the chosen area have to be analyzed. Inter-area comparisons are also necessary: it is important to be sure that the biome represented is of high significance and therefore has a major importance within the country (Diamond and May, 1976).

The Mapimi Reserve, for instance, is located on the Bolson de Mapimi, a central and very important sub-region of the Chihuahuan desert where the desert tortoise (Gopherus flavomarginatus) is endemic. La Michilia, on the other hand, is a typical representative of the western Sierra Madra pine-oak semi-arid forest. At present, we are making efforts to create another desert reserve at El Pinacate, in Sonora, representing the lower Colorado Valley sub-division (microphyll scrub) and the Arizona Uplands sub-division (succulent scrub) of the Sonoran Desert. We are also allocating a large research effort planning a biosphere reserve that will represent the typical cloud forest of the Tamaulipan Biotic Province, at the Eastern Sierra Madre, in the state of Tamaulipas.

3.2.3. Ecological criteria. It has been acknowledged that successful conservation programmes have to be based on the protection of the total environment more than on the preservation of isolated species (Smith, 1976). The holistic, or ecosystem, approach has played a central role in our ecologial studies both for the creation of biosphere reserves (e.g. Instituto de Ecologia, 1981) and for environmental impact evaluation (e.g. Instituto de Ecologia, 1983). Our inventory data for biosphere reserves has been analyzed

by complex multi-variate methods in order to determine communities and associations, analyze their distribution and identify the environmntal factors which determine their occurrence. This multivariate approach has been used in Mapimi for the analysis of range habitats, and has been applied in the Pinacate desert for mapping plant associations and as an aid in determining the best area for the proposed reserve (Halffter and Ezcurra, 1981).

Ecological considerations have also played an important role in the analysis and management of animal populations in our reserves (Barbault and Halffter, 1981; Ffolliott and Gallina, 1981). The location and the size of the Mapimi Reserve have been strongly influenced by our knowledge of the distributional area and territorial habits of the desert tortoise, formerly a highly endangered species. The management of La Michilia is based on the non-competitive and complementary use of forage by white-tailed deer (Odocoileus virginianus) and cattle (Gallina and Ezcurra, 1981). The proposed areas for the Pinacate reserve have been designed to protect the habitats of the bighorn sheep (Ovis canadensis) and of the desert pronghorn (Antilocapra americana).

Within this approach, land use and human settlements are undeniably part of the ecosystem and the study of their interactions with the rest of the system should be considered. In the Sonora Desert, for example, Indian water cropping systems and some forms of traditional agriculture actually seem to increase substantially the diversity and abundance of wild animals by creating more habitat heterogeneity (Nabham et al., 1982). These highly adapted forms of interaction between man and its environment are an integral part of the ecosystem and should be protected as such.

3.2.4. Social criteria. The interaction with the local human communities is a factor of capital importance in the success of biosphere reserves. We think that the best way to protect biological resources is by encouraging their proper long-term use -- this is a central definition in our philosophy. The ejido members and other landowners in both Mapimi and La Michilia, have a strong conscience for conservation, as they derive many benefits from the reserve. They get free professional expertise on range management, cattle management and veterinary treatment for their animals. Some previously overhunted animal populations (e.g. the white-tailed deer) are increasing in numbers and providing again a harvestable resource. The Instituto de Ecologia has also provided advice on beekeeping, and in collaboration with other research institutions some agro-industries are being developed at both reserves (Ochoa, 1981).

Because of its key importance, the possibility of successful interaction with the local population must be evaluated before creating a new reserve or before opening new development programmes. The way local residents perceive their environment, their aspirations in matters of development and of quality of life, their general attitude towards and integration with the rest of the environment are all important criteria that should be taken into account.

In this respect, we have had good collaboration on environmental perception problems with the University of Toronto (Whyte and Burton, 1981) with the aid of the MAB programme. We believe that a good evaluation of the social environment must include: an analysis of the land tenure systems on the area; and evaluations on the openness of ejido members to new ideas, their willingness to collaborate in conservation programmes by not depleting their resources, their disposition to accept management guidelines and their confidence in the scientists working on the area.

4. FINAL CONSIDERATIONS

Di Castri (1981) considers that ecology as a science must learn to act more than to predicate. It must go beyond the stage of opposing every action that seems negative to the environment and get into the more positive stage of proposing realistic alternative solutions on development matters.

The establishment of new biosphere reserves in Mexico will not solve the difficult problems of protecting and managing the country's biotic resources. But it will offer new and realistic alternatives for the conservation and adequate use of some of these resources. Our aim is not only to conserve part of the biotic richness of Mexico for the future; it is also to create new and original forms of research and education and to generate new and more adequate alternatives for the development of the country.

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STRATEGIC PLANNING OF NATIONAL OR REGIONAL SYSTEMS OF BIOSPHERE RESERVES: A METHODOLOGY AND CASE STUDY FROM COSTA RICA

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ABSTRACT. More than a decade of experience in various Latin American and Caribbean countries in the planning of subsystems of protected natural areas of different categories contributed to a methodology for the identification, evaluation and selection of a national system of biosphere reserves. The methodology's 11 steps provide clear guidelines for a scientifically and technically-based selection process, resulting in biosphere reserves which have been uniformly analyzed, evaluated and qualified, both individually and as a system. It also takes into account all existing protected areas of other management categories. In addition, it provides for the establishment of priorities for administration and management strategies indispensible for the implementation of the system. The application of the the methodology in Costa Rica permitted its testing and provided a case study which may be useful to other countries interested in carrying out similar planning exercises.

1. INTRODUCTION

The management planning of individual protected natural areas (wild areas or wildlands), particularly national parks and similar types of areas, have followed a rather long and continuously improving course. This extensive, accumulated experience has resulted in a well-known, proven and widely applied methodology, especially in the Latin American-Caribbean region (Miller, 1980). More recently, the same basic methodology with varying degrees of modification, as well as new methodologies derived in part from it, have begun to be developed and applied to a much broader range of management categories (Barborak, Morales and MacFarland, 1983; Betancourt and Dulin, 1978; Cifuentes and Ferreiro, 1983 in press; Godoy and Morales, 1983; Honduras and CATIE, 1983; Meganck et al., 1981; Meganck et al., 1983; Paucar, 1982).

In contrast, the planning of regional and national systems of protected areas is a more recent development, with relatively few cases where it has been applied. In the Latin American-Caribbean region there does not exist a single attempt at such systems planning, which takes into account all potential management categories for a country (as conceptually and ideally should be the case). Instead, for a variety of institutional, policy, political and practical reasons, management categories have been grouped together because they have generally similar objectives or can be managed by a given institution. The first attempts at planning systems of protected areas were conducted in Canada and the USA for national parks and similar conservation units. More recently, in Latin America and the Caribbean such subsystems plans have been prepared in Colombia, Cuba, Chile, Dominica, Ecuador and Brazil (see Fig. 1) and are being prepared in Costa Rica (Godoy, in preparation; Matamoros, in preparation).

In the specific case of biosphere reserves, no tested and proven methodologies exist for systematic strategic planning of national systems. General selection techniques have been proposed for Australia-New Zealand and semi-systematic search and identification procedures have been developed in

the USA (see Fig. 1). In the later case, terrestrial (continental) biosphere reserves are identified and selected based on suppositions which strongly orient action toward research and monitoring objectives, rather than from the perspective of integrated management to try to fulfill all the objectives of biosphere reserves, at both the individual and system levels. In addition procedures for definition and selection of coastal biosphere reserves in the USA are not attempts to strategically plan national subsystems within the country's protected area system, but instead to plan (select) individual biosphere reserves.

The experience from many countries in the strategic planning of protected areas systems (Fig.1) served as the basis for developing the methodology presented here. It is designed to allow systematic identification, classification, qualification and selection of terrestrial and marine-coastal units which could form a national system of biosphere reserves. The methodology starts from the supposition that almost all countries have protected areas, whether or not in a consolidated system. The identification of potential biosphere reserves is based on an analysis of the existing system (de facto or consolidated).

As a preliminary test case the methodology was applied to Costa Rica. The country is tropical, situated between 82°-02'-26" and 85°-57'-57" W longitude and 8°-02'26" and 11°-13-12" N latitude. It covers 51,100 sq km and has coasts on both the Caribbean and Pacific Ocean. It has great ecological diversity, with an altitude range from sea level to 3,819 meters. The existing national system of protected areas and the rural settlements and projects of the Institute for Agricutural Development (IAD; lands and colonization agency) provided the framework for the study.

2. PROPOSED METHODOLOGY FOR STRATEGIC PLANNING OF NATIONAL SUBSYSTEMS OF BIOSPHERE RESERVES

Figure 2 gives a comparison between the proposed methodology and other similar ones. The horizontal lines enclose comparable steps of the methodologies and procedures, thus indicating the similarities and differences of related stages/steps. The first column shows the general synthesized methodology for strategic conservation planning in general and for strategic planning of protected areas systems, based on all the methodologies and cases applied in Latin America and the Caribbean until now. The proposed methodology is similar to the individual ones upon which it is based, in terms of basic content and sequence of the steps. This also can be seen by making even more detailed comparisons with the individual subsystems planning cases from Latin America and the Caribbean, given in Figure 1. Although there are certain similarities, much more notable differences exist between the proposed methodology and the type composed of general selection techiques or semi-systematic identification and selection procedures (last column, Fig. 2); the latter are only parts or elements of methodologies, not complete ones.

The general outline of the proposed methodology is presented in Figure 3, with some detail of key sub-steps and components. Further elaboration can be found in Cifuentes (1983) and the more detailed methodology will be published in separate form by CATIE in 1984.

3. APPLICATION OF THE METHODOLOGY: PRELIMINARY STRATEGIC PLAN FOR A NATIONAL SUBSYSTEM OF BIOSPHERE RESERVES, COSTA RICA

3.1. Background

Costa Rica was chosen for application of the methodology for technical, practical and logistical reasons. One of the main reasons was its existing national system of protected areas which, although not planned *per se* as a system and not consolidated, is widely known and is being managed actively. Recently prepared management and/or operational plans exist for the majority of the areas, providing readily available basic information. At the national level, a large quantity of high quality basic biophysical, socio-economic and cultural information exists, much of it mapped, which has greatly aided this work.

The plan is the first of its type at the international level. At the national level, the plan is an essential element for consolidation of the existing national protected areas system and the eventual preparation of a strategic plan for that entire system; other elements include planning the subsystems of national parks and similar categories and planning forest reserves and similar categories,

Limitations of time, personnel and available financing determined the depth to which the methodology was applied and tested in its different steps. The first five steps (compilation; inventory; analysis and synthesis of basic information; and analysis of the exsting protected areas system) were satisfactorily completed, although more field verification data would have been useful. Steps 6-10 were carried out in basic form, but will require greater depth and field verification to produce the plan's final version.

3.2. National legal framework and policy on natural and cultural resources

No legal document exists in Costa Rica which contains a general policy on management and use of natural resources. However, the outlines of a general policy can be delineated from the many dispositions given in a broad range of decrees and laws (see Cifuentes, 1983, for details).

Likewise, a set of national conservation objectives has not been offically and legally defined *per se*. Nevertheless, the same laws and decrees give sufficient backing to a set of such objectives developed by Thelen and Dalfelt (1979). Those were prepared at the express request of the Costa Rican government and based on direct consultation and analysis with all national institutions involved in natural and cultural resources use and management. Those objectives are well adjusted to national needs and aspirations and are utilized *de facto* by most institutions. In order to potentially fulfil those objectives, 15 management categories of protected wildlands are recommended for establishment, all of which would be permitted under the existing legal and administrative framework (for details see Thelen and Dalfelt, 1979; Cifuentes, 1983).

At present the country has established 9 of those categories, including 66 conservation units, covering approximately 28% of the national territory (Figs. 4 and 5).

3.3. Objectives and characteristics of biosphere reserves

The objectives and characteristics of biosphere reserves used for the plan are not the same as those given by Unesco-MAB (1974) and generally repeated and used widely (IUCN, 1979). Instead, those and the basic concepts of biosphere

reserve structure (zoning) were reformulated in an attempt to clarify the conceptual framework of biosphere reserves (Fig. 6). That was done with the specific aim of defining them as a true management category and to eliminate the general existing confusion in interpretation of the concept and how it is applied. The proposed new conceptual framework allows the incorporation of all or parts of conservation units of other categories into proposed biosphere reserves, in appropriate situations. The proposed conceptual framework is considered to be an improvement over the existing one, at least for the Latin American-Caribbean region (MacFarland, Cifuentes and Morales, 1983).

3.4. Available basic information

A large amount of good quality basic biophysical, socio-economic and cultural data for Costa Rica was gathered, analyzed and synthesized. A major series of thematic maps, at a scale of 1:750,000, were produced for a large number of key parameters. Various of those were then used in overlays, to facilitate the making of a variety of decisions during the planning process. The major thematic maps produced were: a) Physiographic Regions; b) Principal Watersheds; c) Slopes; d) Geology; e) Geomorphology; f) Soil Types; g) Rainfall; h) Temperature; i) Vegetation Cover; j) Terrestrial Life Zones; k) Coastal-Marine Ecosystems; l) Distribution of Major Species Threatened with Extinction; m) National System of Protected Areas; n) Potential Land Use; o) Political-Administrative Divisions and Population Density; p) National Transporation System; q) Localization of Colonization Projects; r) Indian Communities; s) Zones of Major Erosion Potential and of Protection Potential; and t) Strict Protection Zones.

3.5. National system of protected areas

3.5.1. Analysis of the system. The national system of protected areas was mapped and analyzed in terms of five major aspects, based on detailed information obtained for each unit: a) representativeness of terrestrial and coastal-marine ecosystems; b) potential fulfilment of national conservation objectives; c) potential land/resource use; d) existing land/resource use; and e) administrative and institutional factors.

The matrices which were used for the analysis and the results therefrom are shown in Figures 7-11. A few clarifications and comments are necessary to explain how the matrices were used (further details and interpretation of the results are given by Cifuentes, 1983):

Figure 7: This permits determination of the extent to which the various physiographic regions and different ecosystems (terrestrial, coastal-marine and freshwater-aquatic) are represented in the protected areas system as a whole and within individual areas. With a few exceptions, both ecosystems and physiographic regions are well represented in the Costa Rican protected areas system.

Figure 8: This provides an evaluation of the extent to which the system as a whole potentially can fulfil the national conservation objectives. It does not allow determination of the degree to which each objective is being fulfilled in each unit, since only the potential is evaluated, according to management category. In general the Costa Rican system is directed more toward objectives related to resource protection per se and less toward direct resource uses and multiple use.

Figure 9: This provides a relative evaluation of the potential use of the units. Strict comparisons cannot be made among all units in the system, but rather only between areas of the same management category, since the latter

determines potential use. To obtain the final score for an area those potential uses which would not happen in practice, because of the type of management category, are substracted from the total score. In Costa Rica the greatest use potentiality is found within the forest reserves and one existing biosphere reserve and least in the biological reserves and wildlife refuges.

Figure 10: This evaluates whether existing uses are adequate or appropriate according to the unit's management category and, to a certain extent, its potential use. It does not pretend to evaluate the form of use (practice) per se. Strict comparisons can be made only among units of the same management category. Lower totals indicate protected areas where more inadequate/inappropriate uses exist. The most common inappropriate uses in Costa Rica, shown by the large majority of areas with low totals, are forest product extraction and livestock.

Figure 11: This qualifies the areas as to relative ease of administration and management based on various factors. All units can be compared to each other. The most common deficiencies in the Costa Rican units are availability and capability of personnel, financing, degree of knowledge of the areas and irregular boundaries.

3.5.2. Intrinsic value of the protected areas. Figure 12 combines the results of the factors and parameters qualified previously in Figures 7, 9, 10 and 11. This allows comparisons among areas of the same management category in order to make decisions to fulfil a given objective. The totals do not per se indicate priorities, but can serve as a guide to establish them.

3.6. Potential biosphere reserves of Costa Rica

Based on the analysis of the national protected areas system and general information (thematic maps and field reconnaissance), potential biosphere reserves were identified. Those 5 identified areas were then evaluated in terms of: a) representation of ecosystems and other features; b) use potentiality (uses, goods and services); and c) ease of administration, management and development (administrative and institutional factors). Figures 13-15 show those results.

Figure 16 gives a visual summary of the evaluation of the potential biosphere reserves. It combines the results of Figures 13-15, and the grand total serves as a guide for determining general priorities for implementation and development. It is important to note that those general priorities are subject to variation depending on administrative, financial and political circumstances, which the planning team should take into account when establishing action priorities and strategies.

3.7. Proposed subsystem of biosphere reserves

Based on the grand totals obtained, areas were selected which best fit the selection criteria and, therefore, the objectives of biosphere reserves. Four of the areas were selected and one (Nicoya) excluded because of its low qualification. Those 4 are shown in Figure 17. Their proposed provisional limits follow major divides to try to include complete watersheds; each includes complete watersheds and a number of existing protected areas of various categories (compare Figures 4 and 17).

3.8. Strategies

In summary form, figure 18 shows action priorities determined for each of the proposed biosphere reserves. Those priorities should be amplified, based on a better knowledge of the situation of each reserve, via more detailed field reconnaissance and study.

4. CONCLUSIONS

This methodology developed for systematic strategic planning of national subsystems of biosphere reserves is the first of its kind. The basic content of its steps and their sequence were largely derived from similar methodologies for planning protected areas subsystems of other management categories. The major difference between this methodology and those used for other management categories is at the level of procedural details and specific techniques, which, in turn, are determined by the specific objectives and characteristics of the subject being planned.

It should be clearly understood that both the type and level of detailed breakdown of the various parameters and factors used for evaluations and qualifications in the methodology (i.e. in the matrices), is a function of both the characteristics of the subsystem being planned and available and/or obtainable information. The latter, in turn, depends upon time, personnel, and financial and other resources available to the planning team. Those parameters and factors can be expanded or reduced in number both by basic types and/or in detailed brakdown, according to what the circumstances require and allow in any given case of planning. As an example of such, compare Figure 19, which is a generalized theoretical or generic matrix for evaluating existing land/resource use in a national system of protected areas, with the Figure 10 is used to evaluate those parameters in the Costa Rican case study. The theoretical one contains more different types of parameters and a finer breakdown of those than in the latter case. Time and other limitations in the Costa Rican case study simply did not allow obtaining the information in such detail, so a somewhat simpler set of parameters were used.

With minor modifications the methodology should be applicable for planning regional systems of biosphere reserves, i.e. for two or more countries in a defined region. Nevertheless, it cannot be concluded that the methodology is necessarily applicable for the tropical countries of Latin America and the Caribbean, because only further application and testing in various countries will determine that.

Even though based on numerous cases and considerable experience in planning of protected areas systems, including a variety of techniques used in many different cases and situations, the proposed methodology is a technical model. It should be adapted to the conditions of particular countries and should be tested and evaluated in the field.

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FIGURE 1 : METHODOLOGIES USED FOR STRATEGIC PLANNING OF REGIONAL AND NATIONAL SUBSYSTEMS OF PROTECTED WILD AREAS

GENERAL SYNTHESIZED METHODOLOGY (a)	PLANNING OF INTEGRATED DEVELOPMENT OF NATURAL AND CULTURAL AREAS OF CUBA (b)	PLANNING OF NATIONAL PARKS OF CHILE (c)	STRATEGIC PLANNING OF PROMINENT WILD AREAS OF ECUADOR (d)	PLANNING OF SYSTEM OF CONSERVATION UNITS OF BRAZIL (e)
1. Search for, compilation and presentation of basic information/data: - biophysical parameters of natural ecosystems - socioeconomic and cultural parameters of human systems	1. Establishment of national conservation objectives 2. Characteristics of wild areas 3. Definition of management methods (categories) 4. Inventory, evaluation and classification of sites and objects according to their scientific, cultural, educational, recreational and turistic values: -Establish an information archieve,including maps -Field reconnaissance of each area -Classification of resources -Selection of areas based on: .size .ease of protection .limits .existing land/resource use in area and adjacent region -Evaluation as to representativeness of ecosystems -Integration of national system of natural and cultural areas -Harmonization and integration with national development 5. Definition of strategies for: -Legislation and policy -Organization and institutions -Recreation and education -Training of personnel	1. Establishment of national criteria for classification and evaluation of areas 2. Reconnaissance and evaluation in the field of each area 3. Presentation of analysis and evaluation of each area according to representation of natural ecosystems 4. Presentation of analysis and evaluation of each area according to geomorphological units 5. Summary of results of analysis and evaluation Recommendation of management category for each area 6. Recommendation of national system of national parks 7. Suggestion of strategies and priorities for action	1. Inventory of all wild areas of the country 2. Field reconnaissance of all areas 3. Analysis of information and evaluation of areas 4. Determination of appropriate management category for each area 5. Selection of adequate areas 6. Determination of priorities based on: -biotic representativeness of terrestrial environments -representativeness of marine environments -educational and recreational services for urban centers -proposed management categories 7. Proposition of an extensive wild areas system of prominent areas 8. Proposition of a minimum system 9. Definition of strategies concerning: .establishment .minimum protection .implementation .administration	1. Determination of national conservation objectives 2. Definition of necessary management categories 3. Preparation and analysis of thematic maps 4. Analysis and evaluation of areas as potential conservation units 5. Identification of gaps and overlaps between the units and development poles 6. Selection of areas to form the system 7. Field verification of each area 8. Analysis of information and synthesis of gaps and duplications 9. Proposition of national system of conservation units 10. Description of each area and establishment of individual area strategies

Sources: (a) Putney, 1982; IUCN, 1980
(b) Cuba, 1974
(c) Thelen and Miller, 1976
(d) Putney, 1976
(e) Brazil, 1979 and 1982
(f) Shanks and Putney, 1979
(g) Miller, 1980
(h) McAlpine and Molloy, 1977
(i) US-MAB, 1979; Fernald, et. al., 1981
(j) Ray et. al., 1981

FIGURE 1: continued

PLANNING OF PARKS AND FOREST RESERVES SYSTEM OF DOMINICA (f)	PLANNING OF SYSTEMS OF NATIONAL PARKS (g)	TECHNIQUES FOR SELECTION OF BIOSPHERE RESERVES OF AUSTRALIA/NEW ZEALAND (h)	GUIDELINES FOR THE SELECTION OF TERRESTRIAL BIOSPHERE RESERVES (CONTINENTAL ONES) IN USA (i)	GUIDELINES FOR THE IDENTIFICATION AND SELECTION OF COASTAL BIOSPHERE RESERVES IN USA (j)
1. Definition of conceptual framework -resources situation -evaluation of existing resources 2. Integration and interpretation of available information: -physical capacity of soils -renewable resources limitations -localization of unique resources 3. Inventory in the field and interpretation of data: -land use and vegetation -agricultural capacity -timber potential -critical areas:unique natural areas and water production areas 4. Identification of units for parks and reserves system (permitted uses) 5. Land use recommendations 6. Conformation of parks and reserves system 7. Proposition of system; description of each area 8. Establishment of strategies (given under description of each area)	1. Preparation of conceptual framework 2. Study of existing conservation units 3. Classification and qualification of existing units 4. Summary of information; proposition of preliminary system 5. Search for new areas 6. Adjustment and relocation of existing units 7. Proposition of parks system	1. Establishment of interdisciplinary team to develop a principle ecosystem classification system 2. Application of the system to the country, to provide maps and a description of the principle ecosystems 3. Evaluation of existing reserves in relation to the maps and descriptions and criteria for biosphere reserves 4. Evaluation of existing reserves to identify gaps in the coverage of principal ecosystems, to add new reserves or modify existing ones in order to fulfill the criteria for biosphere reserves 5. Nomination of an optimum number of biosphere reserves to cover the nation's range of principal ecosystems, considering the programs of neighboring countries with similar ecosystems.	1. Determination of conceptual framework, selection criteria, limitations of the criteria, suppositions, definitions and priorities 2. Compilation of information: land tenure, zoning, man-made disturbances, scientific research potential, physical and biolcgical characteristics 3. Selection of the category of biosphere reserve which best describes the site or area, according to: -representativeness of natural ecosystems diversity -representativeness of characteristics unique internationally -possibilities of manipulative research -representativeness of varied and harmonious land uses 4. Evaluation of each area in accord with: -representativeness of natural ecosystem diversity with well-protected, non-manipulated areas -representativeness of unique characteristics -representativeness of natural ecosystems for manipulative research -representativeness of varied and harmonious landscapes -representativeness of man-modified or degraded landscapes, susceptible to restoration	1. Definition of conceptual framework -definition of coastal zone -definition of classification system of coastal zones and description of regions -determination and description of ecological processes 2. Identification of potential areas for biosphere reserves 3. Compilation of information on each area 4. Evaluation of each area according to criteria 5. Proposition of the area for its nomination 6. Nomination of the area as biosphere reserve 7. Communication of resolution and implementation of areas as biosphere reserves

FIGURE 2 .. RELATIONSHIP OF THE MAJOR COMPONENTS (STEPS) OF THE PROPOSED METHODOLOGY WITH THOSE OF SIMILAR ONES

GENERAL METHODOLOGY FOR STRATEGIC CONSERVATION PLANNING (WILDLANLS, LIVING RESOURCES, ETC.) (a)	PROPOSED METHODOLOGY FOR STRATEGIC PLANNING OF A NATIONAL SUBSYSTEM OF BIOSPHERF RESERVES	TECHNICAL PROCEDURE FOR SELECTION OF BIOSPHERE RESERVES (b)
		1. Formation of an interdisciplinary team to develop a principal ecosystems classification system
	PREPARATORY PHASE: Formation of interdisciplinary planning team, preparation of work plan, and gathering of materials, equipment, etc.	
	1. Identification of biosphere reserves conceptual framework	
1. Search for, compilation and presentation of basic information/data	2. Analysis and/or identification of national context 3. Analysis of basic information and preparation of thematic maps for the country	2. Application of the classification system to the country, to provide maps and a description of the principal ecosystems
2. Verification and supplementation of information/data in the field 3. Analysis and synthesis of information/data	4. Analysis of national system of existing and proposed protected wildlands 5. Identification of gaps and overlaps in the system of existing and proposed protected areas 6. Identification and selection of potential biosphere reserves	3. Evaluation of existing reserves in relation to the maps and descriptions and the criteria for biosphere reserves 4. Evaluation of existing reserves to identify gaps in the coverage of principal ecosystems, to add new reserves or modify existing ones in order to fulfill the criteria for biosphere reserves
4. Determination of priorities based on the mapped information/data and field experience	7. Establishment of priorities for the selected areas 8. Proposition of the national subsystem of biosphere reserves	5. Nomination of an optimum number of biosphere reserves to cover the nation's range of principal ecosystems, considering the programs of neighboring countries with similar ecosystems
5. Determination of strategies	9. Determination of strategies at national level and for each proposed reserve	
	10. Production of strategic plan for national subsystem of biosphere reserves	
	11. Evaluation and re-planning	

Sources: (a) Putney, 1982; IUCN 1980
(b) McAlpine and Molloy, 1977

FIGURE 3 : PROPOSED METHODOLOGY FOR STRATEGIC PLANNING OF NATIONAL SUBSYSTEM OF BIOSPHERE RESERVES

PREPARATORY PHASE	IDENTIFICATION OF BIOSPHERE RESERVES' CONCEPTUAL FRAMEWORK	ANALYSIS AND/OR IDENTIFICATION OF NATIONAL LEGAL CONTEXT AND NATURAL RESOURCES POLICY	ANALYSIS OF BASIC BIOPHYSICAL, SOCIOECONOMIC AND CULTURAL INFORMATION AND INFRASTRUCTURE AT NATIONAL LEVEL (includes thematic maps)	ANALYSIS OF NATIONAL SYSTEM OF EXISTING AND PROPOSED PROTECTED WILD AREAS
1. Formation of inter-disciplinary planning team 2. Preparation of team's work plan 3. Preparation of work area, materials, equipment, etc.	1. Study of definitions, objectives and characteristics of biosphere reserves	1. Identification and analysis of legislation and policy relevant to conservation and management of natural resources 2. Identification of national conservation objectives 3. Identification and description of protected wild areas management categories necessary to fulfill national conservation objectives 4. Identification of institutions and agencies responsible for administration and management of protected wild areas of the country	1. Information/data on: .Biotic provinces, lifezones, ecological zones .Coastal-marine ecosystems .Phytogeographic regions .Soil types .Land/resource use capability (potential) .Existing land/resource use .Geomorphology .Watersheds, existing use and trends .Vegetative cover and trends .Climatic zones .Geopolitical divisiones .Development poles .Existing and projected transportation system .Cultural resources (living and past) .Existing and proposed protected areas .Endemic and threatened species	1. Compilation of specific information on existing and proposed protected areas 2. Verification and supplementation of that information 3. Analysis and evaluation of the areas: .Representativeness of terrestrial and marine-coastal ecosystems .Potential fulfillment of national conservation objectives .Potential use .Existing use .Institutional and administrative factors

FIGURE 3 : continued

IDENTIFICATION OF GAPS AND OVERLAPS IN PROTECTED AREAS SYSTEM	IDENTIFICATION AND SELECTION OF POTENTIAL BIOSPHERE RESERVES	ESTABLISHMENT OF PRIORITIES	PROPOSITION OF NATIONAL SUB-SYSTEM OF BIOSPHERE RESERVES	DEFINITION OF STRATEGIES	PRODUCTION OF STRATEGIC PLAN FOR NATIONAL SUB-SYSTEM OF BIO-SPHERE RESERVES	EVALUATION AND RE-PLANNING
.Representation of ecosystems .Potential fulfillment of national conservation objectives .Potential use .Existing use, goods and services .Existing and projected development poles	1. Identification of potential biosphere reserves 2. Field inventories of identified areas and surrounding regions 3. Verification and supplementation of information/data 4. Evaluation and qualification of identified areas: .Representation of ecosystems .Potentiality (uses, goods and services) .Institutional and administrative factors	.Via qualification in the previous step, evaluating the intrinsic value of each area	.Selection of biosphere reserves .Proposition of the subsystem	.Legislation and policy .Land tenure and acquisition .Management and administrative infrastructure .Training of personnel .Public participation and education .Research and monitoring .Utilization of resources .Operations and maintenance .Nomination of the reserves and acceptance by MAB	1. Preparation of plan 2. Presentation and review of plan 3. Publication and distribution of plan	1. Evaluation during implementation 2. Periodic reformulation of the plan

FIGURE 4.

- COSTA RICA -
NATIONAL SYSTEM OF PROTECTED WILD AREAS

PREPARATION & DRAFTING: Lucía Rodríguez
COLLABORATION: Hjalmar Morales

SOURCES:
- SFN, 1980 and 1981.
- CATIE, 1982 (Fig 4).

JUNE, 1983

FIGURE 5 : MANAGEMENT CATEGORIES OF PROTECTED WILD AREAS IN COSTA RICA.

Key:

- ● Primary Objective
- ⊘ Not necessarily primary but always included as important objective.
- ○ Included as objective where resources and other objectives permit.
- — Not applicable.

MANAGEMENT CATEGORY	NATIONAL CONSERVATION OBJECTIVES											RESPONSIBLE INSTITUTIONS
	Conserve and improve hydrological systems.	Prevent and control erosion and sedimentation.	Conserve and improve timber and related forest resources.	Conserve representative samples of ecosystems.	Provide opportunities for recreation.	Protect and administrate wildlife resources.	Conserve genetic resources.	Provide opportunities for research, monitoring and education.	Protect national cultural heritage.	Protect, administrate and improve environmental quality.	Achieve conservation and integrate use of rural and marginal resources.	
Biological Reserve	⊘	⊘	—	●	—	—	●	●	—	—	—	National Parks Service (NPS)
National Park	⊘	⊘	—	●	●	—	●	●	●	●	⊘	
National Monument (Cultural)	○	○	—	○	⊘	—	⊘	●	●	⊘	⊘	
National Recreation Area.	⊘	⊘	—	○	●	—	⊘	●	○	●	●	
Forest Reserve	●	●	●	○	●	●	●	●	⊘	⊘	●	General Forestry Directorate(GFD)
Protection Zone (Water Production)	●	●	○	○	—	—	⊘	○	—	⊘	⊘	
Wildlife Refuge	⊘	⊘	—	●	○	—	●	●	—	⊘	⊘	
Indian Reserve	○	○	—	○	—	●	○	⊘	●	—	●	Indian Communities and CONAI*
Biosphere Reserve	⊘	⊘	○	●	⊘	⊘	●	●	○	—	●	NPS, GFD, ADI* and Indian Communities

* The National Commission for Indian Affairs (CONAI) only advises on and coordinates the administration of the Indian Reserves.

* ADI; Agricultural Development Institute (lands and colonization).

FIGURE 6: BIOSPHERE RESERVES: IMPROVED CONCEPTUAL FRAMEWORK

OBJECTIVES		CHARACTERISTICS		STRUCTURE (zoning)	
Current (a)	Proposed	Current (a)	Proposed	Current (a)	Proposed
1) Conservation of ecosystems and their genetic resources	1) Conserve representative samples of ecosystems, ecological zones or biomes, which are ecologically auto-sustainable to the maximum degree possible and with adequate legal and political guarantees	1) Protected areas of land or coastal environments. Together will constitute a worldwide network	1) Contain representative samples of one or more ecosystems, ecological zones or biomes, which are self-sustainable to the maximum degree possible and with adequate legal and political base	1) Natural or Core Zone -Baseline for the ecological region -Non-manipulative, baseline research and monitoring -Limited/controlled education and training	1) Complete Protection Zone SAME
2) Provision of areas for ecological and environmental research, particularly baseline studies, and on adjacent areas	2) Promote and facilitate basic research and monitoring on those ecosystems, their elements and processes, as well as applied research and monitoring on their appropriate use and management, via study of existing uses and experimentation	2) Network will include significant examples of biomes throughout the world	2) Offer opportunities for basic and applied research and monitoring particularly that directed toward and supporting management and appropriate use of resources, combining human needs and ecological principles	2) Manipulative, Experimental or Buffer Zone -Manipulative methods and techniques permitted for research, monitoring education and training. Traditional practices (hunting, fishing, timber production, etc.) permitted in controlled manner	2) Multiple Function Zone -Basic and applied research, manipulative and non-manipulative -Research and monitoring of environment, but also social, economic, cultural parameters -Education and training at all levels -Appropriate uses of resources experimented with, permitted, improved, promoted and demonstrated (fisheries, tourism, hunting, grazing, forestry production, agriculture, etc.) --Often will have human settlements
3) Provision of facilities for education and training	3) Provide opportunities and facilities for education and training of the general public (all sectors), resource managers and scientists, at all levels.	3) Each B.R. will include 1 or more of the following categories: (i) representative examples of natural biomes (ii) unique communities or areas (iii) examples of harmonious landscapes resulting from traditional patterns of human land use (iv) examples of modified or degraded ecosystems capable of being restored Each B.R. will have a non-manipulative core in combination with one or more other zones where other functions can be carried out	3) Offer opportunities (and eventually facilities) for education and training, for all sectors and levels of society	3) Reclamation or Restoration Zone Managed to study restoration of damaged resources (human-caused or natural)	3) Cultural Zone SAME as 4
	4) Promote the use of the reserves' natural and cultural resources by appropriate practices, assuring sustained production and the permanence of productivity and those practices	4) Each B.R. should be large enough to be effective conservation unit and to accomodate different uses without conflict.	4) Contain types of resource uses and practices which are appropriate and which can be demonstrated, maintained, improved and promoted	4) Stable Cultural Zone Protection and study of ongoing culture and resource use practices which are harmonious with the environment	4) Restoration Zone SAME as 3
	5) Promote appropriate development in the biome (ecosystem, ecological zone), via the study, conservation and promotion of resource use practices appropriate to that ecological region.	5) Should provide opportunities for ecological research, training and education 6) Must have adequate long-term legal protection 7) In some cases will coincide with or incorporate existing or proposed protected areas	5) Have possibilities for promoting ecologically sound development in the region which they represent (=model) 6) Where possible allow for rehabilitative or restorative programs for environments totally or partially altered by inappropriate use.		

(a) Sources: MAB (1974); IUCN (1979)

FIGURE 7 : REPRESENTATION OF TERRESTRIAL AND MARINE ECOSYSTEMS IN PROTECTED WILD AREAS OF COSTA RICA

Key:
1. Insignificant.
2. Regular.
3. Good.
4. Very Good.
5. Excellent.

MANAGEMENT CATEGORY	PROTECTED WILD AREAS — AREA	PHYSIOGRAPHIC REGIONS: Pacific Littoral	Atlantic Littoral	Islands	Talamanca Mountain Range	Central Mountain Range	Guanacaste Mountain Range	Central Valley	Guanacaste Plains	Nicoya Peninsula	Candelaria Hills	Parrita Valley	Coastal Range	General Valley	Osa and Burica Peninsulas	Diquis Valley	Coto Colorado Valley	Northern Atlantic Plains	Southern Atlantic Coastal Belt	TERRESTRIAL LIFE ZONES: Tropical Dry Forest	Tropical Moist Forest	Tropical Very Moist Forest	Premontane Moist Forest	Premontane Very Moist Forest	Premontane Wet Forest	Low Montane Moist Forest	Low Montane Very Moist Forest	Low Montane Wet Forest	Low Montane Very Moist Forest	Montane Wet Forest	Subalpine Wet Paramo	AE*: Lake and Lagoons	Rivers	Freshwater Swamps	MCE**: Rocky Pacific Coast	Rocky Atlantic Coast	Estuaries and Mangroves	Sandy Pacific Beaches	Sandy Atlantic Beaches	Coral Reefs	Coastal Islands	TOTAL
BR*	LA AMISTAD-TALAMANCA			5															2		2	4		4	5		3	5		5	5	3	5									48
NATIONAL PARK	CORCOVADO	5													5					5			4								5	3		5			2	5		4	43
	LA AMISTAD				5																			3	4		3	5		5	3		5								34
	SANTA ROSA	3					4		2											5			5											5		3	2				29
	TORTUGUERO		5															5				5										4	5					5			29
	RINCON DE LA VIEJA						5														1	3		4	5			5				5									29
	BRAULIO CARRILLO					5															4			5			5		4			5									28
	CHIRRIPO				5																			2			5		5	5		5									27
	MANUEL ANTONIO	3										5									3											2		4		1	5			4	27
	CAHUITA		5																5	1												1	4				5	5			25
	PALO VERDE	2					5													5												3	5			5					25
	VOLCAN POAS				5																					2	5		4		3	5									24
	VOLCAN IRAZU				5																						3	3	4			3									20
	ISLA DEL COCO			5																				5										5							18
	BARRA HONDA								5											2			3								2										12
FOREST RESERVE	GOLFO DULCE	3													5						3	5		5							4	4	5	5		4				43
	VOLCAN TENORIO		1				5														2	5		2	5			4			5	5								33
	CORDILLERA VOLCANICA CENTRAL					5																4			5		4	5	2	4		4								33
	LOS SANTOS				5					3												3			3		4	3		4		5								30
	MIRAVALLES						5														2	3		3	5			5				5								28
	RIO MACHO					5																		3	5			5		5		4								27
	ORCSI						5															2		3	5			2				5								22
	ARENAL						3															2			5			5				5								22
	JUAN CASTRO BLANCO					5																3			4			5				5								22
	SAN RAMON						5														5				5			2				4								21
	MATINA		3																5			3										1	4				3			19
	GRECIA					5																		1			5					5								18
	TABOGA							5												5												3								13
INDIAN RESERVE	TALAMANCA				5																3	5		5	4		3					5								32
	CHIRRIPO				5																	4		5	3		4					5								28
	UJARRAS-SALITRE-CABAGRA				5						2										3			5	5		5		3											28
	COCLES		3																5		5			3													5	4		22
	GUAYMI CONTE BURICA	4										5										5		2									5								21
	TELIRE				5																	3			5				2			5								20
	BORUCA-TERRABA										5										5	5		5																	20
	GUATUSO																	5			4	3		5																	17
	TAYNI				5																	5		5	2																17
	GUAYMI COTO BRUS										5											3		2	5			1													16
	ZAPATON									4	3											5			1																13
	GUATIRRISI									5											3			5																	11
	MATAMBU								5												5																					10
	GUAYMI ABROJOS DE MOCTEZUMA											5										5																				10
BIOLOGICAL RESERVE	CARARA								4												2	5		2			2				4	3									22
	MONTEVERDE						5																1		3		2	5				3									19
	HITOY				5																	5		2	3							5									15
	CABO BLANCO	3							5												2											2		4					2		18
	LA SELVA																		5			4		3								3	2								17
	LAS CRUCES										5											3			5							2									16
	ISLA DEL CAÑO			5																	2																	5	5		14
	ISLA GUAYABO			3																3																			4		12
	ISLA NEGRITOS			5																1																			4		11
	ISLA PAJAROS			5																2																			4		11
PROTECTION ZONE	LAS TABLAS				5																			5	1		5	5				3									24
	BARBILLA				5																	5		2	5			1				0									23
	CARAIGRES		5							5													1	2	1		2	3				3									18
	CERROS ESCAZU							5																3			5					3									16
	LA CARPINTERA							3															3	3		1	2					2									15
	LA SELVA					5																5			2							4									16
	RIO GRANDE						5																									3									15
	EL RODEO							5														4		1	3							2									15
	ATENAS						5															3			2																16
	RIO TIRIBI					5																			2																9
WR*	RAFAEL LUCAS RODRIGUEZ CABALLERO							5												5												4									25
	TAPANTI					5																			4																17
	ISLA BOLAÑOS			5																4																			3		12
NM*	GUAYABO				5																				1							3									9
NRA*	SANTA ANA						5															1																			6

AE*: Aquatic Ecosystems (freshwater). MCE**: Marine-Coastal Ecosystems. BR*: Biosphere Reserve. WR*: Wildlife Refuge. NM*: National Monument. NRA*: National Recreation Area.

FIGURE 8 : POTENTIAL FULFILLMENT OF NATIONAL CONSERVATION OBJETIVES BY PROTECTED WILD AREAS OF COSTA RICA.

Key

0 Not applicable.

1. Included where resources and other objectives [illegible] allow such.

2 Not necessarily primary, but always included as an important objective

3 Primary objective

NATIONAL PARKS

NATIONAL CONSERVATION OBJECTIVES	Santa Rosa, Sector Murciélago	Rincón de la Vieja	Palo Verde	Barra Honda	Volcán Poás	Braulio Carrillo	Volcán Irazú	Manuel Antonio	Chirripó	La Amistad	Corcovado	Isla del Coco	Cahuita	Tortuguero
- Provide opportunities for research, monitoring and education.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Conserve genetic resources.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve and improve hydrological systems.	2	2	2	2	2	2	2	2	2	2	2	2	2	2
- Prevent and control erosion and sedimentation.	2	2	2	2	2	2	2	2	2	2	2	2	2	2
- Achieve conservation and integrated use of rural and marginal resources.	2	2	2	2	2	2	2	2	2	2	2	2	2	2
- Conserve representative samples of ecosyst.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Protect national cultural heritage.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Protect, administrative and improve environmental quality.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Provide opportunities for recreation.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Protect and administrate wildlife resources.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Conserve and improve timber and related forest resources.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

FOREST RESERVES

NATIONAL CONSERVATION OBJECTIVES	Matina	Orosi	Miravalles	Tenorio	Arenal	Taboga	San Ramón	Juan Castro Blanco	Grecia	Cordillera Volcánica Central	Río Macho	Los Santos	Golfo Dulce
- Provide opportunities for research, monitoring and education.	3	3	3	3	3	3	3	3	3	3	3	3	3
Conserve genetic resources.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve and improve hydrological systems.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Prevent and control erosion and sedimentation.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Achieve conservation and integrated use of rural and marginal resources.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve representative samples of ecosyst.	1	1	1	1	1	1	1	1	1	1	1	1	1
- Protect national cultural heritage.	2	2	2	2	2	2	2	2	2	2	2	2	2
- Protect, administrative and improve environmental quality.	2	2	2	2	2	2	2	2	2	2	2	2	2
- Provide opportunities for recreation.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Protect and administrate wildlife resources.	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve and improve timber and related forest resources.	3	3	3	3	3	3	3	3	3	3	3	3	3

BIOLOGICAL RESERVES

NATIONAL CONSERVATION OBJECTIVES	Absoluta Cabo Blanco	Isla Guayabo	Isla Negritos	Isla Pájaros	Monteverde	Carara	Isla del Caño	Hitoy	Las Cruces	La Selva
- Provide opportunities for research, monitoring and education.	3	3	3	3	3	3	3	3	3	3
Conserve genetic resources.	3	3	3	3	3	3	3	3	3	3
- Conserve and improve hydrological systems.	2	2	2	2	2	2	2	2	2	2
- Prevent and control erosion and sedimentation.	2	2	2	2	2	2	2	2	2	2
- Achieve conservation and integrated use of rural and marginal resources.	0	0	0	0	0	0	0	0	0	0
- Conserve representative samples of ecosyst.	3	3	3	3	3	3	3	3	3	3
- Protect national cultural heritage.	0	0	0	0	0	0	0	0	0	0
- Protect, administrative and improve environmental quality.	0	0	0	0	0	0	0	0	0	0
- Provide opportunities for recreation.	0	0	0	0	0	0	0	0	0	0
- Protect and administrate wildlife resources.	0	0	0	0	0	0	0	0	0	0
- Conserve and improve timber and related forest resources.	0	0	0	0	0	0	0	0	0	0

INDIAN RESERVES

NATIONAL CONSERVATION OBJECTIVES	Matambú	Guatuso	Quitirrisí	Chirripó	Tayni	Telire	Talamanca	Cocles	Ujarrás-Salitre-Cabagra	Boruca-Térraba	Guaymí Coto Brus	Guaymí Abrojos Montezuma	Guaymí Conte Burica	Zapatón
- Provide opportunities for research, monitoring and education.	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Conserve genetic resources.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
- Conserve and improve hydrological systems.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
- Prevent and control erosion and sedimentation.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
- Achieve conservation and integrated use of rural and marginal resources.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve representative samples of ecosyst.	1	1	1	1	1	1	1	1	1	1	1	1	1	1
- Protect national cultural heritage.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Protect, administrative and improve environmental quality.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Provide opportunities for recreation.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Protect and administrate wildlife resources.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
- Conserve and improve timber and related forest resources.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PROTECTION ZONES

NATIONAL CONSERVATION OBJECTIVES	Barbilla	San Ramón	Atenas	El Rodeo	Cerros de Escazú	La Carpintera	Caraigres	La Selva	Río Tiribí	Las Tablas
- Provide opportunities for research, monitoring and education.	1	1	1	1	1	1	1	1	1	1
Conserve genetic resources.	2	2	2	2	2	2	2	2	2	2
- Conserve and improve hydrological systems.	3	3	3	3	3	3	3	3	3	3
- Prevent and control erosion and sedimentation.	3	3	3	3	3	3	3	3	3	3
- Achieve conservation and integrated use of rural and marginal resources.	2	2	2	2	2	2	2	2	2	2
- Conserve representative samples of ecosyst.	1	1	1	1	1	1	1	1	1	1
- Protect national cultural heritage.	0	0	0	0	0	0	0	0	0	0
- Protect, administrative and improve environmental quality.	2	2	2	2	2	2	2	2	2	2
- Provide opportunities for recreation.	0	0	0	0	0	0	0	0	0	0
- Protect and administrate wildlife resources.	0	0	0	0	0	0	0	0	0	0
- Conserve and improve timber and related forest resources.	1	1	1	1	1	1	1	1	1	1

WR / NM / NRA / TOTAL

NATIONAL CONSERVATION OBJECTIVES	WR: Rafael Lucas Rodríguez Caballero	WR: Isla Bolaños	WR: Tapantí	NM: Guayabo	NRA: Santa Ana	TOTAL
- Provide opportunities for research, monitoring and education.	3	3	3	3	3	164
Conserve genetic resources.	3	3	3	2	2	158
- Conserve and improve hydrological systems.	2	2	2	1	2	140
- Prevent and control erosion and sedimentation.	2	2	2	1	2	140
- Achieve conservation and integrated use of rural and marginal resources.	2	0	2	2	3	140
- Conserve representative samples of ecosyst.	3	3	3	1	1	120
- Protect national cultural heritage.	0	0	0	3	1	114
- Protect, administrative and improve environmental quality.	2	0	2	2	3	99
- Provide opportunities for recreation.	1	0	1	2	3	89
- Protect and administrate wildlife resources.	0	0	0	0	0	81
- Conserve and improve timber and related forest resources.	0	0	0	0	0	49

WR: Wildlife Refuge. NM: National Monument NRA: National Recreation Area.

FIGURE 9 : POTENTIAL USE IN PROTECTED WILD AREAS OF COSTA RICA.

Key:
1: Insignificant
2: Regular
3: Good
4: Very Good
5: Excellent

PROTECTED WILD AREAS		USES, GOODS AND SERVICES												
CATEGORY MANAGEMENT	AREA	PROTECTION OF ECOSYSTEMS	RESEARCH AND MONITORING	EDUCATION	RECREATION AND TOURISM	WOOD PRODUCTION	AGRICULTURE	LIVESTOCK	FISHING AND/OR HUNTING	EXTRACTION OF WILD PLANTS AND ANIMALS AND PRODUCTS	WATER PRODUCTION	TOTAL	SUBTOTAL (NON-RENEWABLE USES)	ADJUSTED TOTAL
BIOSPHERE RESERVE	LA AMISTAD-TALAMANCA	5	5	5	5	3	2	2	4	4	5	40	0	40
NATIONAL PARK	LA AMISTAD	5	5	5	5	4	4	3	4	3	5	43	18	25
	BRAULIO CARRILLO	5	5	5	5	3	2	2	4	4	5	40	15	25
	CHIRRIPO	5	5	5	5	3	1	1	3	2	1	35	10	25
	TORTUGUERO	5	5	5	5	3	3	3	4	3	4	40	16	24
	RINCON DE LA VIEJA	5	5	5	5	3	2	3	3	1	4	35	12	23
	CORCOVADO	5	5	5	4	3	1	2	4	3	4	36	13	23
	ISLA DEL COCO	5	5	5	3	2	1	2	3	4	4	34	12	22
	VOLCAN POAS	3	5	5	5	1	1	2	2	2	4	30	8	22
	VOLCAN IRAZU	3	5	5	5	1	1	1	1	1	3	26	5	21
	BARRA HONDA	3	5	5	5	1	2	2	3	3	2	31	11	20
	SANTA ROSA	5	4	5	4	1	1	2	1	1	1	25	6	19
	PALO VERDE	3	5	4	5	1	1	2	2	2	1	26	8	18
	MANUEL ANTONIO	3	3	5	5	3	1	1	5	4	2	32	14	18
	CAHUITA	3	5	5	5	5	3	3	4	1	1	33	16	17
FOREST RESERVE	CORDILLERA VOLCANICA CENTRAL	5	5	5	5	4	2	3	4	5	5	43	0	43
	RIO MACHO	5	5	5	5	3	2	2	4	5	4	40	0	40
	GOLFO DULCE	5	5	5	5	3	2	3	4	5	3	40	0	40
	ARENAL	5	5	5	5	4	1	1	4	4	5	39	0	39
	TENORIO	5	4	4	5	3	1	2	4	5	5	38	0	38
	OROSI	5	4	3	4	3	2	3	4	4	5	37	0	37
	MIRAVALLES	4	4	3	4	3	1	2	3	4	4	32	0	32
	SAN RAMON	5	3	3	4	4	1	1	3	4	4	32	0	32
	LOS SANTOS	3	3	4	4	3	2	2	3	3	3	30	0	30
	JUAN CASTRO B.	3	2	3	4	3	2	3	3	2	3	28	0	28
	GRECIA	2	2	2	2	2	1	3	2	2	3	21	0	21
	MATINA	1	2	2	2	4	1	2	2	2	1	19	0	19
	TABOGA	1	1	2	3	1	2	2	2	2	1	17	0	17
INDIAN RESERVE	TALAMANCA	5	5	5	5	4	3	4	4	4	5	44	9	35
	CHIRRIPO	5	5	4	5	4	3	3	4	4	5	42	9	33
	UJARRAS-SALITRE-CABAGRA	5	5	5	5	4	2	2	4	4	5	41	9	32
	BORUCA-TERRABA	5	5	4	4	4	2	3	4	4	5	40	8	32
	GUAYMI COTO BRUS	4	4	4	3	3	3	4	3	3	4	35	6	29
	TAYNI	4	4	4	3	4	3	3	3	3	4	35	7	28
	TELIRE	3	4	3	4	4	3	3	4	4	4	36	8	28
	GUATUSO	4	4	4	3	3	2	3	4	4	2	33	6	27
	COCLES	3	4	3	4	3	1	1	4	4	5	32	7	25
	GUAYMI COAITE BURICA	4	4	3	3	2	2	3	2	3	3	29	5	24
	MATAMBU	3	3	2	2	3	3	2	3	3	3	27	5	22
	QUITARISI	2	3	3	2	2	2	3	3	3	3	26	4	22
	GUAYMI DE ABROJOS DE MONTEZUMA	3	4	3	4	2	1	1	3	2	3	26	6	20
	ZAPATON	3	3	2	3	3	2	2	2	3	2	25	6	19
BIOLOGICAL RESERVE	CARARA	4	5	5	3	3	1	1	4	3	5	34	15	19
	HITOY	5	5	4	5	4	1	1	4	5	5	39	20	19
	MONTEVERDE	3	5	5	4	2	1	1	2	3	3	29	13	16
	LA SELVA	3	5	5	4	4	3	3	4	3	3	37	21	16
	CABO BLANCO	3	4	4	3	3	1	1	4	2	3	28	14	14
	ISLA PAJAROS	2	4	4	1	1	1	1	2	1	3	20	7	13
	ISLA NEGRITOS	3	4	4	1	2	1	1	3	1	1	20	8	12
	ISLA DEL CAÑO	2	4	4	1	1	1	1		1	3	18	6	12
	LAS CRUCES	2	3	3	3	3	3	3	3	2	3	27	16	11
	ISLA GUAYABO	2	4	4	1	1	1	1	3	1	1	8	7	11
PROTECTION ZONE (Water Production)	BARBILLA	5	5	5	4	3	2	3	4	5	5	41	4	37
	LA SELVA	4	4	4	3	3	3	3	4	3	3	34	3	31
	CERROS ESCAZU	3	3	3	4	2	3	3	3	3	4	31	4	27
	LAS TABLAS	4	3	3	4	3	2	2	3	2	4	30	4	26
	LA CARPINTERA	3	3	3	2	2	1	2	2	3	4	25	2	23
	EL ROBLE	2	3	2	3	2	3	3	2	2	3	25	3	22
	CARARA ES	2	3	2	3	2	3	3	2	2	3	25	3	22
	RIO GRANDE	1	2	2	2	1	4	3	2	2	2	21	2	19
	ATENAS	1	1	2	3	1	2	3	2	1	2	18	3	16
	RIO TIRIO	1	1	1	2	1	3	3	2	1	2	17	2	15
*WR	TAPANTI	5	5	3	4	2	1	1	3	3	4	32	13	19
	RAFAEL LUCAS RODRIGUEZ CABALLERO	4	5	4	5	1	1	2	3	3	2	30	15	15
	ISLA BOLAÑOS	2	3	3	2	1	1	1	1	1	1	16	7	9
*NM	GUAYABO	1	5	5	4	1	3	3	1	1	3	27	9	18
*NRA	SANTA ANA	1	1	3	4	1	2	1	1	1	1	16	6	10

*WR: Wildlife Refuge. *NM: National Monument. *NRA: National Recreation Area.

FIGURE 10: EXISTING USES IN PROTECTED WILD AREAS OF COSTA RICA.

Key

5: Adequate

0: Non-Existent

-5: Inadequate

PROTECTED WILD AREAS		USES, GOODS AND SERVICES									
MANAGEMENT CATEGORY	AREA	Protection of Ecosystems and others Features.	Research and Monitoring	Recreation and Tourism.	Agriculture.	Livestock and Grazing.	Timber and Related Products Extraction.	Extraction Wild Plant and Animals and Products.	Extraction of Minerals and/or Petroleum.	Education.	Total Points
BR	LA AMISTAD-TALAMANCA	5	0	0	5	5	5	5	-5	0	20
NATIONAL PARK	SANTA ROSA	5	5	5	0	0	0	-5	0	5	15
	RINCON DE LA VIEJA	5	5	0	0	-5	0	0	0	5	10
	TORTUGUERO	5	5	5	0	0	0	-5	0	0	10
	CAHUITA	5	5	5	-5	-5	0	0	0	5	10
	CORCOVADO	5	5	5	0	0	0	-5	-5	5	10
	VOLCAN POAS	5	5	5	0	-5	0	-5	0	5	10
	BRAULIO CARRILLO	5	5	5	-5	-5	0	-5	0	5	5
	PALO VERDE	5	0	0	0	0	0	0	0	0	5
	VOLCAN IRAZU	5	5	5	-5	-5	-5	-5	0	5	0
	MANUEL ANTONIO	5	0	5	-5	-5	0	-5	0	5	0
	ISLA DEL COCO	5	0	0	0	0	0	-5	0	0	0
	CHIRRIPO	5	5	5	-5	-5	-5	-5	0	5	0
	BARRA HONDA	5	0	5	-5	-5	0	-5	0	0	0
	LA AMISTAD	5	0	0	-5	-5	-5	-5	0	0	-15
FOREST RESERVE	SAN RAMON	5	5	5	0	0	0	0	0	5	20
	RIO MACHO	5	5	5	5	-5	-5	5	0	0	15
	OROSI	5	0	0	0	5	-5	5	0	0	10
	TABOGA	5	0	0	0	0	0	5	0	0	10
	GOLFO DULCE	5	5	0	-5	5	-5	5	0	0	10
	MIRAVALLES	5	0	0	0	-5	-5	5	0	0	0
	TENORIO	5	0	0	0	-5	-5	-5	0	0	0
	ARENAL	5	0	5	0	-5	-5	0	0	0	0
	JUAN CASTRO BLANCO	5	0	0	0	-5	-5	5	0	0	0
	CORDILLERA VOLC. CENTRAL	5	0	0	5	-5	0	-5	0	0	0
	LOS SANTOS	5	0	0	-5	-5	-5	5	0	0	-5
	GRECIA	0	5	0	-5	-5	-5	5	0	0	-5
	MATINA	0	0	0	-5	-5	-5	-5	0	0	-20
INDIAN RESERVE	TALAMANCA	5	0	5	5	5	5	5	-5	0	25
	GUAYMI CONTE BURICA	5	0	0	5	5	0	5	0	0	20
	MATAMBU	5	0	0	-5	5	5	5	0	0	15
	GUATUSO	5	0	0	5	5	-5	5	0	0	15
	QUITIRRISI	5	0	0	5	-5	5	5	0	0	15
	COCLES	5	0	0	5	5	-5	5	0	0	15
	UJARRAS-SALITRE-CABAGRA	5	0	0	5	-5	-5	5	0	0	5
	BORUCA-TERRABA	5	0	0	5	-5	-5	5	0	0	5
	GUAYMI COTO BRUS	5	0	0	5	-5	0	-5	0	0	0
	GUAYMI ABROJOS MOCTEZUMA	5	0	0	5	-5	0	-5	0	0	0
	ZAPATON	5	0	0	5	-5	-5	5	0	0	-5
	CHERIPO	5	0	0	-5	-5	-5	5	0	0	-5
	TAYNI	5	0	0	-5	-5	-5	5	0	0	-5
	TELIRE	5	0	0	-5	-5	-5	5	0	0	-5
BIOLOGICAL RESERVE	MONTEVERDE	5	5	5	0	0	0	-5	0	5	15
	LA SELVA	5	5	5	0	0	0	-5	0	5	15
	LAS CRUCES	5	0	5	0	0	0	-5	0	5	10
	ISLA GUAYABA	5	0	0	0	0	0	0	0	0	5
	ISLA NEGRITOS	5	0	0	0	0	0	0	0	0	5
	ISLA PAJAROS	5	0	0	0	0	0	0	0	0	5
	ISLA DEL CAÑO	5	0	0	0	0	0	0	0	0	5
	CARARA	5	0	0	-5	-5	0	-5	0	0	-10
	CABO BLANCO	5	0	0	-5	-5	0	-5	0	0	-10
	NICOY	5	0	0	-5	-5	0	-5	0	0	-10
PROTECTION ZONE (Water production)	BARBILLA	5	0	0	-5	-5	0	5	0	0	0
	LA SELVA	5	0	5	-5	-5	0	5	0	0	0
	ATENAS	0	0	0	-5	-5	0	0	0	5	-5
	LAS TABLAS	5	0	5	-5	-5	-5	5	0	0	-5
	EL RODEO	0	5	0	-5	-5	-5	-5	0	5	-10
	LA CARPINTERA	5	0	5	-5	-5	-5	-5	0	5	-10
	RIO GRANDE	0	5	0	-5	-5	-5	-5	0	0	-15
	CERROS ESCAZU	5	0	0	-5	-5	-5	-5	0	0	-15
	TIRRI	0	0	0	-5	-5	0	-5	0	0	-15
	CARAGRES	5	0	0	-5	-5	-5	-5	0	0	-15
WR	ISLA BOLANOS	5	0	0	0	0	0	0	0	0	5
	RAFAEL L. RODRIGUEZ C.	5	5	-5	0	-5	0	5	0	5	0
	TAHUNTI	5	5	-5	-5	-5	-5	-5	0	5	-10
NM	GUAYABO	5	5	5	-5	-5	-5	-5	0	5	0
NRA	SANTA ANA	0	0	5	0	0	0	0	0	0	5

BR: Biosphere Reserve; WR: Wildlife Refuge; NM: National Monument; NRA: National Recreation Area.

FIGURE II: INSTITUTIONAL AND ADMINISTRATIVE FACTORS FOR COSTA RICAN WILD AREAS.

Key
1: Insignificant.
2: Regular.
3: Good.
4: Very Good.
5: Excellent.

PROTECTED WILD AREAS		ADMINISTRATIVE FACTORS				LEGAL FACTORS		INSTITUTIONAL FACTORS			PROTECTION DEMANDS		
Management Category	AREA	SIZE.	SHAPE.	ACCESSIBILITY.	AVAILABILITY AND CAPABILITY OF PERSONNEL.	LAND TENURE.	LEGAL BACKING.	FINANCING.	POLICY.	DEGREE OF KNOWLEDGE.	SITUATION DUE TO ALTERNATIVE USES TRENDS AND PROJECTS.	REPETITION FEATURES REPRESENTED OTHER AREAS.	TOTAL
BR	LA AMISTAD-TALAMANCA	5	5	2	1	5	5	1	3	1	3	4	35
NATIONAL PARK	VOLCAN POAS	3	3	5	5	3	4	3	4	4	5	4	43
	BRAULIO CARRILLO	5	2	5	4	4	4	5	4	2	3	4	42
	CORCOVADO	4	3	1	4	5	5	4	4	4	3	5	42
	SANTA ROSA	4	3	5	2	2	3	2	3	2	5	5	38
	CHIRRIPO	5	3	2	3	3	3	2	4	1	4	5	35
	TORTUGUERO	4	3	1	1	5	4	1	4	2	5	5	35
	LA AMISTAD	5	2	2	2	4	5	1	3	1	4	5	34
	ISLA DEL COCO	5	5	1	0	5	3	1	1	1	5	5	32
	RINCON DE LA VIEJA	4	3	2	1	3	5	1	3	1	4	4	31
	MANUEL ANTONIO	1	2	4	3	2	3	2	3	3	4	3	30
	VOLCAN IRAZU	2	4	4	2	1	2	3	2	3	2	4	29
	CAHUITA	1	2	4	3	2	3	2	3	3	2	3	28
	PALO VERDE	3	3	2	1	4	2	1	2	3	2	3	28
	BARRA HONDA	2	2	2	1	1	3	1	2	2	4	5	25
FOREST RESERVE	TENORIO	5	5	3	1	4	3	1	2	1	4	5	34
	RIO MACHO	5	4	5	1	4	3	1	2	1	3	5	34
	MIRAVALLES	5	4	4	1	4	3	1	2	1	4	4	33
	LOS SANTOS	5	4	4	3	2	3	1	2	1	3	4	32
	OROSI	5	3	2	1	4	3	1	2	1	4	4	30
	CORD. VOLC. CENTRAL	5	3	4	2	2	3	1	1	1	3	4	29
	GOLFO DULCE	5	1	2	3	2	3	1	3	1	3	5	29
	ARENAL	5	2	4	1	2	2	1	3	1	3	4	28
	SAN RAMON	2	3	5	3	2	1	1	2	1	2	5	28
	J.C. BLANCO	4	3	3	1	3	3	2	3	1	2	3	28
	GRECIA	1	2	4	2	2	3	1	2	3	3	3	26
	TABOGA	1	1	4	-	5	3	1	2	1	3	3	24
	MATINA	1	1	1	-	1	2	1	1	1	0	0	9
INDIAN RESERVE	UJARRAS-SALITRE-C.	5	5	4	1	4	2	1	2	1	4	4	33
	BORUCA-TERRABA	5	5	5	1	3	2	1	2	1	4	4	33
	CHIRRIPO	5	4	3	1	4	2	1	2	1	4	4	31
	TAYNI	4	4	1	1	4	2	1	2	1	4	4	28
	COTO BRUS	3	4	4	1	3	2	1	2	1	3	4	28
	G.A. MOCTEZUMA	4	2	5	1	3	2	1	2	1	3	4	28
	GUATUSO	3	3	3	1	4	2	1	2	1	4	3	27
	TALAMANCA	5	3	2	1	3	2	1	2	1	2	5	27
	TELIRE	3	2	1	1	4	2	1	2	1	4	4	25
	CONTE BURICA	3	2	3	1	3	2	1	2	1	3	4	25
	COCLES	2	2	3	1	4	2	1	2	1	3	3	24
	MATAMBU	2	1	4	1	3	2	1	2	1	3	3	23
	ZAPATON	2	2	3	1	3	2	1	2	1	3	3	23
	QUITIRRISI	1	2	4	1	3	2	1	2	1	3	2	22
BIOLOGICAL RESERVE	LA SELVA	2	2	5	5	5	5	5	3	5	5	3	43
	MONTEVERDE	2	2	4	2	5	5	5	4	4	5	4	42
	LAS CRUCES	2	2	4	2	5	5	3	4	3	5	3	38
	ISLA DEL CANO	1	2	1	1	5	5	2	3	1	5	4	30
	CARARA	2	1	5	2	4	4	1	3	1	2	3	28
	CABO BLANCO	1	1	1	2	4	4	2	3	1	3	4	28
	HITOY	4	2	1	1	2	4	2	3	1	5	3	28
	I. GUAYABO	1	2	1	0	5	5	1	2	1	5	4	27
	I. NEGRITOS	1	2	1	0	3	5	1	2	1	5	4	27
	I. PAJAROS	1	2	1	0	5	5	1	2	1	5	4	27
PROTECTION ZONE (Water production)	BARBILLA	5	5	2	-	4	3	1	3	1	3	5	32
	LAS TABLAS	5	3	3	1	3	2	2	2	1	2	3	27
	LA SELVA	3	2	3	1	3	2	2	3	1	2	4	26
	ATENAS	1	1	4	3	2	3	3	1	1	2	1	22
	EL ROBLE	2	1	5	1	2	1	2	2	1	3	2	22
	C. ESCAZU	2	2	2	1	2	2	2	2	1	2	3	21
	CARAIGRES	2	2	3	1	2	2	2	2	1	2	2	21
	LA CARPINTERA	2	1	3	1	2	2	2	2	1	2	2	20
	TIRISI	1	1	3	1	3	2	2	2	1	2	1	19
	RIO GRANDE	2	2	3	1	2	1	2	1	1	2	1	18
WR	R.L. RODRIGUEZ C.	3	2	4	3	2	3	1	3	3	3	4	31
	TAPANTI	3	2	5	1	4	3	1	2	2	3	3	30
	ISLA BOLAÑOS	2	1	1	1	5	3	1	3	1	2	4	27
NM	GUAYABO	3	2	3	3	4	3	2	3	3	4	5	35
NRA	SANTA ANA	1	1	5	5	5	5	3	3	-	-	-	25

BR: Biosphere Reserve. WR: Wildlife Refuge. NM: National Monument. NRA: National Recreation Area.

FIGURE 12 : INTRINSIC VALUE OF PROTECTED WILD AREAS OF COSTA RICA

MANAGEMENT CATEGORY	AREA	REPRESENTATION OF ECOSYSTEMS AND OTHERS FEATURES	POTENCIAL USE	EXISTING USE	ADMINISTRATIVE AND INSTITUTIONAL FACTORS	TOTAL
BR	LA AMISTAD-TALAMANCA	46	40	20	35	141
NATIONAL PARK	CHACHAGO	43	23	10	42	118
	BRAULIO CARRILLO	28	25	5	42	100
	SANTA ROSA	29	19	15	36	99
	VOLCAN POAS	24	22	10	43	99
	TORTUGUERO	29	24	10	35	98
	RINCON DE LA VIEJA	28	23	10	31	92
	CHIRRIPO	27	25	0	35	87
	CAHUITA	26	17	10	28	81
	LA AMISTAD	34	25	-15	34	78
	PALO VERDE	25	18	5	28	76
	MANUEL ANTONIO	26	18	0	30	74
	IRAZU	20	21	0	29	70
	ISLA DEL COCO	15	22	0	32	69
	BARRA HONDA	12	20	-5	25	52
FOREST RESERVE	GOLFO DULCE	43	40	10	29	122
	RIO MACHO	27	40	10	34	111
	TENORIO	33	38	0	34	105
	CORDILLERA VOLCANICA CENTRAL	33	43	0	23	105
	SAN RAMON	21	32	20	28	101
	OROSI	22	37	10	30	99
	MIRAMALLES	28	32	0	33	93
	ARENAL	22	39	0	28	89
	LOS SANTOS	30	30	-5	32	87
	JUAN CASTRO BLANCO	22	28	0	28	78
	TABOGA	13	17	10	24	64
	GRECIA	18	21	-5	26	60
	MATINA	19	19	-20	9	27
INDIAN RESERVE	TALAMANCA	32	35	25	27	119
	UMARRAS-SALITRE-CABAGRA	28	32	5	33	98
	GUAYMI CONTE BURICA	21	24	20	25	90
	BORUCA-TERRABA	20	32	5	33	90
	COCLES	25	25	15	24	89
	CHIRRIPO	28	33	-5	31	87
	GUATUSO	17	27	15	27	86
	COTO BRUS	16	29	0	28	73
	MATAMBU	12	22	15	23	72
	QUITIRRISI	11	22	15	22	70
	TAYNI	17	28	-5	28	68
	TELIRE	20	28	-5	25	68
	GUAYMI ABROJOS DE MOCTEZUMA	10	20	0	28	58
	ZAPATON	13	19	-5	23	50
BIOLOGICAL RESERVE	MONTEVERDE	19	16	15	42	92
	LA SELVA	17	16	15	43	91
	LAS CRUCES	15	11	10	38	75
	ISLA DEL CAÑO	14	12	5	30	61
	CARARA	22	19	-10	28	59
	HITOY	19	19	-10	28	55
	ISLA PAJAROS	11	13	5	27	56
	ISLA GUAYABO	12	11	5	27	55
	ISLA NEGRITOS	11	12	5	27	55
	CABO BLANCO	18	14	-10	28	50
PROTECTION ZONE	BARBILLA	23	37	0	32	92
	LA SELVA	16	31	0	26	73
	LAS TABLAS	24	26	-5	27	72
	CERROS DE ESCAZU	16	27	-15	21	49
	LA CARPINTERA	16	23	-10	20	49
	EL RODEO	15	22	-10	22	49
	CARAIGRES	18	22	-15	21	46
	ATENAS	12	16	-5	22	45
	RIO GRANDE	15	15	-15	18	37
	TIRIBI	9	15	-15	19	28
WR	RAFAEL LUCAS RODRIGUEZ CABALLERO	25	15	0	31	71
	TAPANTI	17	15	-10	30	56
	ISLA BOLAÑOS	12	9	5	27	53
NM	GUAYABO	9	18	0	33	62
NRA	SANTA ANA	6	10	5	26	49

BR: Biosphere Reserve. WR : Wildlife Refuge. NM : National Monument. NRA : National Protection Area.

FIGURE 13 : ECOSYSTEM AND PHYSIOGRAPHIC REPRESENTATION IN POTENCIAL BIOSPHERE RESERVES IN COSTA RICA.

Key:
1. Insignificant.
2. Regular.
3. Good.
4. Very Good.
5. Excellent.

BIOGEOGRAPHIC REGION	BIOGEOGRAPHIC PROVINCE	POTENTIAL BIOSPHERE RESERVE	PHYSIOGRAPHIC REGIONS																			TERRESTRIAL LIFE ZONES										AQUATIC ECOSYSTEMS			MARINE-COASTAL ECOSYSTEMS						TOTAL
			Pacific littoral	Atlantic littoral	Islands	Talamanca Mountain Range	Central Mountain Range	Guanacaste Mountain Range	Central Valley	Guanacaste Plains	Nicoya Peninsula	Candelaria Hills	Parrita Valley	Coastal Range	General Valley	Osa and Burica Peninsula	Diquis Valley	Cote Colorado Valley	Northern Atlantic Plains	Southern Atlantic Coastal Belt	Tropical Dry Forest	Tropical Moist Forest	Tropical Very Moist Forest	Premontane Moist Forest	Premontane Very Moist Forest	Premontane Wet Forest	Low Montane Moist Forest	Low Montane Very Moist Forest	Low Montane Wet Forest	Montane Very Moist Forest	Montane Wet Forest	Subalpine Wet Paramo	Lakes - Lagoons	Rivers	Freshwater Swamps	Rocky Pacific Coasts	Rocky Atlantic Coasts	Estuaries and Mangroves	Sandy Pacific Beaches	Sandy Atlantic Beaches	Coral Reefs	Coastal Islands	
Neotropical	Central American	Península de Osa y Burica	5											4		5	3	3				4	5		5	5			1			3	3	3	5		3	4			2	63
		Guanacaste	4					5		3									3		5	3	4	3	4	4			4				3		3	3		2	2				55
		Cordillera Volcánica Central					5												4				5		1	5		4	5	5	4		3	4	3							48
		La Amistad - Talamanca				5														3		3	4		4		4		5		5	5	3	5								46
		Nicoya	2		3					4	3										5	2		2								2	3	4	3		4			4	41

FIGURE 14 : POTENTIALITY OF BIOSPHERE RESERVES, COSTA RICA.

Key:
1: Insignificant
2: Regular
3: Good
4: Very Good
5: Excellent

BIOGEOGRAPHIC REGION	BIOGEOGRAPHIC PROVINCE	POTENTIAL BIOSPHERE RESERVES	USES, GOODS AND SERVICES													TOTAL POINTS
			ECOSYSTEM PROTECTION	BASIC RESEARCH	APPLIED RESEARCH	MONITORING	EDUCATION	TRAINING	RECREATION AND TOURISM	AGRICULTURAL PRODUCTION	FORESTRY PRODUCTION	LIVESTOCK PRODUCTION	USEFULNESS AS A DEVELOPMENT MODEL	CULTURES IN HARMONY WITH ENVIRONMENT	RESTORATION POSSIBILITIES	
Neotropical	Central American	Cordillera Volcánica Central	5	5	5	5	5	5	5	4	3	3	5	1	3	54
		La Amistad - Talamanca	5	5	4	5	4	5	4	3	4	2	4	5	1	51
		Peninsulcs de Osa y Burica	5	5	5	5	3	4	3	2	4	3	3	5	3	50
		Guanacaste	4	5	4	5	4	4	4	2	3	4	3	2	2	46
		Nicoya	3	3	4	4	3	2	2	3	1	2	2	1	3	33

FIGURE 15 : ADMINISTRATIVE AND INSTITUTIONAL FACTORS FOR POTENTIAL BIOSPHERE RESERVES, COSTA RICA.

Key:
5: Positive
0: Neutral
-5: Negative

BIOGEOGRAPHIC REGION	BIOGEOGRAPHIC PROVINCE	POTENCIAL BIOSPHERE RESERVES	ADMINISTRATIVE FACTORS ⊙				LEGAL FACTORS		INSTITUTIONAL FACTORS					PROTECTION DEMANDS			
			SIZE	SHAPE	ACCESSIBILITY	AVAILABILITY AND CAPABILITY OF PERSONNEL	LAND TENURE	LEGISLATION	FINANCING	POLICY	DEGREE OF KNOWLEDGE OF AREA	INTERINSTITUTIONAL COOPERATION	POSSIBILITIES OF INTEGRATED MANAGEMENT	EXISTING USE	ALTERNATIVE USES TRENDS AND PROJECTS	REPETITION OF REPRESENTED FEATURES	TOTAL
NEOTROPICAL	CENTRAL AMERICAN	La Amistad-Talamanca	5	5	-5	-5	5	5	5	5	-5	-5	5	5	5	5	30
		Cordillera Volcánica Central	5	5	0	5	-5	0	5	0	0	5	5	-5	-5	5	20
		Penínsulas de Osa y Burica	5	-5	-5	5	5	0	-5	5	5	-5	5	-5	5	5	10
		Guanacaste	5	-5	0	-5	5	0	-5	0	-5	-5	0	-5	5	5	10
		Nicoya	0	0	5	-5	-5	0	-5	0	-5	-5	0	-5	5	0	-20

⊙ Ease of administration.

FIGURE 16 : INTRINSIC VALUE OF POTENTIAL BIOSPHERE RESERVES, COSTA RICA.

BIOGEOGRAPHIC REGION	BIOGEOGRAPHIC PROVINCE	POTENTIAL BIOSPHERE RESERVE	REPRESENTATIVENESS	POTENTIALITY: USES, GOODS AND SERVICES	ADMINISTRATIVE AND INSTITUTIONAL FACTORS	GRAND TOTAL	PRICRITY
Neotropical	Central American	La Amistad-Talamanca	46	50	30	126	1
		Peninsulcs de Oso y Burica	63	50	10	123	2
		Cordillera Volcánico Central	48	54	20	122	3
		Guanacaste	55	46	10	111	4
		Nicoya	41	33	-20	54	5


LAKE NICARAGUA
NICARAGUA
CARIBBEAN SEA
PACIFIC OCEAN
KEY:
BIOSPHERE RESERVE:
1. GUANACASTE
2. CORDILLERA VOLCANICA CENTRAL
3. LA AMISTAD-TALAMANCA
4. PENINSULAS DE OSA Y BURICA
PACIFIC OCEAN
Cocos Island
FIGURE 17
-COSTA RICA-
PROPOSED NATIONAL SUBSYSTEM OF BIOSPHERE RESERVES
PREPARED BY: Miguel Cifuentes
DRAFTING: Hélmer Morales
Lucio Rodrigues
MAY, 1989

FIGURE 18 : ACTION PRIORITIES FOR THE NATIONAL SUBSYSTEM OF BIOSPHERE RESERVES, COSTA RICA.

Key:
1. Urgent and immediate.
2. Not urgent but requires attention in the short-term
3. Requires attention in medium-term.
4. Requires attention eventually or in the long-term.

PROPOSED BIOSPHERE RESERVE	LEGISLATION AND POLICY	LAND TENURE AND ACQUISITION	MANAGEMENT AND ADMINISTRATION	TRAINING OF PERSONNEL	MANAGEMENT PLANNING	PUBLIC EDUCATION AND PARTICIPATION	RESEARCH AND MONITORING	RESOURCE UTILIZATION	OPERATION AND MAINTENANCE
La Amistad - Talamanca	1	2	1	1	1	2	3	1	2
Cordillera Volcánica Central	2	1	3	1	2	1	3	3	3
Guanacaste	3	3	3	1	3	2	4	4	3
Peninsulas de Osa y Burica	1	2	2	1	1	2	3	2	2

FIGURE 19 : EXISTING USE IN THE PROTECTED WILD AREAS OF ... (Country).

Key: 5 : Adequate 0 : Non-existent -5 : Inadequate	USES, GOODS AND SERVICES																
EXISTING AND PROPOSED PROTECTED AREAS	Forests in areas appropriate for the same.	Agriculture in areas appropriate for the same.	Livestock in areas appropriate for the same.	Forests in areas appropriate for agriculture.	Forests in areas appropriate for livestock.	Agriculture in areas appropriate for forests.	Agriculture in areas appropriate for livestock.	Livestock in areas appropriate for forests.	Livestock in areas appropriate for agriculture.	Timber extraction in protection forests.	Timber extraction in production forests.	Protection of ecosystems and features.	Research and monitoring.	Education.	Recreation and tourism.	Extraction of wild animal and plant products (terrestrial or aquatic) in areas with inappropriate practices.	Extraction of wild animal and plant products (terrestrial or aquatic) in areas with appropriate practices.	Others.	Total.
Management Category / Area																			

SCIENTIFIC PRINCIPLES OF DESIGNING A SYSTEM OF NATURE RESERVES IN BYELORUSSIAN SSR

By

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ABSTRACT. Theoretical foundations are presented for designing a system of nature reserves in Byelorussian SSR using the landscape-ecological approach and the principle of conservation-migration river beds. A means is proposed for determining an ecologically balanced relationship between natural, disturbed and cultural landscapes on the basis of the creation of a single spatially continuous system of nature reserves and protected areas by combining them in the original conservation-migration river beds called upon to promote the preservation and rehabilitation of the matter-energy and system-information relationships between the disjunct ecosystems of different ranks and types which form the natural-anthropogenic supersystem of the Republic. The proposed approach is most effective from the point of view of the general theory of systems, information theory, ecology and population genetics. It is also economically feasible.

1. INTRODUCTION

Protecting natural ecosystems requires a new approach that would combine the development of the national economy with the conservation of nature. It should be noted that the sucess of any approach depends on the extent to which the objective laws of natural processes have been taken into account. It is therefore expedient to touch upon some peculiarities of natural ecosystems, their structure and functioning which influence the choice of a successful solution of this problem.

The enormous diversity of living organisms in nature is an indispensable condition of their development, the material that provides the scope for natural selection, and a demonstration of discreteness and continuity of the organic world where all things are interrelated both with one another and with the external abiotic factors. By virtue of the enormous genetic heterogeneity, the species are inexhaustible, like atoms, and are not completely cognizable. Therefore, not only species as systems of populations, but also individual populations cannot be restored even theoretically.

Species as complex biological systems consisting of specific populations have formed in the process of prolonged evolution under certain ecological conditions, and they have become maximally adapted exactly to these conditions. Thus, species as stages of evolution can only be preserved by protecting their habitats, in particular, the coenoses whose components they are.

Hence it follows that the conservation of the entire existing diversity of biogeoconoses -- not only of natural, but also of natural-anthropogenic origin -- is of paramount importance. True, at the present time it is difficult and some times impossible to determine what was formed without man's interference and what was influenced to a certain extent by anthropogenic factors. However, the point is that it is necessary to preserve, if possible, the entire diversity of ecotopes and living organisms inhabiting them in order to

maintain the matter-energy and system-informatiom relations of these components and elements, i.e. the ecological balance in the natural-anthropogenic supersystem.

Proceeding from the history of the formation, the current status and trends of changes in flora and phytocoenoses, fauna and zoocoenoses, it is possible to map out ways for their protection. Relict species, on the one hand, and species well adapted to the present ecological conditions, on the other, should not be treated in the same way. The variety of species and their coenoses existing within specific physical regions should not be regarded as an indispensable condition of normal functioning of the ecosystems. If the biocoenose were left to their own resources, the result would be a reduction in the species diversity and the set of coenoses, degradation and disappearance of most relict species as a result of the natural influence of more competitive species. If the biogeocoenoses reached the climax phase, this would result in a decrease in their productivity, especially in pine forests.

As ecosystems evolve, they become more resistant to possible impacts that would destroy their structure and integrity. The flexibility of ecosystems depends on the ability of some species or subsystems to be replaced by other species performing similar functions. As a result, the existing energy-information relations are preserved and the ecological balance is maintained. A decrease in the flexibility of species replacements leads to a gradual decrease in adaptability to changing conditions. Therefore, strategies limiting space-time changes should be called in question even though they are aimed at environmental improvement. Thus, it may be concluded that the preservation of natural development trends of biogeocoenoses without anthropogenic interference is appropriate for maintaining examples of as intact nature, but there is no need, from both scientific and practical points of view, for territories with strict protection regimes to occupy large areas. The impact of man in temporate regions historically contributed to the creation of a greater diversity of ecotopes and, accordingly, favoured an increase in species diversity. Taking this into account, the diversity of the organic world must be preserved by protecting both the ecosystems which were formed naturally and the ecosystems which are a consequence of the prolonged effects of various anthropogenic factors (hay making, pasturage, felling, burning, out, extensive drainage a melioration, etc.).

However, in the last decades, the negative side of the anthropogenic effects is becoming increasingly stronger. These effects cause radical transformation of the ecological situation (reduction of water supply of large territories, homegenization of ecotopes, etc.). At the same time, the structure of the natural-historical ecosystems with their own internal and external relations is isolated, degraded and destroyed; in particular, differentiation and isolation of individual populations take place leading to the loss of genetic relations and direct elimination of coenotic populations. Moreover, the surviving isolated populations which are below the critical level are also doomed to extinction, since their variability is reduced to a minimum, which results in rapid depletion of the ability of natural selection to raise the level of adaptability of genotypes. In the majority of cases, it is impossible to preserve small populations on limited areas since their genetic fate is predetermined (Metler and Gregg, 1972).

Diamond (1975) points out that the number of species stably preserved in a reservation is a function of the size of the protected area and the degree of its isolation from similar habitats. The species diversity preserved within an area located amid disturbed nature will decrease until it is balanced with the number of species outside it; the smaller the area of the reservation, the faster the disappearance of the species. This is one of the basic principles of protecting the organic world.

A more general principle of ecosystems is as follows: the more complicated the ecosystem, the more stable it is; to maintain the ecosystem's reliability, it is necessary to preserve both a definite level of diversity of living organisms and other (abiotic) medium-forming components. A decrease in the number of species of the ecosystem results in a decrease in its resistence (Gorchakovsky, 1979).

Of particular importance is the nature of the following reactions of ecosystems to the external influences:

a) a change in one variable (in particular, the size of the population) may have an unexpected effect on the other variables in the same locality and, as a result of certain relations, in other localities;

b) small effects in one locality may entail great consequences in other localities, even those situated at a long distance; and

c) the consequences of the effect may arise immediately or suddenly some time after the interference.

It follows from the above that the key problem of protecting natural complexes is the preservation, as far as possible, of the existing internal heterogeneity and complexity of the ecosystem. The natural balance in nature can only be achieved when the ecosystems of all levels are protected as a single natural complex. Therefore, the protected areas must be sufficient to maintain the ecological balance and the potential for self-recovery of the entire natural-anthropogenic supersystem.

Thus, joining up of all the conservation districts having a sufficiently large total area into a single, spatially continous system preserving the entire diversity of species, populations and groups is the most effective way of controlling balanced development of a natural-anthropogenic complex. In Byelorussia, as an intensively managed land, this will make it possible to provide the recovery of disturbed relations between species populations of plants and animals in different protected areas. To achieve this, the creation of a single optimized network of nature reserves of different functional purposes is needed.

It is expedient to include in the list of natural reserves not only the least disturbed areas, but also those which have been destroyed to a significant extent, with the purpose of self-recovery or man-aided re-creation of ecosystems similar to previously existing ones if they are particularly important for maintaining the ecological balance (upper reaches, estuaries and valleys of big and small rivers, huge tracts of marshland, etc.) and if the integrity of the system of nature reserves depends on them.

Based on these principles a cartographic model of a single network of nature reserves has been created using a part of Byelorussia which includes, the Berzinsky Biosphere Reserve. The possibility of maintaining the natural dynamics of flora and fauna (migration of species and their complexes), the population-genetic processes, the preservation of the natural species distribution and the restricted locations of rare plants and animals is realized by combining the natural migratory riverbeds with the belts of maximum concentration of the species distribution and with the rivers along which the majority of plant and animal species migrate.

Such conservation-migration river-beds must be formed from the existing and prospective protected areas, little-developed or underdeveloped tracts of forests, meadows, marshes, and other terrain covered with natural vegetation and water areas, water-conservation forests on the banks of the rivers and

reservoirs, green zones of human settlements, recreational forests, sanitary protection zones of health-resorts and water supply sources, recreation zones, shelter belts along the roads, and other natural territories.

The total area of different nature reserves will make up 10.5 percent of the territory of Byelorussia (at the present time 4.3 percent of the BSSR territory is being protected), and, combined with the protection zones and green shelter belts, it will make up not less than 25 percent --the vitally important minimum of the conservation and other interests of the Republic. In particular, this will make it possible to attain in the nature reserves sufficient representativeness of different types of natural landscapes, flora and fauna in different physical regions of Byelorussia, and to preserve the habitats of the majority of rare and endangered species.

The creation of a single system of nature reserves for the purpose of optimizing the ecological situation in the social-economic complex of Byelorussia is a necessary condition of preserving the zonal and regional peculiarity of the natural ecosystems and successful development of productive forces of the Republic.

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OBJECTIVES FOR MANAGING BIOSPHERE RESERVES: THE PERUVIAN EXAMPLE

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ABSTRACT. Information is presented about the conception and evolution of the systems of management of the natural areas of Peru and their relation with biosphere reserves. The process for the establishment of protected areas including biosphere reserves, which includes the determination of objectives, is briefly described. The participation of local and regional organizations promoting socio-economic development in the management of biosphere reserves, is shown to be particularly important. There is some difficulty caused by the word "reserve", which has a connotation of protectionism and of setting apart in relation to projects of integrated rural development. Finally, providing information and education to the local and regional authorities about the concept and practice of biosphere reserves is proposed.

1. INTRODUCTION

In Peru two categories are recognized for the management of natural areas with strict protection: National Parks, and National Sanctuaries or Reserves. According to law, these two categories plus the national reserves and historic sanctuaries form the "National System of Units of Conservation", the present concept of which is the result of the evolution of similar systems in other parts of the world, interpreted and adapted to Peruvian requirements.

National reserves are areas managed by the Government to conserve fauna of economic interest, acting in the protection of the living communities (e.g. Pampa Galeras National Vicuña Reserve).

Historic sanctuaries are areas managed by the Government to conserve the landscape where events important in the evolution of culture occurred, the enjoyment of which by the people is considered to be a means to reinforce national identity (e.g. Machu Picchu Historic Sanctuary).

Other natural areas defined by law, include national forests, communal reserves, hunting areas and protection forests (see annex).

Table 1 shows the situation of the natural protected areas in Peru, as of July 1983. The total area under various systems of protection is 10,714,993 ha, which represents 8.34% of the total area of the country. In Table 2, details of the national system of units of conservation is presented, as established by the Regulations of Units of Conservation (1977) of the Forest and Wild Fauna Law (1975).

As a result to the movement generated by Unesco, starting in November 1971, the National Administration of Protected Areas, of the Department of Forests and Fauna of the Ministry of Agriculture, proposed the recognition of three biosphere reserves, taking into account that each of them includes a national park as its "core area". In 1977, Unesco recognized the Peruvian proposal, the details of which are presented in Table 3.

2. THE ESTABLISHMENT OF OBJECTIVES

A brief description of the process by which the units of conservation are established in Peru will illustrate how their objectives are elaborated.

In the early years of protected area administration in Peru, between 1965 and 1967, a general inventory was made of the areas that could be included in the national system. The recommendations of the inventory oriented corresponding policies and guided the establishment of the 19 units that exist today under this system.

For each of the units, with the exception of the first two national parks (Cutervo and Tingo Maria), detailed inventories have been taken of both natural and cultural resources, in order to allow a preliminary delimiation. The analysis of boundaries has facilitated the presentation of final proposals for each case.

It is easy to understand, for a developing country like Peru, that the analysis of boundaries continually becomes more important for developing pragmatic proposals, in order to minimize interference caused by socio-economic development in its traditional concept. It can be stated here that the next three units to be established (the Abiseo National Park, El Condor Range National Sanctuary and a national sanctuary east of the Maranon) are the results of a minute analysis of possible conflicts.

The natural and cultural environment in and around the unit to be established determines the selection and priorities of the objectives. It must be noted that according to law all objectives are subordinated to the fundamental purpose of the system, which is the conservation of representative samples of ecosystems. Nevertheless, for a localized strategy, this basic objective could not be accorded first place in the list of objectives.

This planning sequence has resulted in an official document called "Technical Report for the Establishment of Unit ...". An idea of the organization and content of such a document may be seen from that which was presented for the declaration of the Titicaca National Reserve, which reads as follows:

"Technical report for the establishment of the Titicaca National Reserve (Puno).

I. National reference framework
   1.1. The National System of Units of Conservation
   1.2. Localization and regional information

II. Inventory of the Unit
   2.1. Description of the Area
   2.1.1. Physical characteristics
   2.1.2. Biological characteristics

III. Analysis of Limitations

   3.1. Accessibility
   3.2. Possession
   3.3. Human population
   3.4. Utilization of resources
   3.5. Agriculture, livestock breeding
   3.6. Trade and tourism

IV. Delimitation

V. Recommendations

VI. Annexes and Maps"

It should be repeated that this process is followed for all units of conservation. Moreover, even before making public the concept of a biosphere reserve, the Peruvian administration tried to bring together the different categories of management of natural areas in a region. For example, this was done with a national park and a national forest in the Manu River Basin, and a national forest and a hunting area in the range of the Amotapes. This policy was so appropriate that around these two complexes two of the three biosphere reserves that exist in Peru were established.

Two different attitudes about biosphere reserves were evident by the responsible authorities. Some sensed the true concept of the biosphere reserves as an instrument for regional development, which would also allow for the consolidation of units of conservation. Others interpreted the recognition of biosphere reserves simply as a mechanism for international support, which would facilitate the defense of national parks.

This lack of precision about the true character of the biosphere reserve delayed the establishment of their objectives for management until February 1980; three years after recognition by Unesco (1977).

A diagnosis of the situation of the three biosphere reserves recognized in Peru, as of February 1980, was made by a mission of the Intergovernment and Interdisciplinary Programme of the Man and the Biosphere Programme of Unesco, which acted in collaboration with the national committee for MAB, officially established in February 1974. The Peruvian component of this work was formed by highly qualified personnel from the following institutions:

-- National Planning Institute;
-- Natural History Museum of the Major University of San Marcos;
-- National Office for the Evaluation of Natural Resources;
-- General Direction of Forests and Fauna;
-- National Culture Institute;
-- Ministry of Industry, Tourism and Integration;
-- National Agriculture University - La Molina; and
-- Regional Development Organisms.

As a result management processes were developed as the bases of long-range objectives established for each of the three biosphere reserves:

1. To evaluate the natural, cultural, productive, socio-economic, etc., characteristics of the area of the biosphere reserve and its zone of influence;

2. To incorporate other areas that must be part of each of the reserve;

3. To proceed in regional development organisms in order to coordinate the activities of the different sectors of production and service;

4. To prepare Master Plans for each of the reserves; and

5. To elaborate, negotiate, and execute projects that allow the master plan to be implemented.

Among those objectives, and common to the three reserves, has been the need to encourage local and regional development organizations to participate in the concept and practice of the biosphere reserve.

Thus in Peru, there are different designations, institutionalized expressions of regional development that are quite similar in principle to biosphere reserve, or "integral rural settlement projects". This had made for certain difficulties in promoting the concept of "biosphere reserve" among authorities. To overcome these difficulties and succeed in employing biosphere reserves in projects of integral rural settlement use, it is necessary to carry out a constant information programme for a true understanding that "biosphere reserve" equals "integral rural development". If success is achieved in this last point, it would not matter much whether these areas are called Integral Rural Settlement Projects, or biosphere reserves.

Perhaps the selection of the name "biosphere reserve" has not been appropriate. In fact, the word "reserve" has a connotation of protection or of a prevention from use, which is difficult to accept in developing countries and has delayed quick and easy assimilation of the biosphere reserve concept by administrators.

3. CONCLUSION

It must be pointed out that it is not enough to establish objectives for each biosphere reserve, if effective management is to be attained. In Peru, it is necessary, with the present conditions that the Government and Unesco join efforts to stimulate local and regional authorities with enthusiasm for the purpose of making effective management for the recognized biosphere reserves.

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ANNEX: CATEGORIES OF PROTECTED AREAS IN PERU

NATIONAL FORESTS

Natural forests declared for the permanent production of timber, other forest products and wild fauna. Initially their use was exclusively reserved for the government. Nevertheless, by Article 85 of the Decree Law 22175 and later by Article 64 of the Law of Agrarian Promotion and Development, it was established that: "Exceptionally, when it is of national priority, the national forests may be used for industrial and/or commercial purposes by enterprises belonging to the government, of which have participation of the government, by means of non-transferrable contracts of forest exploitation, over areas of no less than 50,000 and no more than 200,000 ha, and for extendable periods of 20 years". Furthermore, "Contracts for forest exploitation for 20,000 to less than 50,000 ha may be granted without government participation".

FORESTS OF PROTECTION

Forests which because of their characteristics and location have the fundamental purpose of conserving soils and waters to protect farming land, transportation infrastructure, other infrastructure and towns, as well as to guarantee the supply of water for human, farming and industrial use.

NATIONAL PARKS

Areas for protection of natural associations of wild flora and fauna and the beauty of the landscape they contain.

NATIONAL RESERVES

Areas for protection and propagation of species of wild fauna, whose conservation is of national interest. The exploitation of their products is carried out by the government. When national reserves must be necessarily established in farming land, the Ministry of Agriculture will be able to authorize the exploitation of wild fauna to be carried out by the holders of said land, and will establish the limitations that make conservation and exploitation harmonious.

NATIONAL SANCTUARIES

Areas employed to protect a species or a determined community of plants or animals, as well as natural formations of scientific or landscape interest.

HISTORIC SANCTUARIES

Areas employed to protect the natural localities in which important events in national history took place.

COMMUNAL RESERVES

Areas in certain locations employed to conserve the wild fauna as a traditional source of food for the benefit of the surrounding towns.

HUNTING AREAS

Areas set aside in lands of public dominion or on private property for the purpose of hunting.

Table 1: Peru - Natural Protected Areas (July 1983)*

	Objective	Category	Number	Area Ha.
I	Strict protection	National parks	5	1,984,606
		National sanctuaries	3	113,424
II	Direct management of resources	National reserves	8	2,946,686
		National forests	6	5,514,102
		Hunting areas	2	120,783
		Communal reserves	-	-
III	Protection of Basins	Forests of protection	-	-
IV	Protection of historic sites	Historic sanctuaries	3	35,392
	Total			10,714,993

Biosphere reserves are not included separately, as these include some of the units considered under the different objectives.

Table 2: Protected areas in the national system of units of conservation (July 1983)

Units of Conservation	Area (ha)	Location (Departments)	Date of establishment
National Parks			
1. Manu	1,532,806	Madre de Dios and Cuzo	1973
2. Huascaran	340,000	Ancash	1975
3. Ceros de Amotapes	91,300	Tumbes and Piura	1975
4. Tingo Maria	18,000	Huanuco	1965
5. Cutervo	2,500	Cajamarca	1961
National Reserves			
1. Pacaya-Samiria	2,080,000	Loreto	1972
2. Salinas-Aguada Blanca	366,936	Arequipa	1979
3. Paracas [1]	335,000	Ica	1975
4. Calipuy	64,000	La Libertad	1981
5. Junin	53,000	Junin and Pasco	1974
6. Titicaca	36,180	Puno	1978
7. Pampa Galeras [2]	6,500	Ayacucho	1967
8. Lachay	5,070	Lima	1977
National Sanctuaries			
1. Huayllay	6,815	Pasco	1974
2. Calipuy	4,500	La Libertad	1981
3. Pampas de Heath	102,109	Madre de Dios	1983
Historic Sanctuaries			
1. Machu Picchu	32,592	Cuzco	1981
2. Chacamarca	2,500	Junin	1974
3. Pampas de Ayacucho	300	Ayacucho	1980
Total	5,080,108		

Source: General Direction of Forests and Fauna/Ministry of Agriculture

1: Including 217,594 ha of territorial sea, which has not been added in the national total.

2: Including approximately 75,000 ha which have not been indicated because, while protected, the exact legal status has not been defined.

Table 3: Peru - Biosphere Reserves and their Components

Biosphere Reserves	Conformation	Area (ha)	Date of Establishment
Northwest	NP Cerros de Amaotape	91,300	1977
	NF Tumbes	75,102	
	HA El Angolo	65,000	
	Total	231,402	
Huascaran	NP Huascaran	340,000	1977
	Surrounding areas	59,239	
	Total	399,239	
Manu	NP Manu	1,532,806	1977
	NF Manu	300,200	
	ZS Rio Alto Madre de Dios	48,194	
	Total	1,881,200	
	Grand Total	2,511,841	

Code: NP = National Park; NF = National Forest; HA = Hunting Area; ZS = Zone of Rural Settlement; R = Reserved Zone.

Note: The reserved zones are areas under transitory protection, especially for scientific research; at present there are four which cover an area of 274,736 ha. Erroneously, some authorities tend to afford them a permanent character. They should really be assimilated, after due study, into one of the categories of management recognized by law.

SITING CRITERIA FOR BIOSPHERE RESERVES

By

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ABSTRACT. At present there are no clear-cut criteria for selecting areas for biosphere reserves. At the same time, areas to be defined as biosphere reserves should reflect the state, functioning and dynamics of the biosphere. This paper discusses an approach based on selection of "global" characteristics of areas reflecting the specificity of individual regions and making it possible to successfully solve problems facing biosphere reserves. An analysis of cartographic information has shown that a "biosphere level" of environmental diversity, and of the diversity of species and ecosystems corresponds to the most significant boundaries of geographical features. In many cases these areas are useful for research because features under observation are within a wide range of environmental conditions. Areas located at the boundaries are optimum from the view point of organization of pollution monitoring as they make it feasible to control, in one point, the invasion of pollutants into air masses generating over various areas.

1. INTRODUCTION

The criteria for selecting biosphere reserves have been developed only in the most general form and therefore cannot verify a choice; it is suggested to locate biosphere reserves in regions having the most typical widespread ecosystems, as well as in conditions corresponding to natural boundaries, and in unique conditions.

At the same time we are confident that not every sucharea can meet the objectives of a biosphere reserve. It seems evident that those limited areas on our planet which we are going to define as "biosphere" ones should, to the greatest possible extent, take in fundamental characteristics reflecting the state, functioning and dynamics of the biosphere. Such an approach based on selection of "global characteristics" does not exclude -- on the contrary, requires -- development of regional approaches reflecting the specific qualities of individual regions.

2. SELECTING CENTRES OF DIVERSITY: THE CASE OF VAVILOV CENTRES

Such an interpretation of the problem is far from being new. At the beginning of this century, N.I. Vavilov carried out "an exhaustive collection of the basic world variety composition of cultivated plant species, and to map centres of the world diversity and centres of the formation of cultivated plants and their wild relatives...in order to elucidate the botanical and agricultural principles of selection" (Vavilov, 1930).

This work was based on a systematic-geographic method to determine centres of the maximum diversity of life forms, the maximum diversity of environmental conditions, and with land antiquity. It is quite clear that the maximum environmental diversity is likely to be in mountain areas situated close to the boundaries of climatic zones and, no doubt, they should be geologically fairly ancient mountain systems. Moreover, Vavilov argues that just mountain areas were the centres of cultivated agriculture.

The geographic principle of selecting potential centres of formation was fully confirmed in practice, and enabled the gathering, in a short while, enormous collections of varieties and races of cultivated plants and their wild relatives.

Thus, we have quite a reliable and tested technique for accomplishing the first objective of biosphere reserves -- protection of the world gene pool. Apparently highly diverse environmental conditions provide for the similar high diversity of ecosystems; moreover, historical analysis of the interaction between man and nature shows that it is here we come across the most diverse forms of this interaction and its consequences.

It is quite clear that in accordance with the criterion of the highest possible diversity of environmental conditions, biosphere reserves should be located within the boundaries of ecotones. Although any boundary increases the diversity, not all of them ensure the highest possible diversity. We may assume that the "biosphere level" of the diversity of species and ecosystems corresponds to the most significant boundaries of geographic differentiation of the planet.

3. USING CLIMATE AND GEOLOGY TO LOCATE BIOSPHERE RESERVES

Geographic differentiation of environmental conditions at a global level occurs, on the one hand, on account of the differentiation of air masses determining latitudinal climatic zones and reflecting specific features of the interaction between land and oceans -- the longitudal heterogeneity of moisture regimes. On the other hand, the lithoorographic heterogeneity of the land surface, affecting climate and ensuring geochemical diversity, is created by global tectonics which, in keeping with the theory of lithospheric flags, is of a relatively discrete nature and determines, in the long run, the evolution of the continents.

The above two factors (climatic and geological) are two independent bases to subdivide areas: the first determines its features to be typified comparatively easily; the second determines, individual features to be typified with some difficulty.

Within this system, regions at the biospshere level can be compared with the largest physical and geographic subdivisions of the continents -- provinces distinguished by identity of the geostructure (ancient flags, shields, orogenetic regions, etc.) determining the unity of their evolution, and by general features for the macrorelief (vast lowlands, plateaus, plains). According to the Physiogeographic Atlas of the World (1964), North America is subdivided into 13 provinces, South (Latin) America - 11, Africa - 8, Australia - 6, Eurasia (including the European subcontinent) - 45, the Asian part in the Arctic and Pacific Oceans - 16, the Asian part adjacent to the Indian Ocean - 11.

The planetary climatic differentiation is reflected, to a certain extent, on the map of biogeographic provinces by Udvardy (1975), yet their boundaries are outlined rather arbitrarily, and are poorly conjugated with specific influences of orographic structures on climate. The map of zonal types of natural landscapes, contained in the Physiogeographic Atlas of the World is much more detailed and precise. This map of geographic zones shows the most important typological regularities on. Thus, centres of the highest expected diversity of ecosystems and the gene pool, corresponding to bioshphere areas of international importance, should be within regions overlapping the boundaries of physical and geographic provinces.

To check the effectiveness of our hypothesis we have compared localities of existing reserves in the USSR and North America, in respect with the different geographic boundaries. Table I shows that the real network of reserve locations clearly reflects a general trend toward selecting for boundaries.

An important feature of these areas is their rather low value in the modern system of economic use. The high diversity of environmental conditions within a limited area and a combination of highly contrasting conditions require the use of complex technology in agriculture as well as in forestry, thus increasing the cost of production.

4. USING BIOSPHERE RESERVES TO ASSESS GLOBAL TRENDS

Let us see to what extent biosphere reserves situated at large geographic boundaries will be of use in solving other objectives established for such sites.

The purpose of scientific research in biosphere reserves can be considered as development of techniques to manage natural processes, populations, and ecosystems, thereby improving the effectiveness of use of natural resources and preservation of the optimum-for-man state of the environment.

The effectiveness of research in these directions is directly connnected with feasibility to observe features in different edaphic and climatic conditions and the specific interaction between different types of ecosystems within their boundaries. If environmental conditions are diverse, it is easy to organize observations ensuring the study of a feature in a wide range of conditions, thereby enhancing the theoretical significance of research findings.

One purpose of global monitoring is to establish the background level of technogenic pollution of the whole biosphere. Of no less importance is to observe possible changes in climate in order to predict and prevent in good time undesirable side effects.

Relatively poor economic development of the geographic boundary areas usually means a minor role of regional and local pollution; it is namely in these areas that we can evaluate the level of pollution which corresponds to the biosphere background transformed to a minimum degree by regional features.

The siting of biosphere reserves within mean statistical boundaries, between large baric structures, usually corresponding to the boundaries between climatic sectors and, accordingly, physical and geographic provinces and zones, makes it feasible to control, in one point, the invasion of technogenic products into air masses generating over various areas.

Since within their boundaries many species are beyond their ecological optimum, they inevitably possess a high sensitivity to changes in environmental conditions, including both climate as well as effects of technogenic products.

It is evident that the impact of climatic change will be registered primarily in the boundary conditions, where, depending on the situation, certain species gain priority and expand their range, the direction of succession shifts, spread of vegetation of one altitude zone over another will be observed, etc. Taken together, such obeservations being carried out in different biosphere reserves will make it possible to identify global trends. Similarly, one can suppose that, in conditions different from the ecologic optimum, individual species will respond to even relatively small background doses of atmosphere pollution.

So the siting of biosphere reserves at the boundaries of the highest biosphere level tallies considerably with the objectives of global environmental monitoring.

There can be no doubt that the same areas provide everything necessary for the training of skilled personnel and ecological education. In conditions of the highest environmental diversity it is much easier to demonstrate, on natural features, the fundamental ecological regularities, the use of different techniques and sophisticated methods to organize observations.

5. BIOSPHERE RESERVES IN HOMOGENEOUS ENVIRONMENTS

The number of biosphere areas distinguished by the formal criterion of crossing natural boundaries at the biosphere level is relatively small -- about 150. By using this criterion we leave out most homogeneous areas having predominantly widespread types of ecosystems -- these are mainly plains characteristic of maximum homogeneity, as well as of maximum intensity of economic use.

Regarding protection of the gene pool, plains areas with a homogenous soil and plant cover, as was shown far back by Vavilov, are usually of minor importance. At the same time being subject to intensive economic use of many centuries, these are the ecosystems that have become most transformed.

Therefore preservation of the most typical, once widely spread ecosystems, is a major problem of biosphere importance. This problem is also significant from the viewpoint of preserving samples of the natural functioning of the biosphere; the natural laws of the functioning of populations and ecosystems can be studied best exactly in these areas.

The need to organize biosphere reserves in homogenous environmental conditions (generally in central parts of regions with most widespread ecosystems typical of them) is also stipulated by the following additional considerations.

First, the global background pollution parameters and respective reactions by ecosystems can be effectively registered exactly in the "cores" of some regions, for example, the central area of the Siberian anticyclone where the meeting air flows pass over vast areas and involve thick layers of the atmosphere. Second, it should be taken into account that global trends of man-induced or natural changes in the functioning of biosphere ecosystems cannot be established only by extrapolation from changes in ecosystems in boundary conditions of their existence; as was mentioned, they have a higher sensitivity and their changes may turn out not to be universal.

6. CONCLUSIONS

Therefore, by creating biosphere reserves at the biosphere boundaries as well as in "cores" of large biosphere regions we ensure the fullest accomplishment of the objectives. It is important to make the sets of ecosystems under examination in reserves of both types as much as possible similar, as that would allow comparison of observations.

And finally, of particular biosphere importance can be unique areas with unique natural complexes such as river deltas, breeding places for waterfowl, geochemical anomalies, areas of intensive volcanic activity, etc. The functional significance of these biosphere reserves needs no comment.

These principles should be taken into consideration in selecting coastal, sea and island biosphere reserves as well.

It therefore seems necessary to organize three types of biosphere reserves with different functional purposes -- maximum diversity, maximum typicalness and maximum universality; these three types reflect the possible problems connected with the functioning of the biosphere at the global level.

Yet pratice, quite understandably, does not always conform to proposed concepts, and this nonconformity will reflect imperfection of the theory rather than drawbacks of human activities. Thus small nations may not have any areas meeting the biosphere status by the above criteria. At the same time MAB pursues the purpose to involve the highest possible number of member countries in the rational use of natural resources, and the "Biosphere Reserves" project within the Programme is a key one by any point. Therefore, it is logical for each country to transfer to the biosphere status those reserves which are characterized by the highest diversity of ecosystems and species or which have the highest value as homogenous or unique areas, even when they do not correspond at all to the above criteria.

On the other hand, the accomplishment of such important goals as scientific research and education requires a developed material and technical basis and communication. This cannot be realized in all the reserves meeting the rest of the criteria; on the contrary, some regional reserves located in the most industrially-developed areas have a developed material and technical basis and good transport accessibility. Taking into account the problems of education and international exchange of experience in research, this feature of a regional reserve will undoubtedly allow it to be defined as a biosphere reserve. For example, the Prioksko-Terrasny Reseve located at the boundary of edaphic and botanical subzones is of a low level (regional); and although the diversity of environmental conditions for typical species of the "Eastern European Plain" country is here relatively high it is certainly insignificant as compared with the corresponding characteristics of such a reserve as, for example, the Caucasian one.

At the same time a good material and technical basis, proximity to scientific centres, and accessibility allow with good reason to consider Prioksko-Terrasny as a biosphere reserve.

Therefore, we have to distinguish two more types of biosphere reserves - national, and scientific-educational centres.

Table 1

Distribution of USSR State Reserves, USA Biosphere Reserves, Biosphere Reserves and National Parks of Canada in respect to boundaries of natural zoning and to main types of ecosystems (in per cent - by the Physiogeographic Atlas of the World)

	USSR (144 RESERVES)	NORTH AMERICA (62 BIOSPHERE RES & NATIONAL PARKS
Islands	6	16.6
Littorals	19	22.6
Delta	2	3.2
Valleys	29	9.6
Banks of large lakes	9.7	9.6
Mountains	49	63
Plains	51	37
Boundaries	(+)5 (±)1.5	3.2
Boundaries of subzones	(+)9.7 (±)3.3	(+)1.6 (±)4.8
Boundaries of formation classes	37	29
Boundaries of formation	57	45
Beyond Geobotanical boundaries	40.7	42
Boundaries of floristic areas	0	(+)0 (±)1.6
Boundaries of floristic regions	(+)10 (±)11	(+)6.4 (±)33.9
Boundaries of floristic provinces	(+)18 (±)12.5	(+)6.4 (±)3.2
Beyond floristic boundaries	45	50
Boundaries of physical and geographic countries	(+)15.3 (±)23.6	(+)19 (±)29
Boundaries of physical and geographic regions	(+)11 (±)21	(+)14.5 (±)16.2
Boundaries of physical and geographic sub-regions	(+)4.8 (±)7	8.1
Beyond physical and geographical boundaries	34	24
Boundaries of climatic zones	(+)12.5 (±)18.7	(+)8 (±)12.9
Boundaries of climatic regions	(+)11 (±)21	(+)19 (±)23
Beyond climatic boundaries	48.6	43.5

Note: (+) - siting at a boundary. (±) - siting in immediate proximity to a boundary

LEGISLATION FOR BIOSPHERE RESERVES: THE INDIAN EXPERIENCE

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ABSTRACT. Recognizing the special needs of biosphere reserves, India has made pioneering efforts to develop legislation specifically for biosphere reserves. This paper traces the development of the Indian experience and highlights major elements of the resulting draft legislation that India currently has under consideration. The paper provides suggestions for other countries deliberating the question of long-term legal protection for biosphere reserves.

1. INTRODUCTION

The MAB Programme (Task Force Report No. 8) stresses that a biosphere reserve "must have adequate long-term legal protection." MAB Task Force Report No. 22 reaffirms this principle: "In order to establish biosphere reserves, it will be necessary for individual countries participating in the programme to ensure that they have a suitable legal framework within which the necessary controls on land use can be implemented".

Little guidance has been provided, however, on fundamental elements important for achieving adequate legal protection for biosphere reserves. The MAB programme does not require protection in law for areas to be included by Unesco in the worldwide biosphere reserve network. IUCN (1979), urged that "it is probably better, in general, that there should not be new legislation specifically for biosphere reserves".

Thus the common practice from the programme's beginning was to incorporate biosphere reserves within existing regimes, though reserves were created in some countries without any formal status. Because the biosphere reserves usually coincided with or incorporated existing protected areas, they were usually established by administrative decree and incorporated within the existing protected areas scheme.

This casual approach to legal protection has raised concern about the long-term survival of biosphere reserves as development pressures on all natural resources increase. Use of existing protected areas legislation may be unsatisfactory and inadequate to cover such key biosphere reserves features as;

1. the kinds of advanced management and zoning techniques required to achieve the objectives of conservation, research, education, and training in view of our expanding knowledge about;

2. achieving in situ long-term preservation of biological diversity, and;

3. overcoming the "island mentality" often associated with other types of protected areas by emphasizing interaction with surrounding land, people and institutions to enhance participation of and benefits to local populations.

Recognizing these special needs, India has made pioneering efforts to develop legislation specifically for biosphere reserves. This paper traces the development of the Indian experience and highlights major elements of the resulting draft legislation that India currently has under consideration. The paper provides suggestions for other countries deliberating the mechanisms to provide long-term legal protection for biosphere reserves.

2. FACTORS INFLUENCING DEVELOPMENT OF LEGISLATION IN INDIA

A number of environmental and institutional factors have contributed to India's interest in developing legislation for biosphere reserves.

2.1. A Rich and Varied Natural and Cultural Setting

By any criteria of selection India occupies an important position in the tropical world. This subcontinent is located where two biogeographical realms (the Palaearctic and the Indo-Malayan) meet, and where the Afrotropical Realm still has influence. India has overland connections with all three regions. Intense mixing of elements of the biota over time, particularly in sub-Himalayan India and in the outer Himalaya, has given India a rich variety of ecosystems and life forms. India has the tropical lowland rain forest of the Great Nicobar Island, the tropical hill evergreen forests of the Western Ghats and the Eastern Himalaya, the monsoon forests of Assam and North Bengal, the high elevation spruce and pine forests of the Western Himalaya, xerophytic scrub of Rajasthan, and the deltaic mangrove forests in the Sunderbans of West Bengal. Pristine coral reefs occur off the Andaman and Nicobar islands. The Kashmir stag, a close relative of the European red deer, survives in the Kashmir Valley and the chevrotain, a native Indo-Malayan species, occurs throughout peninsular India, while India is the exclusive home of the spotted deer. The richness of the bird life in India is exceptional compared with any other geographic region of similar size. India has a wide variety of tropical cash crops, particularly spices and medicinal plants, on which little plant breeding work has yet been done or germplasm collections made.

The human diversity and cultural complexity of the country is equally noteworthy. Some of the world's least known preagricultural tribes exist in the Western Ghats of South Indian and in the Andaman and Nicobar islands. Pastoral tribes can be found in the alpine meadows of the Western Himalaya, in the thorn deserts of Rajasthan, in the rocky wastelands of the Deccan and in the high cool plateau of the Nilgiris of South India. The country's ancient traditions and cultures have given birth to at least three major world religions. The deep-rooted belief in the sanctity of all life, ingrained in the country's religious practices and beliefs, produced such traditional controls on resource utilization as the designation of sacred groves and forests in such diverse places as Maharashtra, Kerala, and Meghalaya.

2.2. Expanded Legal and Institutional Base for Environmental Protection

With this rich background of natural and culture diversity, present-day India has assimilated those legal, administrative, and planning ideas of the West useful for its growth and development. The historical development of India's modern-day legal and policy framework for environmental matters might be viewed as beginning with India's first forest policy of 1894, followed by the Indian Forest Act of 1927. In the past decade activity has accelerated. A comprehensive Wildlife (Protection) Act was enacted in 1972 especially to protect game species and their habitats. Water pollution control legislation was enacted in 1974 and air pollution control legislation in 1981. In many of these fields State and local laws were also enacted to implement and reinforce national programmes.

As these resource sectors developed, India began to focus increasingly on the need for tools to manage each resource for its optimal long-term use as part of the overall natural system. The constitution was amended giving the Central Government concurrent jurisdiction with the states over matters related to forests and wildlife. By 1972 the Central Government had established a National Committee on Environmental Planning and Coordination (NCEPC) as a central body to advise on all environmental matters. In the same year the India Man and Biosphere (MAB) committee was formed under the NCEPC. In 1980 the Government of India created a high-level committee to recommend appropriate legislative and administrative measures to oversee the country's broad environmental concerns in development. Acting on the recommendations of this Committee, the government set up a Department of Environment under the Prime Minister in November 1980. In 1983 the Government established a National Water Resources Council, a National Land Board, and a National Land Resources Conservation and Development Commission.

During this period India also became interested in the international biosphere reserve concept as one tool to better integrate development and environmental goals. This interest grew as awareness increased about the expanding needs of the human population and growing scientific evidence about the potential for increased resource degradation from uncontrolled human use.

2.3. Institutional Attention to Biosphere Reserves

In 1979 a Core Advisory Committee was constituted to identify potential biosphere reserves. The special Committee report noted above recommended that the Department of Environment have direct administrative responsibility for conservation of designated biosphere reserves and that comprehensive legislation be formulated for the establishment and management of such reserves. The development of a Central cadre of scientific and managerial personnel for the implementation of the biosphere reserves programme was also recommended.

In order to identify potential reserve sites, the MAB Committee began the task of inventorying areas with specific characteristics. In 1981 it commissioned a detailed mapping of the vegetation types of the country to identify at least two representative areas for each type. The MAB Committee commissioned a number of reports on these areas, four of which were completed by mid-1983 covering the Western Himalaya, North-Eastern tropical forests and the southern Western Ghats. The MAB Committee continued work collecting scientific baseline data on the impacts of human activity in natural areas. Twelve initial sites were identified and potential candidates meeting the characteristics and objectives of biosphere reserves.

A review of existing legislation revealed that present machinery needed strengthening to cover the comprehensive concepts and activities envisaged for biosphere reserves. The Indian Department of the Environment invited an IUCN legal consultant to provide technical assistance. Two country visits were undertaken, one in 1981 to gather information and the second in 1982 to discuss a preliminary draft bill the consultant had prepared and IUCN had circulated for review.

3. BASIC PRINCIPLES IN INDIA'S DRAFT LEGISLATION

The approach taken for the Indian legislation was to focus on concepts for the principal act that would apply to all reserves; subsidiary legislation or regulations would be developed seperately to meet the particular needs of each reserve. Key aspects of possible interest to other countries are highlighted below.

3.1. Establishing Reserves

It was important to identify broad powers and procedures whereby a reserve site could be offically proposed and than finally declared. The draft bill adopts language from MAB/Unesco documents on the broad characteristics, objectives, and purposes which must be met for an an area to be established as a biosphere reserve. Because of India's federal character, alternatives to ensure an appropriate arrangement between the Central and state government for declaration and management of sites are still under consideration.

The legal status of a proposed site was considered a key factor for establishing a reserve. The Indian legislation sets out procedures for public notice of intent to establish, including notice of anticipated outer core and buffer boundaries, so rights affected by the action can be identified and addressed. Where certain rights must be limited, the draft specifies that existing laws or acquisitions shall be used and suggests a variety of means for compensation, including exchange for the affected rights for rights of similar or greater value outside the reserve.

3.2. Administrative Needs

It was important to outline in the principle legislation an administrative framework for implementation of the programme. The Indian approach incorporated recommendations of a biosphere reserves workshop conducted jointly by Indian and United States scientists and administrators in Bangalore in March 1982. Two seperate but connected mechanisms are envisioned:

a) A National Board for Biosphere Reserves with the authority and responsibility to develop policies, programmes, and plans to carry out all activities under the act; and

b) a Technical Advisory Committee for each designated biosphere reserve to provide assistance and advice on matters relating to the administration and management of the biosphere reserve for which it is constituted. Other necessary staff and technical advisory assistance are authorized.

3.3. Management

Management provisions in the legislation are of particular importance for an effective programme. The Indian legislation requires a management plan for each reserve, sets out the principal items (using the best information available) that should be included in any plan, and recognizes that different management needs may be required for different zones. The draft also designated general responsibilies for preparation, approval and update of the plan.

3.4. Regulated Activities

The Indian draft provides that all activities in a reserve shall be regulated or prohibited in a manner consistent with a management plan for the reserve. Again, a key element is the management plan and its stated objectives and purposes for the reserve. Permission is required for individuals other than biosphere reserve staff to conduct activities in the reserve for such functions as research, educational projects, special ceremonies, or recreation. The procedures for receiving permission are not specified in the principal act but are left to regulations. This approach allows flexibility depending upon the activity contemplated and purpose and condition of the reserve site.

3.5. Enforcement

Enforcement is one of the most serious problems for an effective biosphere reserves programme and as such probably will motivate increased attention to law. Growing economic constraints on governments will require the use of innovative and flexible enforcement tools to expand enforcement capacity and encourage self-enforcement. While enforcement provisions are largely determined by local practice, the Indian draft encourages flexibility. It uses a broad definition of authorized officer to include authorities other than police officers, such as wildlife or forestry officers, and distiguished local-level individuals that the biosphere reserve officials appoint. This approach encourages increased use of individuals who may be able to promote local support.

3.6. Financial Support

Two items have been incorporated in the Indian legislation that may have broad possibilities. First, the bill contains a separate provision that some fees from the reserve might be retained in a special fund (perhaps a "management" or "research" fund) specifically for reserve purposes. Second, the legislation specifies that private contributions designated for specific purposes or reserves may be used for those purposes or reserves.

3.7. Other Concerns: The use of environmental impact assessments

An important development planning concept is encouraged in India's draft. This concept, properly implemented, can help decision-makers make informed decisions about probable impacts of other development on a biosphere reserve so that conservation goals might be incorporated at the planning stages. Generally, biosphere reserves legislation can be a vehicle through which the concept is introduced in the country or cross-referenced when the requirement already exists in another law.

3.8. Involving tribal and local surrounding populations

Involvement of local people is a major concern in the Indian legislation. A provision was added requiring that all possible measures be taken to involve surrounding local populations in the administration, management, monitoring, and enforcement activities of the reserve. This section is intended to protect cultural values and traditions and to increase local benefits from and participation in the programme.

4. SUGGESTIONS FOR OTHER COUNTRIES

A few additional considerations should be noted regarding efforts to design effective legal protection for biosphere reserves.

4.1. The Need for Preliminary Information

Preliminary non-legal analysis is important for making initial judgements and policies on the broad character and needs of the programme as a basis for evaluating existing laws. The best available information should be collected for analysis of the resources to be protected, and existing and potential social, economic and political influences. Legislative analysis proceeds most efficiently once basic programme goals and objectives are defined.

4.2. Make Biosphere Reserves Part of the Development Process

As a relatively new concept in the conservation field, a biosphere reserve programme may stimulate confrontation with established management practices, institutions and procedures if it is not well integrated into existing processes. To facilitate integration, concerned and affected government sectors should be involved as much as possible from the beginning of programme development. MAB Committees can be a valuable tool for coordination across sectors and agencies. Planning agencies, often key factors in development and fiscal decision-making, also should be consulted and kept informed about proposed and existing sites. Efforts should be made to incorporate biosphere reserve policies into national development plans and conservation strategies.

4.3. Incorporate International Criteria in Legislation

An important value of the Unesco/MAB biosphere reserve concept is the international network created to exchange information about fundamental problems and to utilize multidisciplinary expertise from all parts of the world. When a country is considering principle elements to be addressed in legislation it may be desirable to include international references covering the major objectives and characteristics. Provisions also should encourage public participation and involvement of local populations, concepts that are being increasingly recognized in international materials and need to be adapted to each country's situation.

4.4. The Need of Increased Documentation of Experience

Many of the principles in the Indian draft were adapted from principles identified in the 1980 IUCN publication, Guidelines for Protected Areas Legislation. The adaptation of these principles involves some considerations unique to the biosphere reserve concept. Information is still scarce regarding experience with legal protection of biosphere reserves, but it is clear that the use and nature of law varies widely from country to country, an approach in one country may not always be appropriate for another country. At the same time, exchange of information can provide valuable background material.

Countries should participate in and encourage efforts to increase documentation and research in biosphere reserve law to improve our understanding of the strengths and weaknesses of different legal approaches and opportunities. Law can be an important and dynamic social tool to help protect and maintain sustainable resource systems but increased effort is necessary to utilize its full potential for biosphere reserves.

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BIOSPHERE RESERVES: THE SIZE QUESTION

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ABSTRACT. Biosphere reserves are intended to protect a representative set of the planet's ecosystems. Each must be of a size that will maintain the characteristic diversity of the ecosystem. Isolated wildlands almost always lose species through a process of impoverishment. A joint Brazilian/American research project is studying the process and trying to estimate the minimum size necessary to protect characteristic diversity. Preliminary results and problems relating to determining appropriate size for biosphere reserves are discussed.

1. INTRODUCTION

In today's world, various factors are reducing the total amount of wildlands remaining on the planet and to fragment those that remain; the fragments in turn tend to diminish, if not disappear. Even designated protected areas are subject to pressures for reduction. Under these circumstances, the question of appropriate size of reserves is not academic.

Unfortunately, there is as yet no precise answer to the size question. Yet answers are needed now and time for research seems an unwarranted luxury. In this situation, the only reasonable response combines a provisional (and cautious) set of criteria for minimum size and proposed research to illuminate the topic.

There are undoubtedly those to whom the size question seems purely academic, feeling that there will be little choice as to the areas that conservation will "get", so that it is rather pointless to bother about size. Yet it seems oddly futile not to be knowledgeable about the topic of size, so as to be able to secure an adequate area when possible or to manage a smaller one more effectively when the ideal is unattainable. Here, as in other areas of human endeavour, knowledge is clearly preferrable to the lack thereof.

2. SOME BASIC DEFINITIONS

It is necessary to define precisely the purpose of a conservation area, in this case of a biosphere reserve. In contrast to many protected areas, especially some of the earliest ones where aesthetic and/or recreational purposes predominated, biosphere reserves are concerned with the protection of biological diversity as well as protection of ecological relationships and processes. With biosphere reserves the intent is to protect a representative series of the world's ecosystems. The size question aside, this is a difficult scientific question in itself: what set of places would be satisfactory as a "representative series"?

Assuming that, for the Amazon for example, a set of places can be determined that would constitute a representative series, the question arises as to what is a representative ecosystem? The term ecosystem is applied very widely being as applicable to a semi-permanent puddle, as to a forest glade, as to a

vast stretch of forest. In each case there is a characteristic set of species and processes, in this example each being subsumed by the biological formation next greatest in extent. The smaller ecosystem is often less permanent in one spot than the larger, but it may well be a regular feature, merely changing in location within the larger ecosystem. Presumably in the case of biosphere reserves we are thinking in terms of the largest units, and ones large enough so that the smaller units which change in location are able to persist.

This is a different question than is frequently framed in terms of large vs. small (Simberloff and Abele, 1976; Whitcomb et al., 1976). That question has tended to focus on number of species; as often put, whether a series of small reserves will protect more or fewer species than a single large one of equivalent area. That question is of real and practical importance, particularly, for example, when the decisions involve smaller features of the landscape such as patches of herbaceous vegetation with species very sensitive to soil type. It is also a real question on a much larger scale if there is a choice -- as in Indonesia -- of conservation areas within a ceiling (of, say, 5%) of total land area. There, two reasonably large areas on different islands can protect more diversity than an extra large reserve on only one island. Yet this Indonesian example also involves the question of what size biosphere reserve would be necessary to protect a representative ecosystem (in the larger sense) on both islands.

To examine that question properly it is necessary to separate it from that of larger landscape processes on which the ecosystem may depend. That is not to say they should be ignored, but that they are separate issues. Once the size question itself is resolved, then other aspects can be accommodated, such as adding a buffer factor to carry the ecosystem in its full diversity through e.g. excessively dry periods (as many southeast Asian tropical forests are currently experiencing). Another example would be to address the landscape management approaches necessary to maintain the overall Amazonian hydrological system (Salati) in addition to the question of ideal minimum reserve size.

Having defined a representative ecosystem in general terms and in the larger sense for biosphere reserves, it is necessary to consider further precision for operational purposes. It is useful to begin thinking about the problem without the problems introduced by the isolation which derives from fragmentation. A generally positive relation between species number and area has been known for over 150 years. Although there is considerable variance for any ecosystem type in number of species from samples of equivalent area (Connor and McCoy, 1979; Simberloff, 1983), it is equally true that any ecosystem type has a characteristic species area curve. However variable, numbers of tree species are at least an order of magnitude greater in typical Amazonian forest than they are in the mid-Atlantic deciduous forests of North America. What we are seeking therefore in a minimum critical size (Lovejoy and Oren, 1980) for a biosphere reserve is one that will protect its species/area curve. In other words, within the considerable variance which may be expected (Connor and McCoy, 1979), it should be possible, centuries hence, to sample a given sized plot within a reserve and always encounter the characteristic species number. As a representative ecosystem, will by definition include its larger predators, such as the large cats, and they, in turn require large areas (often up to 710 sq km/pair), the minimum critical size is likely to be at least in terms of hundreds of sq km.

3. THE ISOLATION FACTOR

Maintenance of characteristic diversity is an easier goal if the reserve is not isolated; the area-related aspects of its ecology will maintain the

characteristic diversity and species/area relation of the total size of the habitat. It is the introduction of the isolation factor which introduces considerable difficulties.

The effects of isolation have received considerable attention within the last decade. They have been examined by considering the differences in species composition between islands of different sizes (and differing lengths of isolation) and equivalent mainland areas. They have been examined by considering similar differences between forest patches left in the course of development and extensive forest tracts or historical records thereof. Based largely on ornithological studies, there has been a reduction in species number in almost all instances.

An important exception is the work by Simberloff (1976) with insects on an experimentally fragmented mangrove island. In this instance, the total number of species was slightly greater on the artificially created archipelago than on the original island. This may in part reflect greater dispersal ability on the part of mangrove insects.

The story might also have been more in conformance with the bird studies cited above had the study been oriented toward protection of a representative mangrove ecosystem including characteristic vertebrates (mostly avian). It is hard to tell, because while the birds may have been oblivious to the fragmentation of the mangrove island, it is certain that the island, either before or after experimental treatment, would not have been capable in itself to support them. Nonetheless, some of the bird species are sufficiently flexible in their scavenging behaviour that they may well have persisted in the general area, and continued to visit the small area of mangrove, even if in reduced numbers. It is also important not to push the parallel between a mangrove island and a primary tropical forest too far.

The theory of island biogeography (MacArthur and Wilson, 1967) has also been used as a basis for predicting a reduction in species number after isolation (Diamond, 1972; Diamond and May, 1976; Terborgh, 1974; Wilson and Willis, 1975). This also is to be expected from consideration of species/area curves (Lovejoy and Oren, 1980).

In all, there is overwhelming consensus that loss of species is to be expected after isolation. Thus, any newly established and isolated conservation area will never remain what it appears to be at the moment of establishment; it will be subject to a process of impoverishment.

The interesting question both scientifically and from a practical conservation point of view is whether there is any order to species loss -- whether certain ones or certain kinds are more likely to be lost. Conversely, when the process of species loss is largely finished and some sort of equilibrium (probably dynamic) is reached, will there be a similarity in species composition between reserves of similar size? The theory of island biogeography is neutral on this point (Simberloff and Abele, 1976). However, given the common experience of naturalists that some species require larger areas then others it can be the general expectation that species loss and resulting species composition will not be entirely random.

4. AN EXPERIMENTAL APPROACH TO ISOLATION

A joint Brazilian-American research programme in the Central Amazon is helping study on several aspects of the species loss process. A size series of forest patches from one to 10,000 ha is being left for experimental purposes in the

course of development. The patches are being studied while still part of continuous forest and subsequent to isolation while losing species. Two tiny reserves (at one and ten ha) were isolated in 1980; further isolations are occurring in 1983.

Already three aspects of the species loss process have become apparent. First there can often be an influx of mobile organisms (in this case birds) which flee the surrounding area adding an overpopulation problem to the area (Lovejoy et al., 1983). This was seen in terms of an elevated capture rate immediately after isolation. This effect can be somewhat if not entirely eliminated (presuming it is considered desirable to do so) by arranging the method of habitat destruction (cutting in this case) to encourage the mobile organisms to move away from the intended reserve.

Second, there will be an invasion of second growth species from the newly formed edge (Burgess and Sharpe; Lovejoy, et al., in press). This has been noted dramatically with butterflies in the minimum size project. While species numbers in the reserves were initially depressed (presumably by smoke from burning surrounding cleared areas), they later increased because of secondary succession species. These have invaded the reserves as far as 100 in numbers, and up to 300 in rare instances. Except for a central 25 ha core, hundred ha reserves have butterfly communities that are largely altered. This invasion will obviously occur in other groups of organisms, and is already obvious in plant species closer to the edge.

Third, there has been a dramatic edge effect from the altered physical parameters. No longer insulated by the mass of vegetation, temperature and relative humidity fluctuate greatly in the surrounding area. Hot dry air enters the forests which previously knew only cool and damp. That together with exposure to the wind has led to notably elevated numbers of tree falls and tree mortality in the ten ha reserve (Lovejoy, et al., 1983, in press).

The above effects are primarily ones that have to do with the edge or its creation, in contrast to those that derive from reduced area and isolation. Already with respect to the latter, linked losses have been noted (Lovejoy et al., in press). Ant-following birds disappeared because army ant densities were too low. Three or four species of frogs dependent on standing water to complete reproduction disappeared because the area was too small to support peccaries which maintained the requisite water in their wallow. Certainly many more linkages can be expected such as between pollinators and dependent plant species.

What kinds of species can be expected to be lost first? For birds, Terborgh and Winter (1980) suggested larger size may be related to increased probability of local extinction. This may well be true in the Amazon study but the results are not yet clear. An important negative correlate of size may, in any case, be population density and this has been shown to relate to probability of local extinction; the rarer to begin with, the less likely to survive isolation (Terborgh and Winter, 1980). This seems to hold as a generality for mammals in the Amazon study. Density is likely to be far more important for tree species, but time to actual extinction is too long to provide much of an answer soon, unless the answer can be teased from cessation of reproduction as an indication of extinction to come.

How rapid are the changes? Within 12 months the one ha reserve could no longer be considered a representative forest bird community. The changes in birds of the ten ha reserve are slower, but certainly apparent after 3 years. The changes in the butterfly community were more rapid; neither the one nor the ten ha reserve could be considered representative after just a few

months. Changes in the butterfly community of a 100 ha reserve can be expected to be only slightly slower, with only the core of the forest maintaining anything like a primary forest butterfly community. In contrast, changes in the tree community will be much slower in reserve sizes over 100 ha because area effects will predominate over edge effects.

Attempts to define the elusive minimum critical size (i.e., the size at which the ecosystem retains its charactersitic diversity) must focus on changes induced by the area effect. Afterwards an additional amount can be added to compensate for edge-induced change. Reserves of different sizes will have different rates of species loss. These can be used to estimate at what size species loss (which is to be expected after isolation for any size) will be such that characteristic diversity will not be significantly diminished. This will involve extrapolation beyond the experimental sizes for which data will be available, through a family of curves for at least four orders of magnitude should give some confidence about extrapolating one or two more. At least there is no apparent reason to be concerned about possible major change in shape of curves for areas larger than those for which actual data exist.

Care must be taken in the above calculations to avoid the trap of considering all species to be of equal ecological importance. For example, loss of a single species such as the major grazer in a grassland ecosystem could have a highly significant effect on the reserve hoped to be representative.

The Amazon forests which are the site of this work probably represent an extreme of the minimum size problem. This is to be expected from their high species numbers, low densities per species, complex relationships among species, and other features of their biology. The edge effects from changed physical conditions are probably as great as will occur in any environment. The actual isolation may be greater than for most habitat types; certainly birds of temperate deciduous forests seem less inhibited about crossing open areas.

The minimum size for an ecologically effective Amazon forest biosphere reserve is probably in the few thousands of sq km. For environments other than tropical wet forests it will probably be less. Ideally there should be a minimum size project for every major type of ecosystem. Even in the Amazon it would be useful to have similar data from the many forest variants. The necessary human and fiscal resources for this do not exist, but there would still be great value in having information on species loss even for individual plots. This would be essential data for management of biosphere (and other) reserves.

5. CONCLUSION

In considering the size question for the many biosphere reserves which must be established now, one can do no better than to look around at existing forest and habitat patches or islands to see which sizes seem capable of maintaining characteristic diversity. However, these cannot be considered infallible touchstones as they may still be undergoing the species loss process. For any size of consequence, an island is likely to be a safer basis because in most instances (excluding man-made ones) the islands are likely to have had a longer period of isolation. Failing their availability there seems little alternative to considering what might be an adequate area to maintain a healthy population of the top carnivore, and then, for safety's sake, doubling it.

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CONSERVING THE GREAT BARRIER REEF THROUGH ZONING

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ABSTRACT. This paper describes the system of resource management which has been implemented in the Great Barrier Reef Marine Park. The Marine Park is being progressively extended and is expected to cover some 300,000 sq km of marine environment of the north-east coast off Australia within the next year or so. A principal mechanism for management is the zoning plan, which divides the Marine Park into zones in which there are varying degrees of control over human activity and varying levels of protection for the natural environment. The Marine Park concept is consistent with the IUCN criteria for a Multiple Use Protected Area (Category VIII) and with Unesco's criteria for biosphere reserves. The paper discusses the reasons for the apparent success of the programme and concludes that it could be applied to other parts of the world, if there is sufficient public and government commitment to conservation and sustainable use.

"How complex and unexpected are the checks and relations between organic beings, which have to struggle together in the same country" (Darwin, 1882).

1. INTRODUCTION

1. THE GREAT BARRIER REEF MARINE PARK

The Great Barrier Reef Marine Park is not a national park, but a multiple-use protected area, fitting the definition of Category VIII of the IUCN classification system (IUCN, 1982). It also meets the criteria for selection and management as a biosphere reserve (Category IX), although it has not been formally proposed or established as one. The Reef has been inscribed on the World Heritage List as a natural site (Category X).

Through the use of zones, levels of protection within the park vary from almost complete absence of restriction on activity in some areas to areas where almost no human activities are permitted. The only activity which is prohibited throughout the park is mining, other than for research purposes.

In the zoning plans which have been developed so far, there are three major categories of zones:

1.	Preservation zones and Scientific Research Zones	Equivalent to IUCN Category 1, Scientific Reserve/Strict Nature Reserve. The only human activity permitted is strictly controlled scientific research.
2.	Marine national park zones (there are three)	Equivalent to IUCN Category II, National Park. The major permitted uses are scientific, educational and recreational.

3. General use zones	Equivalent to IUCN Categories IV, Managed Nature
(there are two)	Reserve and VI, Resource Reserve. Uses are held at levels which do not jeopardize the ecosystem or its major elements. Commercial and recreational fishing are permitted.

Fig. 1 illustrates the zoning plans for the Capricornia Section of the Great Barrier Reef Marine Park, which covers an area of 12,000 sq km. The zones are fixed during the life of a zoning plan (generally five years). They are complemented by areas which give special protection from time to time to animal breeding or nesting sites, to areas of scientific research or to areas for the appreciation and observation of undisturbed marine life.

I believe that the ability to provide for a complete spectrum of levels of use and protection within the park is one of the main reasons for the evident success of the system. The many other reasons which help to explain this success are mentioned later in this paper.

2. THE GREAT BARRIER REEF

The Great Barrier Reef is the largest system of corals and associated life forms anywhere in the world, covering an area of almost 300,000 sq km on the Australian Continental Shelf -- roughly the size of the United Kingdom. The Reef stretches for almost 2,000 km along the north-eastern coast in a complex maze of approximately 2,500 individual reefs, ranging in size from less than 1 ha to more than 100 sq km. In the north the Reef is narrow and its eastern edge is marked by a series of narrow "ribbon" reefs but in southern areas it broadens out and presents a vast wilderness of "patch" reefs separated by winding channels.

The Reef is diverse not only in the form and size of the individual reefs and islands which constitute it, but in its inhabitants. Six species of turtle occur in the region and there are more than 1500 species of fishes. More than 300 species of hard coral have been identified and the islands are inhabited or visited by more than 240 species of birds. The major human activities in the region are tourism and fishing. The value of tourism in the region has been estimated at more than US $100 million per annum.

3. LEGISLATION AND ADMINISTRATION

The Great Barrier Reef Marine Park Act (the Act) was enacted in 1975. Its provisions, and zoning plans and regulations made under it, override conflicting provisions of all other State and Federal laws except in relation to navigation of ships larger than 500 tonnes and the flying of aircraft.

The Act created the Great Barrier Reef Marine Park Authority (the Authority) with three principal functions: to recommend areas to be included in the park; to make zoning and management plans; and to carry out or arrange for research. The Authority has many other ancillary functions. It is a three-man statutory body, with two of its members selected by the Federal Government and one by the Queensland Government. One of its members is intended to represent the non-Government sector. The Authority employs about 50 highly trained staff, well qualified in various disciplines.

While the Authority formally reports to one Minister, in effect it reports to a four-man Ministerial Council, consisting of two members from the Federal Government and two from the Queensland Government. There is a Consultative Committee, comprising usually fifteen members, selected to represent all major relevant interests in the Great Barrier Reef Region, which advises the Authority and the Minister.

The Authority was created as a result of widespread recognition, particularly within the scientific community, of the value of the Great Barrier Reef to Australia and of the need to establish a mechanism to protect it. The Authority was established and continues to operate in a situation of controversy regarding Federal and state powers and rights in the Territorial Sea, within which lies a large part of the Great Barrier Reef.

No other State of Australia is bordered by reefs approaching the size, diversity and splendour of the Great Barrier Reef. It is inevitable that the Reef will be regarded by many as a national asset and by others as an international asset. Many, including scientists, have demanded that the Federal Government should retain a dominant role in the management of the whole Great Barrier Reef, however it may be defined. Others, not all of them in Queensland, have maintained that management of the Reef, including the islands, should be carried out by the state Government. Constitutionally, the Queensland State Government has responsibility for all the islands in the Great Barrier Reef Region above low water mark, except for those few that are owned by the Federal Government. These and all the waters, reefs and shoals below low water mark are the responsibility of the Federal Government.

Much that has been done so far to protect and manage the Great Barrier Reef has resulted from public pressure and because many of the pressures have been conflicting, as in all controversial public areas, government action has involved compromise. The essence of the compromise has been for the Federal Government to maintain overriding constitutional power in the Great Barrier Reef Region, while involving the State of Queensland cooperatively in all aspects of the establishment and management of the Great Barrier Reef Marine Park. Queensland maintains jurisdiction over most of the islands and the two governments have agreed to manage the adjacent areas complementarily.

This compromise has been reflected in the creation and composition of the Ministerial Council, the Authority itself and the Consultative Committee, and in the way that they operate.

4. SIMILARITY TO A BIOSPHERE RESERVE

The criteria for selection and management of a biosphere reserve include:

> "Each biosphere reserve will include one or more of the following: representative examples of natural biomes; unique communities or areas with unusual natural features or exceptional interest.... A biosphere reserve must have adequate long-term legal protection. Each biosphere reserve is large enough to be an effective conservation unit, and to accommodate different uses without conflict... Each biosphere reserve will be zoned to provide direction as to its management...." (IUCN, 1982).

The Great Barrier Reef meets all of these criteria, but because of the protection provided by the legislation and Australia's international obligations deriving from the inscription of the Great Barrier Reef on the World Heritage List, it could be considered that there does not appear to be any need to seek to have the Reef formally designated as a biosphere reserve.

5. PRESENT STATUS

Six sections of the Great Barrier Reef Marine Park have been declared. They cover almost 80% of the Great Barrier Reef Region. Investigation is proceeding regarding declaration of sections of the park in the remaining 20%.

Zoning plans have been prepared for three sections. One of those plans has been in operation for two years. The other two are expected to come into operation in 1983 -- they are at present before both Houses of Parliament. The Authority will progressively develop zoning plans for other sections. Intensive and extensive consultation with the general public and interest groups will continue to be a feature of the process.

6. WHY IS THE SYSTEM WORKING?

6.1. Public Commitment

The Great Barrier Reef is recognized by the great majority of Australians as a priceless national asset. Independent surveys have confirmed that the commitment of the public in every state of the nation to protection of the natural qualities of the Reef is very high and is increasing. Despite the oil crises of the past few years and the possibility of gaseous or liquid hydrocarbons existing under the Reef, surveys indicate that more than 80% of Australians oppose oil drilling in the Region.

The importance of this public commitment to the conservation-oriented management of the Great Barrier Reef cannot be over-emphasized.

6.2. Overriding Legislation

It has been mentioned earlier in this paper that the provisions of the Great Barrier Reef Marine Park Act prevail over any conflicting provisions of almost all other legislation in Australia. I believe that this is essential to the success of the Act and the administrative system which has been created under it.

The Authority's primary mandate is to ensure a reasonable use of the resources of the Great Barrier Reef Marine Park consistent with conservation of the Great Barrier Reef. Inevitably, decisions of government made on the basis of recommendations by the Authority vitally affect the interests of other government ministries. Many of these ministries are large and powerful with a responsibility to exploit Australia's natural resources. In the absence of the overriding provisions of the Act, it would be naive to expect such ministries to allow their economically-focussed activities to be constrained by conservational criteria.

Because the Act is known to prevail, the need for coercion is largely eliminated. Problems of conflict have in every case been resolved by negotiation and compromise, without jeopardizing the conservation of the Reef. The ability and willingness of the Authority to avoid coercion, both within government and outside it, are vital factors in the success of the system.

6.3. Public Participation

The Act requires the Authority to involve the public in some of its decision-making processes. However, the Authority goes far beyond its statutory obligations in its public participation programmes. We are

committed to this process, not only because it contributes to public acceptance of zoning and management plans, but also because our experience has shown that better decisions are made if the knowledge of all sectors of the community is tapped. The decisions are judged to be better because they provide for reasonable use, consistent with conservation in ways which are manifestly fairer or more efficient.

The Great Barrier Reef is a common resource. The usual long-term effect on a common resource of uncontrolled operation of the free market is that the common resource is destroyed (Hardin and Baden, 1977). Participation of all sectors of the public in decisions about the use of a common resource helps to ensure that the public good -- conservation of the common resource -- prevails over the private good of maximization of profit.

6.4. Sustainable Use

The zoning plans for the Great Barrier Reef Marine Park allow for all reasonable uses except mining. Reasonable use is taken to mean use that does not jeopardize the long-term conservation of the Great Barrier Reef. In the absence of complete understanding of the Reef and the complex interactions and processes which occur in and around it, perhaps the best criterion for determining whether a use is reasonable is sustainability.

The Authority and its programmes are acceptable to most sectors of the community because they are seen to be reasonable and to avoid unnecessarily restricting the use and enjoyment of the Great Barrier Reef. Without public acceptance, the Authority and its programmes would be in jeopardy.

6.5. Policies of the Authority

The factors which have been described above as contributing to the success of the Marine Park system have been derived from the Act. The Authority has a set of policies which, in my view, also contribute greatly to the system.

Decisions about zoning and management are taken, and will always have to be taken, in the absence of complete knowledge. Nevertheless, our policy is to base decisions as far as possible on scientifically-derived information. To this end, we play a major role in the identification, coordination, establishment and use of scientific studies directed towards answering management questions. Our experience has been that much can be accomplished without great expenditure of money.

The Authority does not lightly make decisions which adversely affect existing commercial or amateur activities. If those activities are already consistent with conservation of the Reef then the Authority is likely to make decisions which support them and which prevent them from becoming destructive. As an example, we assist tourist operators in the development of activity programmes for visitors which are focussed on conservation and education.

The Authority is a small agency, and wishes to remain so. To the maximum extent practicable, we work through other agencies and with their officers. There are several reasons for this. We believe that flexibility and efficiency diminish with increasing size. We do not expect the public to be impressed by an agency which grows endlessly, which sets up management systems that compete with existing management systems of the same or a different government, which is not committed to efficiency or which absorbs vast sums of public monies.

7. CONCLUSION

The Great Barrier Reef is unique and the commitment of the Australian people to its conservation is great. This commitment has led to the establishment of legislation and a management system in which conservation is the dominant theme, with reasonable use of the Reef's resources being encouraged. The public participates in decision-making and is to a degree self-regulating. The Authority acts as the trustee of the Great Barrier Reef Marine Park, on behalf of the people of Australia.

How applicable is the system to the management of marine (or terrestrial) resources in other places? Much of the methodology could be applied with success in many parts of the world, but it should be recognized that limitations on economic activities and on the actions and powers of influential private and government interests are essential if application of the system is to achieve conservation. Therefore, strong public and government commitment to sustainable use of a natural resource would appear to be a necessary prerequisite to successful application of the system anywhere.

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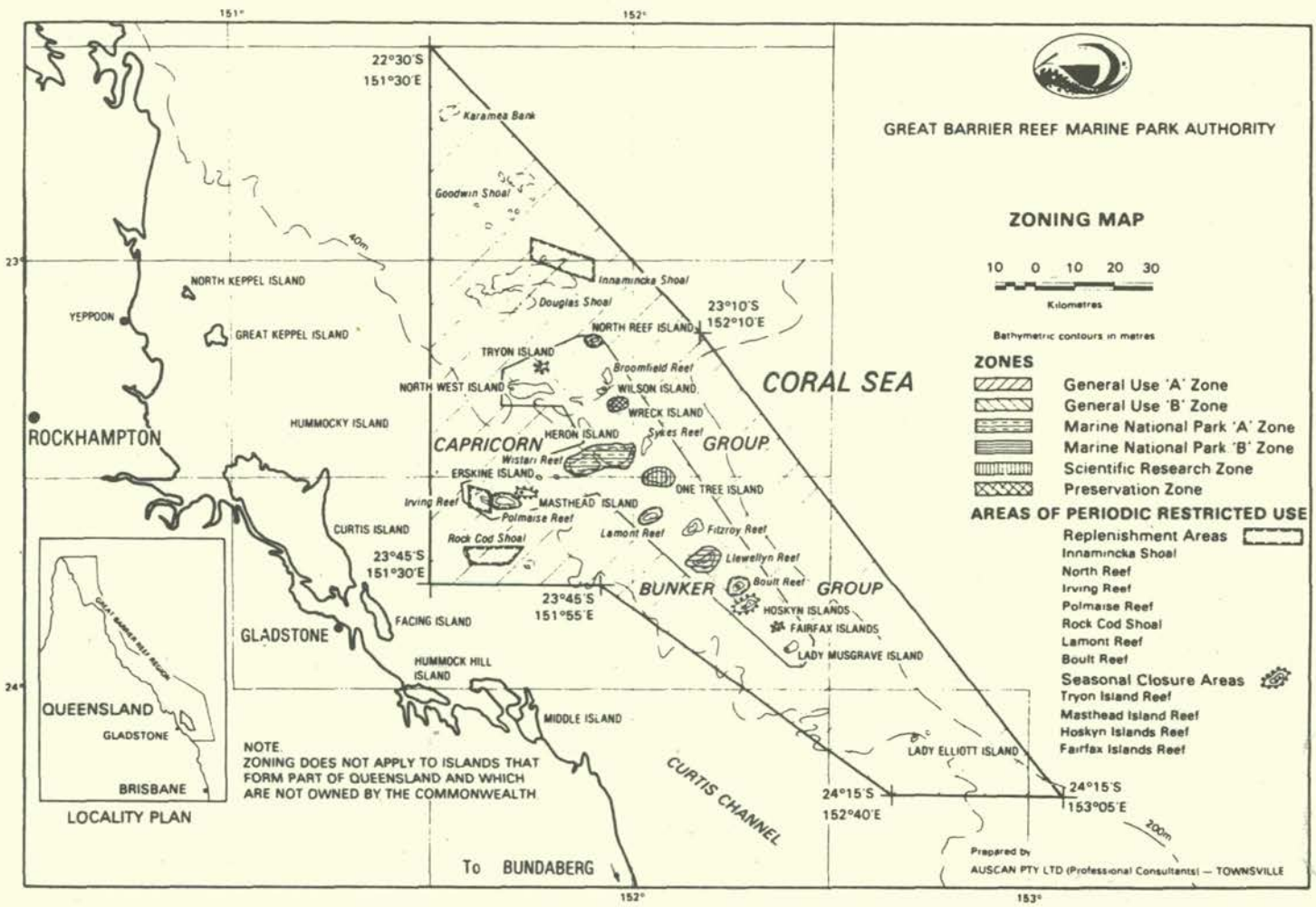
Figure 1

The Capricornia Section of the Great Barrier Reef Marine Park

(Source: Great Barrier Reef Marine Park Authority)



MANAGEMENT PLANNING IN THE PLATANO RIVER BIOSPHERE RESERVE HONDURAS

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ABSTRACT. Natural Renewable Resource (RENARE) personnel at the Platano River Biosphere Reserve, a 500,000 ha site in eastern Honduras, are implementing MAB guidelines and activities in an exemplatory fashion developing innovative ecodevelopment programmes and other reserve activities which are setting new directions for the MAB biosphere reserve programme. Much of their success is due to the elaboration and use of long-term management strategies and short-term operational plans, the first ever designed for a biosphere reserve. The plans feature preservation of genetic material and conservation and development for indigenous peoples residing within the site. Appropriate technology and ecodevelopment projects under the plan, which may also be applicable elsewhere will be designed for sustainable development with minimal resouce impact.

Management planning is an ongoing process, with input from a variety of entities including the local population, the MAB National Committee, top level decision makers and the international conservation community. Although the reserve still has several formidable barriers to overcome, its chances of not only being successful but also leading the way in innovative biosphere reserve management look very promising.

1. INTRODUCTION

Implementaion of the MAB programme within biosphere reserves is as varied as the reserve sites themselves. At one end of the spectrum are reserves where managers have not only grasped the essence of the programme, but have gone on to expand or modify it, aggressively pursuing MAB goals and objectives.

At the other extreme are reserves whose entire manifestation of the programme rests upon a rather cryptically worded Unesco plaque tucked into a dark recess of an interpretive center, a mystery to both visitor and staff alike.

It is interesting to note that the economic status of a country has little to do with the level of programme implementation. At a recent regional conference on biosphere reserves, most speakers represented relatively well funded park programmes. Yet many prefaced their remarks with the honest yet disturbing admission that until they received an invitation to address the conference they had little or no understanding of biosphere reserves, despite the fact that they were supposed to be the managers of such sites.

Contrast this with one fledgling biosphere reserve in a developing nation where MAB guidelines are being implemented in an exemplary fashion, and where the programme itself is setting new standards and directions for biosphere reserve management. Not only do the reserve managers comprehend and support the programme, but many of the local residents, most of whom are "illiterate" in the formal sense of the term, share this understanding.

The remarkable success of this project, especially in the face of a multitude of social, political and economic problems, is due principally to the development and implementation of a comprehensive management plan, one of the first written specifically for a biosphere reserve and one which has actively sought to incorporate local inhabitants into the planning process. A history and analysis of this ongoing exercise in biosphere reserve management is the topic of this paper.

2. BACKGROUND

Honduras, the developing nation in question, is not a large country. Yet biologically and geographically it is extremely diverse, with both a Caribbean and a Pacific coastline and a multitude of mountain ranges and intermountain valleys. These have created an amalgam of habitat types including both broadleaf and pine forests. In addition, Honduras' geographic setting in the transition zone between North and South America adds to the variety of floral and faunal species (Monroe, 1968).

But not unlike many tropical nations, deforestation and accelerating habitat destruction threaten to severely affect not only the integrity of natural ecosystems but also future development options. For example, flooding in the economically important Sula valley, much of it related to deteriorating watersheds, causes an estimated US $33.5 million damage annually to agriculture and infrastructure. In 1974, Hurricane Fifi battered the country leaving 12,000 dead and 150 million dollars in property damage. Most of this destruction was not due to high winds but rather to deforestation related mudslides and flooding (Campanella et al., 1982).

A growing awareness of the economic and social impacts of inappropriate land use spurred government officials to launch a series of resource management programmes. These have included, among others: watershed management projects and the establishment of a protected wildlands system.

The development of a network of parks and equivalent reserves became the task of the Directorate of Renewable Natural Resources (RENARE). In 1976 RENARE began a nationwide inventory of wildland areas to identify prime sites for conservation management. This was to be a comprehensive system which included not only national parks but other wildland categories such as natural monuments, wildlife refuges, resource reserves etc., all of which have distinct management objectives (Hellie and Glick, 1976). The biosphere reserve concept was not part of RENARE nomenclature at that time.

One of the areas surveyed, the watershed of the Platano River in eastern Honduras, did not seem to fit into any of the traditional management categories. It is a huge area, almost 500,000 ha mostly in a primary state (MacFarland, 1982). However, the existence of native peoples living and working within the region seemed to negate the option of absolute protection, a general prerequisite for national park designation. Not only did relocation of these cultures (mainly Miskito Indians) seem impractical, but their apparent successful adaptation to the rain forest environment was considered worthy of protection and a potential asset to the global significance of the site. Thus, a management strategy which would incorporate human populations and their development into the conservation of genetic resources, seemed to be necessary (Glick, 1980).

The introduction of the biosphere reserve concept by wildland specialists of the Tropical Agricultural Research and Training Center (CATIE) which assisted in the inventory, gained immediate acceptance by RENARE. In addition, a MAB

representative visited the site, further clarifying MAB goals and programmes and encouraging the establishment of a reserve in the Platano region (Gilbert, 1978). Although technical assistance from both of these international agencies was instrumental in catalyzing Honduran interest in developing a reserve site, it was the long-standing RENARE tradition of promoting wildland management for ecodevelopment that had prepared the ground for such rapid germination and blossoming of the MAB concept. RENARE had been perceptive enough to realize that in a financially strapped nation such as Honduras, natural area protection could be most successfully promoted on a primarily economic basis. While scientific, social, esthetic and educational justifications could supplement conservation arguments, it was the economic value of wildland protection that had to be emphasized.

3. ESTABLISHMENT OF THE RESERVE

The establishment of the reserve followed a logical sequence of 4 planning activities;

1) Initial natural and cultural resource investigation of the area;

2) Supplemental pre-management planning activities;

3) Development of the management plan; and

4) Implementation of the management plan and follow-up activities.

This long term comprehensive strategy was based upon a modified model for wildland planning (Miller, 1978) and incorporated components of both the MAB programme objectives and the RENARE department orientation. Because no other biosphere reserve had previously developed and implemented a management plan, Honduras was ploughing new ground -- modifying prior wildland planning experience when possble and creating new methodologies when necessary.

3.1. Initial natural and cultural resource investigations of the area

The vast reaches of the Platano watershed were virtually unknown to scientists until the advent of this project. The initial inventory utilized topographic maps, aerial photographs and overflights as a means of designing the survey methodology. These investigations involved a multidisciplinary team of professionals with several local inhabitants serving as guides and field assistants. A cinematographer also participated and later produced a short film which was used in the promotional campaign for the reserve. Scientists collected reams of data from the native people which proved invaluable during the development of the management plan. The principal reason for the resource inventory was thus to provide as thorough an understanding as possible of not only natural and cultural features but also real and potential problems, opportunities and priorities.

RENARE also utilized this phase of initial contact to disseminate information on biosphere reserves to local inhabitants and solicite their ideas and opinions on the programme. This data was analyzed, organized and published which served as an easy reference to all gathered information, and also provided solid evidence to other agencies that RENARE was committed to the project and was capable of carrying out the initial steps leading to on-site management.

3.2. Supplemental pre-management planning activities

In order to optimize the actual management planning exercise several important supplemental actions had to be carried out. Perhaps the most important was the gaining of solid support of top decision makers and heads of state, other governmental and non-governmental agencies, the general public, and of course the residents of the reserve.

With these target groups identified, specific action plans were formulated to effectively convey the biosphere reserve message to each group. A National MAB Committee was formed which included representatives from all relevant governmental and non-governmental agencies. This was extremely important as the integrated management plan envisioned by RENARE included health, education, cultural development, anthropology and archeology, forestry and agriculture elements. Press releases, audiovisual presentations, pamphlets and other materials were utilized in the public education campaign. A non-governmental conservation group adopted the Platano as one of its principal environmental education themes and assisted in this effort (Betancourt, 1982). Finally, special emphasis was directed at promotional activities within the reserve. A resident director was hired from the local population, work began on the construction of a reserve headquarters, local labourers and reserve guards were hired, and, of paramount importance, a reserve environmental education programme was launched.

3.3. Development of the management plan

The management plan was designed to guide reserve development for the next several years. Though based upon the internationally tested Miller methodology, the final plan outline was modified in several ways to include both MAB guidelines and the sustainable development orientation of RENARE. As in the traditional Miller plan outline, the document began with general objectives. However, in addition to addressing the need to protect natural resources, objectives also focused upon the socio-economic development of the native peoples and the conservation of their cultural heritage. Also, the site would be utilized as a testing ground for new technologies and land use practices which would mitigate the negative impacts of development and ensure sustainable resource harvesting patterns (RENARE, 1980). Knowledge gained from these efforts would then be transferred to adjacent regions and beyond. Not only would implementation of appropriate land use lessen development impacts within the reserve, but could, if transferred to other areas, ensure that the Platano watershed was not eventually transformed into an island of natural vegetation awash in a sea of destruction.

These goals were reflected in the reserve zoning. Not only were traditional "natural" ("intangible") and "administrative" zones identified, but "cultural" and "buffer" zones were also included. Controlled resource utilization and manipulative experimentation would be facilitated in these areas as well as normal development activities (RENARE, 1980). Local imput was important in the identification of all of these zones. Current and projected resource use patterns had to be identified to ensure that the needs of the local population would be met without compromising important or unique genetic resources.

Management programmes and sub-programmes followed the general Miller methodology (i.e. "Environmental Management", "Public Use", and "Operations") with the addition of a "Resident Ecodevelopment Programme". This programme was designed to address the needs of local people (health, education, agriculture, forestry and wildlife utilization) and the reserve objectives

related to appropriate development practices. An integrated development programme and map brought together all activities and their human and material needs into one cohesive, coordinated unit.

The planning team itself was an integrated effort. Biologists and anthropologists shared the same thatched hut and later in the capital, the same desk with wildland planners and park administrators. Representatives from CATIE and MAB worked closely with the Hondurans during this phase. The National MAB Committee also provided input in the plan review process. This process was formalized with the celebration of a national seminar on the reserve and its proposed management plan. At this conference the draft document was outlined and distributed for comments (Wild, 1980) which were later incorporated into the final plan.

3.4. Implementation of the management plan and follow-up activities

The final management document was by design, not final at all. The strategy would be continually evaluated and revised to meet changing budgets and dynamic human and natural systems within and adjacent to the reserve. Though the plan did provide basic guidelines and long-term goals, the breadth of the report had preempted the depth needed to effectively launch "in situ" management activities. Thus a short, two year operational plan was drawn up (Aguilar et al., 1981). The operational plan was based on and coordinated with the long term management plan. In detail, the plan breaks down management sub-programmes into specific activities, complete with budgets, human and infrastructural needs and identifies responsible personnel. The operational plan has been instrumental in transforming general management goals into on-the-ground action. Initial operational plan priority projects have included the establishment of basic reserve infrastructure and protection programmes as well as some ecodevelopment projects to demonstrate benefits of reserve status to local inhabitants. Basic research is stressed as a means of ensuring that management is relevant to the needs of both man and nature.

Reserve staff have been recruited primarily from the local population. Participation in training exercises is a continual component to employee duties. A Miskito Indian cultural awareness group has also been formed with functions to monitor management and its impact on the Miskito Indians and other residents of the reserve.

Though to some degree management activities are flexible, they have been carried out in a logical, systematic fashion. Not only does plan implementation include activities within the reserve, but simultaneously education and extension activities occur at both a regional and national level. Coordination of interagency cooperation is also an ongoing programme and perhaps a key factor in the advancement of the reserve.

4. STATUS OF THE RESERVE

At the outset of this paper the relative success of the Platano River Biosphere Reserve was noted, especially when compared to many sites with significantly greater human and financial resources. However, a completely optimistic picture would not be an honest portrait. Several problems still exist and some are very serious. Limited financial support has hindered complete programme implementation, especially the hiring and training of adequate reserve staff (Erazo, 1983). As a result, resource protection has suffered, with not only insufficient vigilance but also cutbacks in educational programmes. While there is a growing "biosphere reserve consciousness" among the local and regional residents, this is still deficient

in some areas and has resulted in misunderstandings and potentially disruptive attitudes. Benefits of governmental intervention into local affairs have been slow in materializing and this, of course, speaks much louder than an attractive management document (MacFarland, 1982).

Externally land use pressure continues to mount on the reserve borders. A major highway project is being contemplated and while it will not enter the reserve it will open large adjacent areas to what will most probably be unplanned human settlement. Similar projects in other humid tropical forests have left a legacy of widespread destruction in their wake.

A lack of active cooperation on the part of all involved entities also threatens the efficiency of the project. Inter-institutional jealousy and already overcrowded agendas have handicapped cooperative efforts between the multitude of agencies which share important support roles. (Betancourt, 1982). Until these agencies, including RENARE, can overcome such barriers, the project will never realize its full potential.

Nevertheless, despite these problems, the project continues to advance. The next few years will be a critical period in its evolution. RENARE, encouraged by worldwide recognition and support, has indentified this site as a pilot wildland management project with a sizable portion of the Departments's scarce resources earmarked for the Platano. Even more important, there is a sincere desire to demonstrate that developing nations such as Honduras can make an outstanding contribution to global conservation and in transforming biosphere reserve theory into practice, may lead the way.

ANNEX. GENERAL GUIDELINES FOR MANAGEMENT PLANNING WITHIN BIOSPHERE RESERVES

Management plans serve a multitude of purposes. Not only do they provide for logical, systematic development of sites and ensure that reserve objectives are fully realized, but they can also be "biosphere reserve consciousness raising" exercises for reserve staff and residents as well as decision makers, other agencies and the general public. In order to accomplish these goals, several basic precepts need to be followed. Some of these guidelines are elaborated below:

1. Before management planning begins, a long term strategy must be mapped out. This should include pre-planning, planning and post-planning activities. Human and financial resources should be taken into account, target groups and priority actions identified, and the workload divided. All involved should know their specific tasks.

2. MAB committees should be formed and utilized in all levels of the planning process. Not only can they provide valuable input, but their active involvement should ensure a commitment by sponsoring agencies in the implementation stages of the plan.

3. The search for funding should begin early in the planning process with potential funding sources continually updated during the evolution of the reserve.

4. Promotion of the project should also be started early enough so that decision makers and the public can vicariously experience the development of the site from unmanaged wildland to comprehensive administration. Education programmes should focus initially upon the definition of the biosphere reserve concept and its aptitude for the site.

5. Management planning should be based upon a thorough knowledge of the resource. If such information does not exist, it must be gathered. Special emphasis should be placed upon identification of resource utilization patterns by local and regional inhabitants, if applicable. Residents of the area must be incorporated into the inventory teams. These surveys can be used to initially introduce the biosphere reserve concept to local inhabitants and solicit their ideas related to reserve management.

6. Data collected should be analyzed in relation to its impact upon the subsequent management plan. The resource inventory document itself can be an important tool in selling the idea to decision makers and potential funding sources. This also applies to the management plan. Several copies should be produced.

7. The management planning exercise itself must follow a well laid out work schedule. The team should be interdisciplinary with adequate expertise in all aspects of the envisioned document. The knowledge of MAB committee members can be tapped for this information. At least one member of the group should come from the reserve region. An environmental education element should be incorporated into all contacts with the inhabitants of the site. Representative committees can be formed among local people to guarantee that firm lines of communication exist between the planning team and reserve residents. Regional inhabitants should eventually be hired and trained at all levels.

The planning outline does not have to be a carbon copy of some of the more well known methodologies, but it should contain several standard elements such as; objectives, basic management and development concept which establishes guidelines for programmes, projects and physical development, a zoning scheme which defines and identifies management zones, management programmes and sub-programmes and an integrated development programme which coordinates all previously mentioned components.

8. The draft plan should be reviewed by a host of agencies and individuals. A conference or workshop which includes the MAB committee, representatives of reserve residents, the press, decision makers and others is a good means of introducing and explaining the project and soliciting public and institutional imput.

9. More detailed operational plans which are based upon the general long term management plan should be drawn up on a bi-yearly basis. These must be detailed enough to facillitate immediate on-site implementation. They should identify what will be done, who will be doing it and when, and what resources will be needed.

10. Several of the previously mentioned activities should be ongoing during the subsequent plan implementation phase. These include continual resource inventories and monitoring of environmental and cultural changes to assure plan relevance to the dynamic realities of the reserve. Education programmes and promotion of the project should be mandatory at all levels (decision makers, international organizations, the general public, and reserve residents). Funding campaigns should be uninterrupted to assure long term support for the project and realization of promised benefits for those affected by reserve management. MAB committees should be kept actively involved. Communication and feedback loops must be maintained between reserve administration and inhabitants.

11. Finally, the project should be periodically evaluated. An outside party is often helpful in providing an objective critique of reserve progress and problems. The reserve management plan should be flexible enough to incorporate suggested modifications.

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PLANNING AND MANAGING A MULTI-COMPONENT, MULTI-CATEGORY INTERNATIONAL BIOSPHERE RESERVE: THE CASE OF THE LA AMISTAD/TALAMANCA RANGE/BOCAS DE TORO WILDLANDS COMPLEX OF COSTA RICA AND PANAMA

By

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ABSTRACT. This paper describes ongoing efforts to establish and manage a lateral biosphere reserve containing a complex of natural and cultural reserves along the Costa Rica-Panama border. It is the largest, most diverse wildland area remaining in southern Central America, home to indigenous peoples maintaining subsistance lifestyles and containing most of the two countries' hydroelectricity generating potential. The history of conservation efforts in the region and the considerable problems encountered in its planning and integrated management are described. Management priorities are outlined, such as land ownership consolidation, boundary adjustment, completion of individual reserve management plans and overall reserve management guidelines, implementation of resource protection, environmental education/extension and applied research programmes, and improved inter-agency cooperation in reserve management. Long-term management goals for the biosphere reserve are reviewed, including: improving land utilization practices in and near the area; investigating and applying native peoples' knowledge of wild genetic resources; producing sustainable economic benefits for reserve inhabitants and national populations through integrated management of the reserve; and, assuring lasting protection of the region's outstanding natural and cultural resources. Threats to reserve integrity are described, including plans for pipelines, mining, and road construction, archaeological site looting, poaching and spontaneous colonization. International assistance in reserve planning and management, including biosphere reserve and World Heritage Site designation, is seen as stimulating local support for reserve protection and opposition to development projects which threaten the reserve.

1. INTRODUCTION

The adjoining wildlands of the Talamanca Range of southern Costa Rica and the Bocas de Toro region of western Panama represent the most altitudinally and ecologically diverse natural area remaining in Central America, exceeded in size only by the vast lowland forests, swamps and savannas of the Mosquitia region of eastern Nicaragua and Honduras. These border wildlands also contain important archaeological sites, the majority of the hydroelectricity generating potential of the two countries, and substantial populations of three Indian tribes practicing stable, subsistence lifestyles. This paper describes the ongoing efforts to plan, establish and manage a series of natural and cultural reserves in the border area, and incorporate them into the international biosphere reserve network. It is hoped that this discussion will prove useful for planners and managers working on similar multi-component and multinational biosphere reserves, especially those containing populations of indigenous peoples.

2. NATURAL AND CULTURAL SIGNIFICANCE OF THE COSTA RICA-PANAMA BORDER WILDLANDS

2.1. Natural significance

Covering a vast region of more than a million ha, the border wildlands of Costa Rica and Panama stretch from near sea level on the Atlantic-Caribbean slope and approximately 1000 m on the Pacific slope to over 3800 m on southern Central America's highest peaks. Because of this altitudinal diversity and annual precipitation ranging from 2000 to over 7000 mm, these wildlands represent the most ecologically diverse natural area in the Central American region. For example, the Costa Rican sector contains 8 of the 12 biogeographical life zones (sensu Holdridge) found in that country. The area contains the only large continuous mass of high altitude natural vegetation found in Central America, including sizeable, almost pure oak (Quercus spp.) forests, high altitude bogs, and 95% of the paramo (Andean alpine scrub) in Central America, a vegetation type which reaches its northern-most extension in Costa Rica (CATIE-SPN, 1982; Murillo, 1982; Ramirez, 1982; Tosi, 1981).

Geologically, the Talamanca Range is formed of highly folded and faulted metamorphic rocks derived from recent marine sediments and intercalated with intrusive igneous formations. The uplifting of the area commenced during the Tertiary about 60 million years ago. Pleistocene glaciations on the highest peaks have left moraines, cirque lakes and other geological features not found elsewhere in Central America (Weyl, 1955).

Slopes throughout the region are generally very steep (over 45%) and because of this factor and high rainfall, soils are for the most part extremely poor and unsuited for permanent agriculture (Villalobos, 1982). However, because of the high rainfall, distributed throughout the year, the hydroelectricity generating potential of the area is enormous, and represents the best hope for energy independence of the two countries, which lack known coal, oil or gas reserves and have serious balance of payments problems due mainly to their foreign oil bills (CATIE-SPN, 1982).

Because of the areas' marked climatic, altitudinal and edaphic variability and its position on a "land bridge" connecting the biogeographically distinct regions of North and South America, plant and animal species and community diversity is remarkable. The number of endemics and endangered species is very high (including six felines, the resplendent quetzal (Pharomachrus mocinno, giant anteater Myrmecophaga tridactyla, and Baird's tapir Tapirus bairdii). Many species of migrant birds from North and South America winter in the area, and seasonal altitudinal migrations among resident birds, butterflies and other faunal groups are thought to be very important, a phenomenon which poses special problems for reserve planners (Tosi, 1981). The border wildlands cover more than a million ha, the largest pristine tract remaining in Costa Rica and Panama. As such, they provide the two countries' best hope for protecting genetically viable populations of endangered animal species high on the food chain and with very large territories, such as the jaguar Felis onca and harpy eagle Harpia harpyja (Vaughan, 1982).

2.2. Cultural significance

Countless archaeological sites, including petroglyphs, burials and residential areas, have been found recently in the wildlands on both sides of the Costa Rican-Panamanian border. Investigations of these sites have begun to provide very important information on the pre-Colombian inhabitants of southern Central America, who were culturally very different from the Mayas, Toltecs and Aztecs to the north and the Incas to the south (Stone, 1977; Drolet and Markens, 1982; Corrales, 1982).

Indigenous reserves and homelands along the perimeter of the border wildlands contain most of the remaining Indian population of Costa Rica and a sizeable percentage of that of Panama. The three major tribes inhabiting the area are the Cabecars and Bribris in Costa Rica, and Guaymis and a small population of Bribris in Panama. The indigenous groups have developed migratory agricultural technologies and hunting, fishing, and gathering methods well adapted to the limitations imposed by their environment. These tribal peoples, although somewhat acculturated, still possess an incredible amount of knowledge about values of plant and animal genetic resources, of great potential importance in the fields of medicine, chemistry and agiculture (Borge, 1982; Corrales, 1982; Ocampo, 1981; Murillo and Garcia, 1982; Fernandez Guardia, 1975).

3. HISTORY OF CONSERVATION EFFORTS IN THE COSTA RICA-PANAMA BORDER REGION

Although establishment of the first indigenous reserves in the Talamanca Range of Costa Rica occurred in the late 1940s, effective field action to protect Indian cultures and conserve the area's natural resources is a recent phenomena. In December 1974, the First Central American Meeting on Conservation of Natural and Cultural Resources was held in San Jose, Costa Rica. At that meeting, sponsored by IUCN, FAO, OAS and Unesco, representatives of the six countries present signed a resolution promoting the development of international parks and reserves in areas within the region where wildlands cross international boundaries (IUCN, 1976). One of the sites specifically mentioned as a high priority for such a reserve, and the only one where the resolution is being implemented, is the Talamanca Range of southern Costa Rica and the Changuinola River basin of adjacent western Panama.

Following up on the 1974 resolution, between 1975 and 1982, the Costa Rican government created and began managing a complex of adjoining national parks, Indian reserves, forest protection zones and biological reserves which now cover almost the entirety of the Talamanca range -- over 500,000 ha or 10% of the country's area. This effort culminated in March 1982, with the inauguration of the 192,000 ha Costa Rican sector of La Amistad International Park.

The creation of the Costa Rican sector of La Amistad was a direct result of two resolutions, signed by the Presidents of Costa Rica and Panama in 1979 and early 1982. Citing the resolution of the 1974 San Jose meeting, the presidents directed their countries' resource management agencies to proceed with joint planning and development of wildlands along their border, especially an international park to be named La Amistad (Friendship), as part of overall cooperative efforts existing since the early 1970s to promote joint development of the border zone. The resolutions, and the decree creating La Amistad-Costa Rica, specifically mentioned the intention of the two countries to nominate their border wildlands for inclusion in the international network of biosphere reserves and on the World Heritage List. The resolutions also stated the intention of the two countries to seek cooperation from the Wildlands and Watershed Program of the Tropical Agricultural Research and Training Center (CATIE), of Turrialba, Costa Rica, in providing technical assistance in planning the border wildlands.

Progress in implementing the 1974, 1979 and 1982 resolutions on the Panamanian side of the border has been slower but nonetheless positive. In 1976 Volcan Baru National Park was created in the border area to protect the ecosystems surrounding Panama's highest peak and watersheds originating within the area. Resource inventories and a management plan for these areas have now been completed, with IUCN and CATIE assistance (LaBastille, 1976; MacFarland and Zadroga, 1981).

Costa Rican and Panamanian authorities originally hoped that joint nominations could be presented for consideration of the two countries' border wildlands as a single, bi-national biosphere reserve and World Heritage Site from the start. However, because of the delays in planning the Panamanian sector, the Costa Rican government decided to proceed unilaterally in 1982 and submitted nominations to Unesco for inclusion of their share of the wildlands in the international biosphere reserve network and on the World Heritage List. The area was accepted as a biosphere reserve in June 1982, and the nomination for inclusion of the Costa Rican sector on the World Heritage List will be formally considered in late 1983.

This biosphere reserve and proposed World Heritage Site comprises a reserve complex of just over 500,000 ha including the following areas: La Amistad International Park-Costa Rican sector, Chirripo National Park and Jitoy-Cerere Biological Reserve, all managed by the Costa Rican National Park Service (CRNPS); five Indian reserves (Tayni, Talamanca, Telire, Chirripo and Ujarras-Salitre-Cabegra); Las Tablas and Barbilla Forest Protection Zones managed jointly by the CRNPS and the Costa Rican Forest Directorate (CRFD); and the Las Cruces Botanical Garden, managed by the Organization for Tropical Studies (OTS), a university consortium (see Figure 1). All areas but Las Cruces are contiguous; the Botanical Garden is less than 25 km from Las tablas, and was included because of its excellent classroom, dormitory and research facilities, ideal as a base for biosphere reserve-related training and research activities.

4. PLANNING AND MANAGING THE COSTA RICAN SECTOR OF THE BINATIONAL WILDLANDS

The following section describes the planning and management of the Talamanca Range-La Amistad Biosphere Reserve as an example of the development process for a reserve cluster containing both natural and cultural protected areas, and whose management is entrusted to a series of different agencies.

4.1. The planning process

Starting in the late 1940s, but mainly in the 1970s, the Costa Rican government created a complex of natural protected areas and indigenous reserves covering most of the Talamanca Range. A common problem involved in almost all of these well-intentioned efforts was that resource inventories, especially of land tenure and location of human settlements, were not undertaken beforehand. As a result, later studies have shown that many of the Indian reserves contain sizeable non-Indian populations, are owned by non-Indians, or exclude some Indian settlements or hunting grounds. Similar problems affect the natural reserves of Talamanca. In addition, questions have arisen about the appropriateness of the management categories of the individual reserves or parts of them.

As a follow-up to the 1979 resolution in which the Costa Rican government declared its intent to create its sector of La Amistad Internaional Park, the government decided to contract CATIE to direct a detailed resource inventory and planning effort for the entire border wildlands area.

The planning effort, now well underway, is a good example of an interdisciplinary, interinstitutional approach to resolving resource management problems. The team consists of four levels of participants: the CATIE-contracted core planning team; full-time counterparts from the Costa Rican National Park Service Planning Department; representatives of other Costa Rican governmental institutions, assigned part-time to aid in the planning effort; and student and faculty volunteer collaborators from Costa Rican universities.

Since many of the team participants had no prior experience in similar efforts, the project began with a short intensive training course for them on the principles and procedures of wildlands planning according to the methodology proposed by Miller (1980). At the end of the exercise, each participant was assigned specific responsibilities in the initial search for all existing information on the natural and cultural features and socio-economic situation of the region.

Soon after, field inventories were initiated by the project's full-time staff and university collaborators in the Talamanca Range, to complement and update available information on the resources of the area and ground check the interpretation of available air photos covering about 50% of the region. Studies also began of land ownership and occupation, the results of which will be combined with data from ecological surveys to redefine the limits for La Amistad and adjacent protected areas.

The planning team is now working on general management guidelines for all Talamanca reserves; recommendations on revising their limits, zoning and management categories; and an overall biosphere reserve zoning scheme. In addition, the long-term management plan for La Amistad and adjacent Chirripo National Park, the two areas initially considered the "core" zone of the biosphere reserve, will be completed by 1985.

4.2. Current reserve management

Until long-term general management and development plans can be prepared for all CRFD and CRNPS managed areas in the biosphere reserve, management is being carried out by a combined force of approximately 30 rangers, under the terms of short-term (2 years), annually revised and updated operational plans, prepared by their staff and the planning team according to the methodology proposed by Barborak et al., (1982). The plans are designed to provide park and reserve managers with a simple, practical guiding document which permits them to maximize the impact of reserve management programmes and make the best use possible of limited financial resources and personnel. Management emphasis is placed on resource protection, environmental education/extension programmes directed at neighbours of the reserve, construction of basic infrastructure (trails, signs, ranger posts, etc.) and assistance in resource inventories as part of the overall biosphere reserve planning effort.

Management of the indigenous reserves is somewhat different. The Costan Rican National Indian Affairs Council (CONAI), Agrarian Development Institute (IDA) and agencies such as the Health and Education Ministries, advise Indian community leaders and assist in obtaining national and interntional support for priority programmes in the reserves, such as basic health care and bilingual education. They also pay salaries for health promoters, teachers, and the approximately 10 reserve wardens dedicated primarily to preventing invasions of reserve lands by non-Indian colonists. Actual decisions regarding internal affairs are made by community development councils in each reserve. Land ownership is communal, not individual, and the indigenous people live in widely scattered houses and not in organized villages. This makes delivery of services such as health care and education very difficult, but this arrangement is probably well adapted to the migratory agriculture practiced by most of them and in response to centuries of often-hostile encounters with outside civilization.

No formal inter-agency council or advisory board has yet been formed between the major management agencies and Indian reserves' community councils, but continual informal meetings help to assure coordination in management. As an initial example of the type of cooperative activity which the management

agencies hope to jointly carry out, in February 1983 a one-month ranger course, funded through the World Heritage Convention, was held at Las Cruces and in the Costa Rican sector of La Amistad National Park. Participants invited instructors from CATIE and all the involved management agencies, and invited participants from biosphere reserves in four neighbouring countries.

4.3. Dealing with major management problems

A series of existing and potential problems and threats affect efforts to plan and manage the biosphere reserve. The major problem along the lower slopes is the presence and continual expansion of colonization fronts created by migratory agriculturalists and land speculators, resulting in forest destruction, habitat elimination, and watershed degradation. Many of these squatters have legalized their claims by staying over ten years on "barren" government land; if forcibly removed all must be paid damages and relocated according to Costa Rican agrarian law. Buying out all these areas would be beyond the financial capability of the Costa Rican government. To attack this problem, constant ranger patrols are carried out, to monitor activities of existing colonists, who are prohibited from expanding their farms, and to discourge new invasions. Complete inventories of land occupation, ownership and values of private land and squatters' "improvements" are being completed in cadastral and tax offices in San Jose and by surveys carried out by rangers in the field. Interpreted, ground-checked air photos and tax and title information are being used to map precisely the affected areas. The eventual goal is to redefine park and reserve limits to eliminate those areas whose acquisition would be most costly and politically difficult, and whose ecological importance is minimal.

A major social problem is the distrust and suspicion with which reserve residents and neighbours, Indian and colonist alike, view the reserves and their rangers. To counter this problem, comprehensive environmental education and extension campaigns have recently been initiated with the aim of reaching every household, school, and community group in and adjacent to the reserves by 1985. Also, wherever possible, natives and colonists are hired as guides, porters and field assistants during field inventories.

Aside from budget and personnel limitations and localized resource use, problems such as colonization, poaching, and looting archaeological sites, a number of potentially devastating development projects have recently been proposed for areas in or near the biosphere reserve, as supposed "quick-fix" solutions to the Costa Rican financial crisis. These include construction of a cross-Talamanca highway, copper mining, and construction of a trans-continental oil pipeline. The latter two projects, of course, would also include road construction, and all would have a series of secondary impacts, such as massive uncontrollable colonization along the road routes, logging, and watershed destruction. All of these projects are the subject of serious national debate.

International financial and technical assistance and moral support is of utmost importance in protecting the biosphere reserve from both chronic problems such as poaching and major threats such as oil pipelines. Funding received or requested through a number of agencies, such as Unesco (World Heritage and MAB Programmes), IUCN/WWF (Tropical Forest Campaign), and the New York Zoological Society has been and will continue to be of critical importance in training personnel, expropriating private lands, buying equipment, building infrastructure, and supporting resource inventory and planning efforts. CATIE technical assistance has been of critical help in organizing and directing the planning and initial management effort.

The importance of biosphere reserve and World Heritage Site status in obtaining public and official support within both Costa Rica and Panama cannot be understated. The possible loss of international prestige by a government, involved in approving projects which threaten the integrity of "one of the world's few biosphere reserves" or "an area declared by the UN to be part of the World Heritage" or "one of the world's greatest natural areas" is important in convincing decision-makers to not approve such projects and in gathering enough strong local support to successfully block even officially sponsored schemes.

4.4. Long-term development philosophy

The overall, long-term management and development concept for both the existing Costa Rican sector of the biosphere reserve and its planned counterpart in Panama differ markedly from that applied in many developed countries. In the Northern Hemisphere, emphasis has been placed in biosphere reserves on basic research and monitoring, visitor services for public enjoyment and education and resource protection. Most developed-world biosphere reserves have been created on top of long-established national parks, ecological reserves and similar protected areas and the new designation has often not resulted in any change in management focus.

In the Costa Rican-Panaman border biosphere reserve, as in other biosphere reserves in Central America, management will concentrate on making tangible contributions to improving human welfare: applied research of potential values and uses of wild genetic resources; protection and management of watersheds for maximum downstream hydroelectricity generation, irrigation, domestic water supply and flood control benefits; environmental education and extension programmes; promotion of appropriately scaled and designed resource-based tourism; and design and implementation of improved land use practices in cultural reserves and in degraded areas adjoining natural reserves.

5. DISCUSSION

It should be clear that to initiate the planning and development of a truly functioning biosphere reserve, a complex task anywhere, is especially difficult when the reserve is a multicomponent or on an inhabited bi-national area, in the developing world, and not simply a new veneer and label superimposed on an existing strictly protected area in regions where phrases such as "ecodevelopment" and "sustained production of goods and services" do not form part of reserve managers' vocabularies.

Problems such as spontaneous colonization, poaching and archaeological site looting, complicate enormously the management of the Talamanca Range-La Amistad Biosphere Reserve in Costa Rica and will also be troublesome in the Panamanian sector of the reserve once it is established. But it is because of these problems, not in spite of them, that the biosphere reserve concept is so important and appropriate in the Talamanca Range and in many ecologically diverse areas with similar socio-economic problems throughout the developing world. The squatter, poacher, or grave robber is not a criminal, but rather an individual looking for a way to keep food in his family's stomachs. The management problems described in this paper are really not problems, but rather symptoms of problems typical in developing countries -- land scarcity, population growth, soil impoverishment, acculturation of indigenous peoples, and poorly conceived development schemes.

The resolution of these problems is of critical importance if developing countries really hope to "develop" in any sort of sustainable fashion, bringing benefits to all sectors of society. Since human problems and those involving protection of the earth's natural heritage and genetic resources in the developing world are intertwined, an integrated approach to resolving them, both within and among nations, is necessary. The Man and the Biosphere Programme provides a valuable framework for attempting this. The case of the Costa Rican-Panamanian border wildlands is a tangible example of both the opportunities and difficulties posed in development of a multi-component, bi-national biosphere reserve in the developing world, as a means of reconciling socio-economic development and resource protection and in order to achieve long-term protection of outstanding natural and cultural values and genetic resources, while simultaneously contributing to sustainable socio-economic development at local and national levels.

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Figure 1. Border wildlands of the Talamanca Range and Changuinola Basin, Costa Rica-Panamá.

THE BOUCLE DU BAOULE, MALI

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ABSTRACT. The Boucle du Baoule Reserve in Mali, West Africa, is situated in the northern Sudan (=Savanna) zone, just south of the Sahel (=Tropical steppe) zone. The vegetation, mostly Combretum scrub savanna, is still basically intact. The fauna, typical for the northern Sudan zone, is seriously depleted, mainly because of poaching. The Sahel and northern Sudan zones have always been the most densely populated areas of tropical Africa. The reserve is consequently under heavy pressure, mainly from the semi-nomad pastoralists which have seen the carrying capacity of their traditional grazing grounds north of the Reserve reduced through the extention of agriculture in particular and exhaustion of the soils in general. The proposed management plan should help to preserve this part of the Sudan zone - the only one in West and Central Africa - with as many avantages for the local population.

1. INTRODUCTION

This paper is based on the work of the project on Research on Rational Utilization of Wildlife in the Sahel, the fieldwork of which was carried out in Mali, from 1977 to 1982. The project, financed by the Dutch Ministry of International Cooperation, was executed jointly by the Forestry Service of Mali and the Agricultural University of Wageningen. As the results and conclusions of the project are not yet published, the present paper reflects only the interpretation and opinion of the author, and not those of the research worker, nor of the Malian authorities. The "Parc National de la Boucle du Baoule" the adjacent reserves was proclaimed a Biosphere Reserve in 1982, and forms thus a link in the international network of Biosphere Reserves in the arid and the savanna regions.

2. THE SUDAN AND SAHEL ZONES OF NORTHERN TROPICAL AFRICA

2.1. Environment

The Sudan zone of northern tropical Africa (see map 2) can be considered as the 'true' savanna zone, as compared to the evergreen forest zone to the south, and the tropical steppe to the north (Schnell, 1970-1977). The climate of the Sudan zone is tropical with a distinct dry and wet season. Annual rainfall varies from 1,000 - 1,200 mm in the south to 400 - 500 mm in the north. Towards the north, the annual rainfall decreases, but even more important, also becomes more erratic. This irregularity is the main climatic factor in the Sahel, not only because the rainfall is unpredictable during the wet season, but there is also a tendency for there to be prolonged periods in

which the rainfall is below the long-term average; this has been the case since the late 1960's. Positive feed-back mechanisms (Nicholson, 1982) may reinforce a dry period once started, even without the influence of Man.

2.2. Flora and fauna

The vegetation of the Sudan zone is in general savanna, with a continuous grasslayer, shrubs and trees forming an open canopy. Toward the arid zones the total cover of the vegetation decreases, and is more sclerophilous, forming a tropical steppe. The grasses are predominantly perennial in the savanna (Sudan) zone and practically only annual in the Sahel (Schnell, 1970-1977). The rather vague boundary between savanna and steppe can be put at around 400 mm annual rainfall.

The Sahel has a few -- for West Africa at least -- typical species such as giraffe, Giraffa camelopardalis; red-fronted gazelle Gazella rufifrons, cheetah Acinonyx jubatus and ostrich Struthio camelus. Toward the Sahara, species adapted to arid environments occur: oryx Oryx dammah; Gazella spp. and addax, Addax nasomaculatus, the latter being a true desert species.

2.3. Man

The Sahel and the northern Sudan zone have always been the most densely populated regions of tropical Africa, with the possible exception of parts of Ethiopia.

The absence of Glossina spp. and Simulum spp., the vectors of sleeping sickness and river-blindness respectively, made cattle husbandry possible. The combination of a seasonal climate, great river-systems, and a mosaic of vegetation types such as savanna, gallery forests and floodplains, offers a great variation in means of subsistence. This potential, together with contacts with the outside, notably the Arab world, has resulted in well-developed states such as Ghana, Mali, Senegal, etc., over large parts of the Sahel and Sudan zones.

2.4. Landuse

The major form of landuse in the Sahel has always been cattle husbandry, nomadic in the arid regions and semi-nomadic more to the south. Semi-nomadic pastoralists exploit the good grazing grounds of the Sahel in the rainy season, but are forced, because of the lack of water and food, to move more to the south, where not only the quality of the pastures is lower (Pennning de Vries and Djiteye, 1982), but where the risk of disease is also much higher. The floodplains of the larger rivers offer good but limited grazing grounds during the dry season. Agriculture, which needs a regular and predictable rainfall regime, has developed in the Sudan zone more than in the Sahel (where it was only found in the more favourable localities).

The relation beween the pastoralists and the farmers has always been rather close, though not without friction, through the exchange of both goods and services (Harris, 1980). The exploitation of wild fauna has given rise to specialization only in the case of fish. Hunting is mostly carried out in combination with other occupations on the village level, usually farming; pastorallsts, with the exception of the Maure, do not hunt often.

2.5. Present situation

The situation as described above is still basically intact, but relations with the environment have become strained to say the least. Developments in the last 100-150 years have had a dislocating impact on these societies: colonization; the decrease of the importance of the trans-Saharan trade routes; the growing importance of the towns on the Atlantic coast; the establishing of modern states, with boundaries, regulations and ideologies foreign to traditional societies; the introduction of modern technologies; and a far from coherent modernization (e.g. veterinary care without equivalent improvement of pastures) have led to a situation of disequilibrium. The human population has increased in numbers, but not in means to exploit an ecosystem with distinct limits to its exploitability. The result is an overall, but slow exhaustion of the system (Penning de Vries and Djiteye, 1982) punctuated by locally severe degradation and aggravated by periods of drought.

It is thus not surprising that developments past and present, the density of the human population and the intensity of landuse, has not left much of the natural ecosystem unimpaired. No large animal species have disapppeared from West Africa in historical times apart from the black rhino Diceros bicornis, but typical Sahel species, such as giraffe, ostrich and cheetah are, becoming increasingly rare. The same can be said for the more widespread species elsewhere in the northern Sudan and Sahel zones.

3. THE BOUCLE DU BAOULE

3.1. Environment

The Boucle du Baoule Biosphere Reserve is situated in the northern Sudan zone in Mali (see maps 1 and 2). Annual rainfall since 1970 has averaged about 500 mm in the north to 80o mm in the south, but the long-term average is 150-200 mm higher. The Reserve is underlain by sandstone, often capped by ironstone, and for the larger part strongly dissected. Soils are mostly rather shallow. The Baoule river has a deeply incised bed, almost without a floodplain.

3.2. Flora and Fauna

The vegetation is typical considering the edaphic and climatic conditions: shrub savanna and dominated by Combretum spp., and Isoberlinia savanna woodland in the south. The Baoule has a narrow fringe of riverine woodland for most of its course .

The larger fauna is also typical (nomenclature according to Haltenorth, 1977); elephant Loxodonta africana; hippopotamus Hippopotamus amphibius; warthog Phacoehoerus aethiopicus; giraffe Giraffa camelopardalis; buffalo Syncerus caffer; roan antelope Hippotragus equinus; hartebeest Alcelaphus buselaphus; waterbuck Kobus ellipsiprymnus; reedbuck Redunca redunca; bushbuck Tragelaphus scriptus; oribi Orebia oribi; grey duiker Sylvicapra grimmia; red-flanked duiker Cephalophus rufilatus; lion Panthera leo; leopard Panthera pardus; spotted hyena Crocuta crocuta; striped hyena Hyaena hyaena; baboon Papio cynocephalus; green monkey Cercopithecus sabaeus; patas monkey Cercopithecus patas.

3.3. Landuse

The landuse fits the general pattern of the northern Sudan zone: pastoralists mainly in the northern part of the Reserve in the dry season, and agriculture, adapted to local rainfall conditions, throughout the zone.

The Baoule region is not particularly suited to cattle. Perennial grasses, with their dry season regrowth, are only important in the southern part, which also holds the highest risk in sleeping sickness and other diseases. The risk of sleeping sickness is high, in all seasons along the Baoule.

The main constraint for agriculture is the relatively small area of suitable soils. The presence of river blindness reduces the potentially available settlement area near the rivers. The net result is that the area of the Reserve has a low population density, about 0.4/sq km, as compared to 6.2/sq km north of the Boucle and 4.9/sq km south of the Reserve.

The main trend in landuse in the region is toward increase in cultivated land (as opposed to intensification of agriculture), especially to the north of the Reserve. This has an immediate impact on the pastoralists, who see not only their grazing grounds reduced in those areas, but also find them increasingly inaccessible when the crops are still on the fields in the early dry season.

These developments have led to the "Opération de Développment Integré du Kaarta" (the region north of the Boucle) to construct of cattle trails across the Kaarta and straight into the "empty" Reserve, in order to guide the cattle through the Kaarta at the end of the rainy season and avoid conflicts between farmers and pastoralists. The result, of course, is an increase in cattle numbers in the Reserve at least during the early dry season.

3.4. The state of the natural ecosystem

The larger fauna of the Boucle is in demand, and under strong pressure from three groups of illegal hunters: hunters from the larger towns, with often modern equipment; local hunters, mostly part-time farmers (the pastoralists do little hunting); and Maures from the north hunting for the market in Mauritania.

The result of this illegal hunting has been a stong decrease in annual numbers to the point of extermination of a number of species. A major factor is that the Baoule region is a transition between savanna and steppe. A number of species (e.g. buffalo, hartebeest) have in the region the natural limits of their distribution and are therefore especially vulnerable to disturbances.

The vegetation of the Reserve is more or less intact, the major disturbance being clearing for agriculture. Cutting for wood is rather limited because of low population density and distances to larger markets. Only the palm Borassus aethiopum, with its straight bole and termite resistant wood, is commercially exploited to some extent.

Fishing and gathering of minor forest products occurs but does not exert much pressure on the ecosystem. In terms of conservation, the Boucle du Baoule is intact as far as soils and vegetation is concerned, but its fauna is seriously depeleted.

4. THE MANAGEMENT OF THE BOUCLE DU BAOULE RESERVE

4.1. History

Part of the region was first declared a protected area in 1926, and after a few changes in status, declared a National Park in 1954. The surrounding reserves followed a similar development: the Badinko became a 'reserve totale de faune' in 1952, the Fina followed in 1959; and the Kongosambougou became a forest reserve in 1955. Finally, in 1982 the Boucle du Baoule National Park and the Fina, Kongosambougou and Badinko reserves were declared a Biosphere Reserve.

4.2. Management options

The management plan currently in preparation is based on the following considerations:

-- the Baoule region is one of the few larger areas in the transition zone between the Sahel and Sudan zones, which is still more or less intact; and

-- the landuse is not entirely in line with the present management objectives or the concepts of the Biosphere Reserve.

In order to arrive at a comprehensive and coherent view of the potential and the problems of the region, an inventory and land evaluation were carried out. This resulted in a number of options for the management of the region, based on the possible forms of landuse, their interactions and relations, and the socio-economic and institutional framework. This led to the following conclusions:

(a) Extensive cattle husbandry is, in its demand on grazing grounds and water, comparable to the requirements of wildlife and only to a certain extent are the two compatible considering that what is used by one is no longer available for the other. As pastoralists and their cattle are by nature not easy to regulate, the management question concerning their presence comes close to a yes or no situation. Cattle and agriculture are to a certain level compatible, if not linked positively; but in the case of the Baoule region, the problems with cattle are caused by the increase in land under cultivation north of the Baoule. Solutions will have to be found there, as the current trend will lead to large-scale exhaustion and degradation of the soils.

(b) Agriculture is as practiced cannot be combined with wildlife conservation. The effects of agriculture under the current technology are still strictly localised, but this may well change in the future.

(c) Wildlife, and especially the larger animals, have strong territorial demands in terms of minimum areas required. This is independent of the possible forms of exploitation such as hunting, tourism, etc.

(d) Activities such as fishing and the gathering of minor forest products do seldom influence the ecosystem to such an extent that they have to be considered separately as land utilization types.

4.3. The proposed management plan

A proposed management plan is based on the formal limits of the area under management of the Forestry Service. The different sectors of the reserve have the following management objectives:

-- the National Park and the Fina: core reserve with tourism and gathering of minor forest products by the surrounding villages allowed. This configuration has the advantage of being the narrowest in the east-west direction, and thus the least obstructive to cattle migrations.

-- the Kongosambougou (and the whole zone north of the Baoule): grazing reserve or, preferably, core reserve like the Park and the Fina.

-- Bakinko: grazing reserve or game reserve, to be decided on basis of detailed plans to be proposed shortly.

-- buffer zones with the same management objectives as the adjacent reserves will have to be established and maintained, especially on the right bank of the Baoule.

-- the farming areas in the Kenyé valley and at the southern border of the Fina will, in the first phase, have to be kept within the present limits.

-- the future of the farming areas currently within the reserves has to be considered later, in the light of the results obtained, and of the means available.

5. DISCUSSION

Undoubtedly the biosphere reserve concept is a useful tool for conservation. Its flexibility enables plans to be adapted to various problems encountered. However, this does not eliminate the need of making choices, of drawing lines. The name "Biosphere Reserve" suggests that the basic idea behind it is that Homo sapiens, as a biological species subject to ecological laws, should be able to behave as such. This may happen, but only on the level of the species population as a whole. In terms of impact upon other species, Homo sapiens provide the most serious population problem that the planet has probably ever known.

At the level of sub-populations e.g. those human groups living in and around a Biopshere Reserve, managers must deal with those characteristics that enable Man to manipulate his environment, to a far greater extent than any other species on earth and to avoid, at least for the time being, the consequences of his acts by constantly moving himself around, and drawing resources from more than just his direct environment.

When dealing with a specific region such as the Boucle du Baoule, one encounters first the problem of poaching; most species in the region are poached by more or less commercial hunters, not by hungry peasants in need of of food. More important is the fundamental matter of compatibility of different land uses. Man manipulates the system to extract food and other products from it, and what man uses is thus not available for other purposes. It is a hard and undeniable fact that much more food is needed and that the

means to manipulate the system are also increasing, thus not only leaving less "nature" but also increasing negative effects of pollution and the like. This makes several forms of landuse incompatible with the conservation of natural ecosystems. Use of "ecological" forms of agriculture, however desirable, do not change the basic problem. Stable landuse is a condition for conservation, but it is not the same as conservation; choices cannot be avoided.

For example, in the short term elephants and food-crops do mix rather too well, so at least some land utilization types have to be separated geographically. This, however, does not mean that all interaction or integration is impossible. If, for instance, game cropping is chosen as an objective for the Bakinko, the farmers having their fields outside the reserve could (and should) play an important role in the exploitation. The advantage of the biosphere reserve concept is that once the different ecological and sociological components have been defined, a coherent entity can be assembled.

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BIOSPHERE RESERVES: AN INDIAN APPROACH

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ABSTRACT. It is estimated that the Indian region harbours about 45,000 species of plants and 65,000 species of animals. While in the biota there are African, European, Indo-Malayan, Sino-Japanese, Eurosian and Mediterranean elements, a large number of the species are endemic to India. Though India was quite conscious of the need of conservation of its flora and fauna from the early 20th century, a major step was taken by enactment of Indian Wildlife (Protection) Act in 1972. Today, India has 44 National Parks and 207 Sanctuaries covering a total area of 87,835 sq km. To supplement these efforts, Indian MAB Committee has identified 12 representative ecosystems to be protected as biosphere reserves. Eco-development programmes in the surrounding areas of the biosphere reserves, participation by the local population in the environmental management, monitoring and education through organizing Paryavaran Kendras (Environment Centres) are among the important elements of the programme.

1. INTRODUCTION

When the Biosphere Reserve Programme was initiated in 1971, the Indian National Man and Biosphere Committee was already organizing and aiding the various MAB research projects in India. In 1979 the Indian National MAB Committee constituted a "Core Advisory Group of Experts" for preparing a preliminary inventory on potential areas for recognition as biosphere reserves within the framework of national conservation effort.

1.1. Rich biological heritage

The idea of conservation is not a new one for India. References are scattered in ancient Indian literature emphasizing the conservation of fauna and flora. Ashoka's Pillar Edicts are a glowing example. The descriptions of fauna and flora of the area also occur very often in the ancient Indian literature. These references and descriptions are not surprising and go well with India's cultural heritage which in essence has been conservational in approach. The Indian region, with a total area of 328 million ha, is indeed very rich in biological diversity. It is estimated that about 45,000 species of plants occur in this country. The vascular flora which forms the conspicuous vegetation cover, itself comprises 15,000 species.

The region is equally rich in fauna. More than 50,000 species of insects, 4,000 of molluscs, 6,500 of other invertebrates, 2,000 of fish, 140 of amphibians, 420 of reptiles, 1200 of birds and 340 of mammals (i.e. more than 65,000 species of animals) are recorded from this country.

The wild relatives of the crop plants together with related species constitute gene pools which are rich sources, of many important and desirable traits. Such species are distributed in centres of diversity/origin of crop plants. These regions are ironically the regions of least productivity and most such regions are populated by tribes where socio-economic advancement will bring changes in crops and agricultural techniques resulting in the loss of thousands of years of selection and adaptation of the traditional crop plants. These plants contain vast treasures of genes for resistance to pests and diseases and adaptation to stress conditions. Good land is a finite

resource, and if we have to increase agriculture production, perhaps it will be by expansion into marginal land where these traditional varieties still thrive.

Over 150 species of economic plants have their genetic diversities in the Hindustan Centre of Diversity (Zeven and Zhukovsky, 1975) in the Indian sub-continent and most of these species grow in some of the proposed biosphere reserves. Besides, there is a vast number of other economic plants which are utilized only for their wild populations which have their home in the proposed biosphere reserves.

Parallel to such an enormous diversity in plants, there is also considerable diversity in domesticated animals and their wild and semi-wild relatives, such as buffalo, goat, sheep, pig, poultry, camel, ass, yak, horse, etc. The productivity of these animals is very low. However, having undergone periods of rigorous selection, races are hardy, adaptable to heat and parasitic stresses, and can survive on very poor roughage. Obviously, such animal genetic treasures at present existing in the wild or with tribal populations also needs to be conserved.

1.2. Habitat and biotic diversity

This biological diversity is undoubtedly due to the great variety of habitats found in the sub-continent, reflected in the fact that 12 biogeographic provinces are found within India (Udvardy, 1975). According to Udvardy's classification, India falls under two realms, the Himalayan region in the Palaearctic Realm and the rest of India in the Indo-Malayan Realm.

The whole region is rich not only in ecological and biological diversity but also is the confluence of several realms; biota includes African, European, Indo-Malayan, Sino-Japanese, Eurasian and Mediterranean elements.

1.3. The conservation effort

India was quite conscious of the need of conservation since the last quarter of the 19th century. Several pieces of legislation were enacted for the conservation of fauna and flora. However, the most important step toward conservation was perhaps taken by the enactment of the Indian Wild Life (Protection) Act of 1972. Large areas in various parts of the country were declared as Sanctuaries and National Parks under this Act. Some 44 National Parks and 207 Sanctuaries have been constituted under this Act. This network of National Parks and Sanctuaries covers 87,835 sq km and accounts for 2.7% of the total area and about 12% of the total forested area of the country as a whole. Sanctuaries and National Parks are oriented more toward species and their habitats, while the basic purpose of biosphere reserves is the conservation of the biotic community as a whole.

2. NATIONAL BIOSPHERE RESERVE PROGRAMME

To achieve this objective of affording protection to biotic communities as a whole, the Core Advisory Group of Experts followed the standard criteria for selection of biosphere reserves set by Unesco and identified the following 12 sites as potential biosphere reserves together with their locations:

S. No.	Biosphere Reserve	States
1.	Nilgiri	Tamil Nadu, Karnataka & Kerala
2.	Namdapha	Arunachal Pradesh
3.	Nanda Devi	Uttar Pradesh

4.	Uttarkhand (Valley of Flowers)	Uttar Pradesh
5.	North Islands of Andamans	Andamands & Nicobar
6.	Gulf of Mannar	Tamil Nadu
7.	Kaziranga	Assam
8.	Sunderban	West Bengal
9.	Thar Desert	Rajasthan
10.	Mannas	Madhya Pradesh
11.	Kanha	Manhya Pradesh
12.	Mokrek (Tura range)	Meghalaya

While recommending the potential biosphere reserve areas, the Group tried to cover as many as 9 out of India's 12 biogeographic provinces. As evident from the list above, the Himalayan highland, the Thar desert, the Malabar rain forest, Indo-Ganges monsoon forest, Deccan thorn forest, Cormandel, Mahanadian, Bengalian rain forest and Andaman and Nicobar Islands were covered by their recommendations.

3. ESTABLISHMENT OF A CENTRAL CELL FOR PROGRAMME IMPLEMENTATION

The Biosphere Reserve Programme is based on principles of conservation and is essentially an ideal management concept for all protected areas. In India, the management of all protected areas is directly the responsibility of the concerned states or Union Territories. This arises from the present constitutional framework and the federal policy nurtured thereunder. The states are also the proprietors and custodians of "Land" and "Forests", the two resources vital to the Biosphere Reserve Programme. The implementation of this progrmme will thus have to be in keeping with the present pattern and the modalities for this purpose have to be worked out accordingly. If, however, some state government or UT Administration agrees to transfer its responsibility in this respect to the Centre, there should be no difficulty in handling such responsibility directly to the Central Government. But, as a general rule, this would depend on the concerned state government.

However, it is contemplated that the Central Government will, through a special Cell created for the purpose, assume direct responsibility in three main respects:

-- Full financial assistance for the approved items of the programme;

-- Technical expertise and know-how, including trained personnel; and

-- Detailed guidelines covering all aspects of management for implementation by the State machinery, followed by close and effective monitoring and supervision.

The Central Government would play a key role in the setting up and management of these conservation areas, particularly since the effort involves substantial investments which could not be forthcoming easily from the state governments. The Central Government will also make it possible to keep a greater check over local pressures and for maintaining consistency of management practices and scientific research over the country as a whole. Under the education programme, Paryavaran Kendras (Environmental Centres) will also be established in each biosphere reserve. This would enable researchers, teachers, students and even interested amateurs, to undertake field work for purposes of research, education and training as also familiarization with the problems in a particular biosphere reserve.

The management of these areas will call for a combined effort by personnel from diverse backgrounds. A key role will have to be played by technical

experts in the areas of ecology and other environmental sciences. The management would also involve personnel from technical departments such as forestry, agriculture, animal husbandry, fisheries, soil and water conservation, tribal/rural welfare, etc. It is important that such personnel should make a long-term commitment to conservation effort and involve themselves for substantial periods. They should be encouraged to do so by including an element of "flexible complementation" in the scientific and technical cadres from the very beginning. They should also be given attractive emoluments to provide compensation for working in difficult and remote areas without normal amenitites. To fulfil the diverse and specialized tasks involved in the management of biosphere reserves, specialized cadres will be required. Such central cadres of scientific personnel will be created, along with the supporting and managerial cadres.

3.1. Concept development

The Department of Environment, which has been recognized as the "nodal agency" for the Biosphere Reserve Programme, has already done considerable spade-work in this area. It has been engaged in developing the concept through scientific enquiry, partly through mapping of the biogeographic regions and vegetation types of the country as well as by identifying the critical areas and undertaking intensive floral, faunal and other studies. In this effort, the basic scientific support in respect of flora and fauna is being provided by the Botanical and the Zoological Surveys of India, which are the organizations attached to the Department of Environment. The National Eco-development Board, set up to catalyze eco-development activities is also linked to the Department of Environment. More recently, the entire work relating to wildlife conservation and management was transferred to the Department of Environment and there is a close link-up between these activities.

3.2. Declaration of selected areas as biosphere reserves

Once an area is selected for inclusion under the programme, the central and state governments will take appropriate action to get it designated as a biosphere reserve and to set up the machinery for implementation.

The Central Government may assume full responsibility for meeting the costs, including recurring costs involved in the establishment and maintenance of biosphere reserves. The costs of acquisition of land rights may, however, be shared equally between the Centre and the concerned state. While local management will be with the state authorities, the Central Government would assume responsibility for making available technical expertise to carry out the scientific and technical programmes and will also concern itself with monitoring, appropriate supervision, guidance and evaluation.

3.3. Local participation

The approach of the entire MAB Programme is to associate the local population as far as possible with the formulation and implementation of research projects. This approach becomes all the more important when etablishing and managing the protected areas, which invariably involve restrictions on and changes in the traditional landuse patterns.

It is only when a biosphere reserve is integrated into its region and constitutes a positive element in the local socio-economic milieu that its future can be really ensured. It is, therefore, necessary that the people are made to understand the merits of the programme so that they become the guardians and custodians of the reserves. Environmental education and

training is aimed at achieving these goals. Hence, it is proposed to open environmental centres in each biosphere reserve to create general awareness as well as to impart and disseminate the knowledge and skills on the relevant subject areas.

3.4. Research and monitoring

Since conservation efforts must be backed with a strong component of research for fully utilizing the benefits emanating out of the creation of biosphere reserves, the Indian National MAB Programme envisages research on the following major aspects:

-- Baseline data collection for preparation of an inventory of abiotic and biotic components of the biosphere reserves; collection of information on meteorology, land-use practices, distribution and status of key species as well as endemic, rare and threatened species; socio-economic survey regarding the local population, their occupations, needs, etc.

-- Monitoring research to concentrate on climatological measurements; soil, water and air pollution studies; productivity, phenology, population dynamics of selected animal and plant species; energy and material flow; demography of human population; patterns of human utilization of wild plants and animals for food, fodder, drugs, shelter, etc.

-- Manipulation research to investigate the effects of various kinds and degrees of human use and interferences.

-- Restoration research designed to study ways of rehabilitating degraded ecosystems or restoring climax where this has disappeared.

To begin with, the assistance of existing organizations like Survey of India, National Remote Sensing Agency, Botanical Survey of India, Zoological Survey of India, Geological Survey of India, India Meteorological Departement, various universities and research organizations will be fully utilized. However, in the long run, a strong cadre of trained scientists to undertake environmental research in the biosphere reserves will have to be developed for which the international organizations like IUCN and Unesco will be asked to play a key role in terms of arranging training programmes.

3.5. Role of international organizations

Research and monitoring is implicit in the biosphere reserve programme. This requires a cadre of trained manpower and establishment of a strong research base which is resource intensive. The developing countries have insufficient trained manpower, particularly in the areas of nature conservation and ecology which are relatively new subjects. At the same time, adequate financial support is unlikely to come from the governments for developing research facilities. It is here that the international organizations can play a key role by extending assistance to countries in training scientists and managers involved in the programme and also by fiscal support for research and monitoring stations.

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NATURE CONSERVATION IN THE BYELORUSSIAN SSR

By

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ABSTRACT. A wide complex of scientifically grounded conservation measures (organizational, legal, economic, technical) in the Byelorussian SSR is discussed. The role of national, scientific and public organizations in the field of conservation and rational use of the Republic's natural resources is shown. Main achievements in this field are mentioned. National measures aimed at protecting land resources, improving soil fertility, protecting flora and fauna, water resources and atmospheric air are dwelt upon broadly; special attention is paid to characterizing the Republic's reserve features, the area of which from the Republic's total territory will increase by 10% up to 1990.

1. INTRODUCTION

The problems of nature conservation and rational use of natural resources in Byelorussia, as in other Republics of our country, have always been of national importance. The nature conservation legislation of the Republic is based on a system of environmental protection standards developed under the guidance of V.I. Lenin, who, in the very first years of the Soviet State, signed more than a hundred decrees and other documents providing for the rational use and protection of land, entrails of the earth, forests and waters, creation of nature reserves and sanctuaries in our country, and hunting and fishing control.

2. THE HISTORY OF CONSERVATION IN BYELORUSSIA

The Berezinsky State Reserve, one of the first reserves, was established in 1925 in the north of Byelorussia by decrees of the Soviet power. In 1939 the Belovezhskaya Pushcha was declared a state reserve. Our Republic suffered tremendous damage during World War II. Leonid Leonov, a writer, wrote that the forest usually shares the fate of its people. This is quite true of Byelorussia. During the German invasion every fourth citizen perished, and every third hectare of the forest was destroyed.

After the war, immense projects were initiated to develop and transform waterlogged lands of Polesie, and to regenerate forests. Basic research of the natural complex, in the course of which some destroyed reserves were restored and new reservation areas for protection were designated, preceded these projects.

The development of industry and agriculture in the Byelorussian SSR concentrated the population in urban areas and resulted in corresponding changes in and transformation of nature and the environment of the Republic. These changes cause problems which are urgent not only for Byelorussia but for all industrialized countries. In solving these problems special attention was paid so that natural resources could be used without damaging others and that economic activities would not disturb the natural equilibrium, and that nature would serve man for ever.

Since 1960, when the BSSR Council of Ministers State Committee for Nature Conservation was established, conservation and rational use of natural resources acquired a more stable scientific and national foundation. The Nature Conservation Act and the Resolution of the BSSR Council of Ministers "On the Protection of Natural Relics on the Territory of the Byelorussian SSR" were adopted respectively in 1962 and 1963.

Numerous scientifically-based legislative, technical, economic and organizational measures meeting the main principles of the Stockholm Declaration have been implemented in the Republic during the last 10-12 years. Taking into account stricter conservation requirements, branch normative acts related to all major natural resources have been significantly renewed. The following State Codes have been approved by the Supreme Soviet of the Byelorussian SSR: on Lands (1971), Waters (1973), Mineral Wealth (1977), and Forests (1980); laws on Protection and Use of Wildlife (1981), on protection of atmospheric air, and on public health; and legislation providing for a vast system of legal rules aimed at preventing pollution of and improving the quality of the environment.

The new Constitution of the Byelorussian SSR adopted in 1978 makes nature conservation and the responsibility of officials to protect nature the fundamental law of the Republic; it reflects all the 10 principles formulated in the final Act of the Conference on Security and Cooperation in Europe, signed in Helsinki.

The right of man to "favourable conditions of life in the environment the quality of which allows one to lead a prosperous life" and one's special responsibility for protection and improvement of the environment and also for conservation and reasonable management of natural resources are fixed in the Fundamental Law of Byelorussia.

3. CURRENT CONSERVATION MEASURES IN BYELORUSSIA

The Republic has recently introduced planning of conservation measures on the basis of a developed general ecological prognosis of possible changes in nature and in view of the development of some branches in the Republic's economy until the year 2000, and also on the basis of some prognoses for particular branches, general plans and schemes of complex protection and use of natural resources. The General Scheme for Use of Land Resources in the Byelorussian SSR for the period up to 1990 and the General Scheme of Protected Areas approved by the Byelorussian Government are documents of great importance.

For some industrial regions with complicated situations, regional measures for environmental protection are being technologically and economically substantiated. Such a project, for instance, is being developed for the Soligorsk industrial region, where potassium salts are mined for the Naroch Lake basin, the largest resort in the Republic.

The general ecological prognosis reflects the present state of biosphere resources, their possible changes resulting from economic development, main directions of the rational use of natural resources, nature conservation activities and environmental research. Accordingly, more than 205 conservation research projects of national economic and social value are being developed at present in our Republic by some Institutes of the Byelorussian Academy of Sciences, branch research institutions and higher educational establishments. A total of 55 establishments are involved in these activities.

The main achievements concerned with the problems under discussion at the present Congress are primarily results of completed research on projects of the International MAB Programme dealing with protected forest ecosystems. Such studies have revealed the regularities of effects by major anthropogenic factors (drainage and subsequent farming) on natural complexes and their constituents. Valuable data have been obtained on the organic matter transformation and enzymatic activities of soils at different stages of development under the natural and artificial phytocenoses.

Studies of water regulating and the protective role of forests have shown the effect of forest phytocoenoses on the infiltration of surface waters and transfer of the surface runoff to an intrasoil one. Some forestry measures which would alter the water regulatory function of forests and which would optimize the area of forests by mutual transformation of forests and agricultural lands have been proposed.

In order to estimate the degree of human impacts on forest and boggy ecosystems, scientific and technological prognoses of possible changes in natural complexes and methodological guidelines to decrease the adverse drainage effects have been developed and disseminated among organizations concerned. A long-term scheme for a network of protected areas in Byelorussia is being developed to ensure long-term preservation of natural complexes in the future, including valuable phytocoenoses and some flora and fauna species.

Since the Berezinsky Reserve was included into the network of biosphere reserves, large-scale research under the MAB Programme has been performed in the Republic. Particularly in and around reserves, the hydrological regime and the productivity of bogs and waterbodies, ecological regularities of the composition and development of plain forests, and the structural and functional analysis of fauna of animals and birds in different biotopes are being studied. Monitoring of the geophysical medium and biological components of forest biogeocoenosis is under way.

The studies in the field of conservation and rational use of natural resources are coordinated by a specially established Scientific Council for Biosphere Problems of the Byelorussian Academy of Sciences, consisting of eminent and leading experts of the Republic.

Scientifically-based prognoses and general plans make it possible to design, locate and rationally run national economic development, and consequently to determine correctly a technological strategy of development of the national economy from ecological viewpoints.

In the field of environmental education, special environmental courses have been included in the curricula of secondary and occupational schools and higher educational establishments; lecturing bureaus and people's universities are in action everywhere.

To promote implementation of the outlined conservation measures a system of control and observations consisting of state and public organs is now effective in the Republic. Standing deputy commissions on nature conservation work at the Supreme Soviet (the highest governmental body), as well as at local Soviets. The Byelorussian State Committee for Nature Conservation has numerous regional and district sections, the Byelorussian Hydrometeorology and Environmental Control Agency is active in this field and a number of branch control services of Ministries and Departments of health, agriculture, forestry, and fisheries, etc., also have environmental responsibilities.

The Byelorussian Hydrometeorology and Environmental Control Agency ensures collection, generalization, estimation and dissemination of information on levels of environment pollution and coordinates background observations carried out in reserves, particularly in the Berezinsky Biosphere Reserve.

The Byelorussian Nature Conservation Society, comprising one third of the Republic's population, is very helpful to governmental conservation bodies.

To prevent soil erosion and to rationally use lands, forest trees have been planted over 68,000 ha of sandy lands, ravines and river banks. Tree plantations have been established on an area of over 333,000 ha in collective and state farms, and this has increased the forest coverage of the Republic to 34.5% which may be considered the optimum required to provide the ecological balance in Byelorussia.

A system of special protected natural areas with different purposes has been established in the Republic to maintain the ecological balance of nature; to preserve particular animal and plant species, their gene pool, living organisms, unique and typical landscapes; and to educate the public. The total of protected areas covers more than 900,000 ha, or 4.4% of the Byelorussian territory. Today they comprise 2 reserves, 2 hunting reserves, 4 hydrological, 4 landscape, 1 forest, 8 lakes, 32 botanical reserves (including 12 for drug plants and 20 for cranberries), 6 game reserves, and 200 natural relics and monuments. By 1990, the area of reserve features will cover about 10% of the Republic's territory.

Besides, 16 Republican recreation zones cover 500,000 ha and the number of local recreation zones has increased considerably in the Republic. Any economic activities, except servicing and those oriented at accomplishing target objectives, are prohibited there. Much has been done to create new green zones and to extend the existing ones, their total area being now 1,130,000 ha; over the past 10 years it has increased by 37%. All the cities and urban settlements are surrounded at present by forest zones.

The forests of green zones and other types of protective plantings are free from felling and economic activities are aimed only at increasing the ecological and conservation role of the forest stands. In view of this, the area of non-utilized forests under special protection which fulfil ecological and recreational functions covers now more than 10% of the whole territory of the Republic.

A complex programme on the conservation and rehabilitation of rare and endangered animal and plant species is being carried out in the Byelorussian SSR. "The Red Data Book of the Byelorussian SSR" approved by the BSSR Council of Ministers which lists 84 animal and 85 plant species is a scientific basis for these activities. Hunting and picking of plants are prohibited in the Republic, and trade in wild animals and plants is regulated in accordance with the International Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES) as well as sale and purchase of these species of animals and plants, their parts and derivatives, except cases provided for by the Convention.

These measures have resulted in an increased number of aurochs, elk, wild boars and deer; the number of river beavers has reached the former level and they are being re-established now; and nurseries are created to breed rare species of animals.

Protection of water resources and atmosphere is given a special concern in the system of Republican measures. Realization of water management measures aimed at regulation of river runoff and interbasin diversion, and building of ameliorative systems makes it possible to meet fully the water demand of the population, industry and agriculture of the Republic at present and in the future.

Concern for air quality has become a problem of national importance. To prevent atmospheric pollution, gas and dust collecting plants are being constructed at a rapid pace, technological processes are improved and low-waste production techniques are introduced. During the last two years more than 300 new gas treatment plants were built and nearly 1000 were reconstructed, their efficiency being increased considerably. Certain progress was achieved in solving a number of problems related to protection of the air basin against admixtures harmful to man's health.

4. CONCLUSION

However, the complexity of solving many-sided problems associated with environmental protection do not permit us as yet to remove negative phenomena and processes occurring in nature as a result of intensive anthropogenic (technical) impacts. These phenomena are known to occur in many regions and states of the world and have a global character. Scientists and experts of all the countries and continents should do their best to solve the most urgent problem -- protection of the human environment -- in order to ease and eliminate such phenomena. The 1st International Congress on Biosphere Reserves is an example of such a noble international mission aimed at conserving natural complexes and the gene pool of plants and animals. The strategy and principles to be developed at the Congress will undoubtedly not only promote further development of conservation activities but will also serve the better mutual understanding among nations and strengthening of peace on the globe.

CHAPTER 3

THE RELATION OF BIOSPHERE RESERVES TO OTHER PROTECTED AREAS

RELATING THE BIOSPHERE RESERVE TO OTHER PROTECTED AREA MANAGEMENT CATEGORIES

By

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ABSTRACT. The concept of the biosphere reserve is one of the major innovations in natural resources management, providing a framework to relate that management directly to the needs of people. Its bold goal is to promote a balanced relationship between people and their environment, and, thus, to serve human needs by promoting sustained, ecologically sound development. It is hoped that the biosphere reserve programme will make an important supplementary contribution to national programmes of conservation and integrated resource management and ecologically sound development.

The attempt to set up a worldwide network of biosphere reserves is a new and important initiative in the efforts to provide an assured future for mankind. If handled imaginatively it should provide an excellent opportunity of increasing understanding of the problems of the biosphere and of involving people, especially local people, in conservation and management which have a vital bearing on their own future.

1. INTRODUCTION

The concept of the biosphere reserve is one of the major innovations on natural resources management in recent decades, providing a framework to relate that management directly to the needs of people. Its bold goal is to promote a balanced relationship between people and their environment, and, thus, to serve human needs by promoting sustained, ecologically sound development.

In practice, however, the impact of the concept has been highly variable around the world, in general depending on the kind and amount of resource management work already underway when the biosphere reserve was proposed.

A review of implementation of the concept around the world suggests that its overall impact has been limited in terms of actual resource management, with only limited success in fulfilling human needs through ecologically sound development. This limited impact was to be expected because the concept was introduced into a worldwide context in which resource management efforts in general, and protected areas specifically, are facing a series of strategic problems in trying to contribute to solving human needs through supporting ecologically sound development. Those problems include: a general lack of interaction with surrounding lands, peoples and institutions, the "island mentality"; narrowly-viewed benefits with little relation to human needs; out-of-date management policies and practices; inappropriate information for the public; and a weak scientific foundation for management (Miller, 1982).

The idea of the biosphere reserve programme was to build upon existing resource management efforts to solve those problems, focusing specifically on three key issues: biological conservation; scientific management; and the relationship between natural resources and people. The biosphere reserve concept could not be expected to solve all problems by itself nor to have

immediate, strong impacts. An innovative and challenging concept requires considerable time to evolve; it needs to be applied, experimented with and improved. Likewise, some delay until practical impact is achieved can be expected with a concept intended to be applied at the global level, thus requiring breadth and a certain flexibility.

A fundamental problem, therefore, is that the biosphere reserve has not been sufficiently clearly defined and understood as a true, separate management category, complementary to the many other much better understood categories of protected areas which exist and are practiced around the world. Nor is the relationship between those other categories and the biosphere reserve sufficiently clear, particularly how all or parts of the others can be incorporated to form parts of biosphere reserves, in order to achieve mutual objectives and help fulfil the broad objectives of biosphere reserves. That problem, in turn, has been one of the key factors influencing the rather slow process of putting the concept into practice, from identification to selection, establishment, management and development.

The goal of this document is to provide a strong basis for clarifying and greatly improving those basic concepts, precisely because they have been evolving steadily.

2. A PROPOSED CONCEPTUAL FRAMEWORK FOR BIOSPHERE RESERVES

Based on considerable analysis and synthesis, IUCN has refined and modified the objectives and characteristics of biosphere reserves, considering them as a true management category (see Figure 1).

2.1. Objectives for biosphere reserves

The proposed objectives are:

-- Conserve representative samples of ecosystems, ecological zones or biomes, which are ecologically auto-sustainable to the maximum degree possible, and with adequate legal and political guarantees.

-- Promote and facilitate basic research and monitoring on those ecosystems, their elements and processes, as well as applied research and monitoring on their appropriate use and management, via the study of existing uses and experimentation.

-- Provide opportunities and facilities for education and training of the general public (all sectors), resource managers and scientists, at all levels.

-- Promote the use of the reserves' natural and cultural resources by appropriate practices, assuring sustained production and the permanence of productivity and those practices.

-- Promote appropriate, integrated development in the biome, ecosystem, or ecological zone, via the study, conservation and promotion of resource use practices appropriate to that ecological region.

2.2. Characteristics of biosphere reserves

The proposed characteristics which biosphere reserves should have are:

-- contain representative samples of one or more ecosystems, ecological zones or biomes, which are self-sustainable to the maximum degree possible, and with an adequate legal and political base.

-- Offer opportunities for basic and applied research and monitoring, particularly that directed toward and supporting management and appropriate use of resources, combining human needs and ecological principles.

-- Offer opportunities (and eventually facilities) for education and training, for all sectors and levels of society.

-- Contain types of resource uses and practices which are appropriate and which can be demonstrated, maintained, improved and promoted.

-- Offer opportunities for promoting ecologically sound development in the region which they represent, i.e. serve as a model for such development.

-- Where possible, allow for rehabilitative or restorative programmes for environments totally or partially altered by inappropriate use or other phenomena.

-- Large enough to constitute an effective conservation unit and to accommodate different uses without conflict.

-- In most cases, incorporate one or more existing or proposed protected areas.

It should be clearly understood that this modified conceptual framework combines elements which reflect current thinking after 10 years of experimentation and evolution of the concept. Those elements -- ecological representation, research and monitoring, education and training, appropriate exploitation and protection, restoration and development -- are combind so as to define the biosphere reserve as an effective tool (management category) in the planning, administration and management of resources of a country, through the combination of conservation and ecologically sound development.

The modified conceptual framework also provides a much improved base for clarifying the structure (zoning) of the biosphere reserve and the relationship between management categories of other protected areas and the biosphere reserve.

Finally, the biosphere reserve concept must maintain reasonable flexibility, without leaving it so totally open to interpretation that in managerial terms it would be confusing and inoperable.

3. THE SPECIAL FOCUS OF BIOSPHERE RESERVES

Almost every country in the world has its own series of protected areas set up for various purposes and given names (e.g. National Parks, National Forest, Forest Reserve, Cultural Monument, Multiple Use Area) whose exact definition varies from country to country. What then is the special focus of the biosphere reserve that distinguishes it from other management categories, while being complementary to those others?

There are six special features:

1. The emphasis in selection is on representative samples of major ecosystems rather than on those that are exceptional.

2. An international network is formed in which the international character is ensured by an exchange of information and personnel through MAB Committees and MAB Technical Notes.

3. Biosphere reserves provide for applied and manipulative research and monitoring on the appropriate use and management of the ecosystem's resources, in portions of the reserve.

4. They combine conservation of ecosystems, research and monitoring, education and training, development of appropriate direct uses of resources and improvement of production systems, and promotion of ecologically sound, integrated development, all as major objectives.

5. They play an integrative role with local populations whose knowledge and social and economic activities comprise a significant management input, and who should benefit directly from the reserve.

6. They focus their efforts on the relationship between man and the biosphere.

These features give a different character and emphasis to the biosphere reserve, which justifies a special term of international validity.

4. RELATIONSHIP OF BIOSPHERE RESERVES TO OTHER PROTECTED AREAS

4.1. General relationship

In some instances biosphere reserves will be established specifically for the purposes of the MAB programme in places where there have previously been no protected areas. But, most often a biosphere reserve is likely to profit from existing protected areas and include a part or the whole of those within its boundaries. As there will normally be no special legal category of biosphere reserve this can be done without any change in the administrative responsibility for managing the area.

Figure 2 shows how the different protected areas, or parts of them can contribute to the various zones of biosphere reserve. The former are listed on the left (rows of the table), the latter above (columns). All biosphere reserves should ideally include the Core Zone, Multiple Functions Zone (Buffer) and Cultural Zone.

For example the Core Zone could be provided by all or part of a Strict Natural Reserve, Park, Natural Monument, Managed Nature Reserve or the wilderness zone of a Multiple Use Management Area. The Cultural Zone of a biosphere reserve would usually be provided by a Protected Landscape or Seascape or part of a Multiple Use Management Area or Anthropological Reserve. Multiple Function (Buffer Zones) and degraded areas can similarly be derived from suitable parts of existing protected areas.

4.2. Possible relation to sites included on the World Heritage List

Sites which will be included in the World Heritage List are rather different from the other categories of protected areas considered above, because these sites will be recognized under international law -- the Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972). The

site will be approved by the World Heritage Committee, set up under the Convention, according to criteria which have been established by the Committee. These criteria lay emphasis on the unique, outstanding character of the World Heritage Sites in contrast to biosphere reserves which conserve representative samples of terrestrial and aquatic ecosystems.

It will be seen from the criteria that it would be possible for certain outstanding biosphere reserves to conform also to the criteria for World Heritage Sites. There are already a number of cases in which biosphere reserves have been approved as World Heritage Sites: e.g. Rio Platano Biosphere Reserve, Honduras and Darien National Park/WHS/BR, Panama.

5. SOME SUGGESTIONS FOR FUTURE PRIORITY ACTIVITIES

A number of key strategic and priority activities are needed over the next decade of the MAB Programme if biosphere reserves are going to begin to meet their potential:

1. Evaluate existing biosphere reserves to determine if they are fulfilling all the objectives of the management category as a guide for future prioritized action. Miller (1982) has suggested a number of key aspects which need to be considered.

2. Establish strong support for biosphere reserves at international, national and local level.

3. Establish and implement a series of key strategic actions to promote the value and use of both MAB and biosphere reserves, but in terms of real implementation, not just conceptually.

6. SUMMARY AND CONCLUSIONS

1. The biosphere reserve is set up for a special combination of purposes which are not duplicated by any other category of protected areas.

2. Part of the whole of protected areas of other categories may be included in a biosphere reserve provided that they meet the criteria for inclusion.

3. This need not lead to any change in the legal status of such areas. For example, if they are within a national park or strict nature reserve, they can continue to be so.

4. It is hoped, on the other hand, that the biosphere reserve programme will make an important supplementary contribution to national programmes of conservation and integrated resource management and ecologically sound development.

5. It is not to be expected that the biosphere reserve network will ever meet all the needs of biological conservation, nationally, regionally or internationally. They should be supplemented by other more detailed programmes.

The attempt to set up a worldwide network of biosphere reserves is a new and important initiative in our efforts to provide an assured future for mankind. The emphasis of the programme is on the relation between man and nature. To be successful it must preserve areas of undisturbed nature as genetic reservoirs and as standards against which change outside can be measured and

judged. It must equally include man and his works. If handled imaginatively it should provide an excellent opportunity of increasing understanding of the problems of the biosphere and of involving people, especially local people, in conservation and management having a vital bearing on their own future.

A series of key strategic activities are needed over the next decade if the MAB Programme and biosphere reserves are to fulfil their truly great potential.

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FIGURE 1: BIOSPHERE RESERVES: IMPROVED AND CLARIFIED CONCEPTUAL FRAMEWORK

OBJECTIVES		CHARACTERISTICS		STRUCTURE (zoning)	
Existing (a)	Proposed	Existing (a)	Proposed	Existing (a)	Proposed
1) Conservation of ecosystems and their genetic resources	1) Conserve representative samples of ecosystems, ecological zones or biomes, which are ecologically auto-sustainable to the maximum degree possible and with adequate legal and political guarantees	1) Protected areas of land or coastal environments. Together will constitute a worldwide network	1) Contain representative samples of one or more ecosystems, ecological zones or biomes, which are self-sustainable to the maximum degree possible and with adequate legal and political base	1) Natural or Core Zone -Baseline for the ecological region -Non-manipulative, baseline research and monitoring -Limited/controlled education and training	1) Complete Protection Zone
2) Provision of areas for ecological and environmental research, particularly baseline studies, and on adjacent areas	2) Promote and facilitate basic research and monitoring on those ecosystems, their elements and processes, as well as applied research and monitoring on their appropriate use and management, via study of existing uses and experimentation	2) Network will include significant examples of biomes throughout the world	2) Offer opportunities for basic and applied research and monitoring, particularly that directed toward and supporting management and appropriate use of resources, combining human needs and ecological principles	2) Manipulative, Experimental or Buffer Zone -Manipulative methods and techniques permitted for research, monitoring, education and training. Traditional practices (hunting, fishing, timber production, etc.) permitted in controlled manner	SAME 2) Multiple Functions Zone (Buffer Zone) -Basic and applied research, manipulative and non-manipulative -Research and monitoring of environment, but also social, economic, cultural parameters -Education and training at all levels -Appropriate uses of resources experimented with, permitted, improved, promoted and demonstrated (fisheries, tourism, hunting, grazing, forestry production, agriculture, etc.) -May have human settlements
3) Provision of facilities for education and training	3) Provide opportunities and facilities for education and training of the general public (all sectors), resource managers and scientists, at all levels	3) Each B.R. will include 1 or more of the following categories: (i) representative examples of natural biomes (ii) unique communities or areas (iii) examples of harmonious landscapes resulting from traditional patterns of human land use (iv) examples of modified or degraded ecosystems capable of being restored Each B.R. will have a non-manipulative core in combination with one or more other zones where other functions can be carried out	3) Offer opportunities (and eventually facilities) for education and training, for all sectors and levels of society	3) Reclamation or Restoration Zone Managed to study restoration of damaged resources (human-caused or natural)	3) Cultural Zone SAME as 4
	4) Promote the use of the reserves' natural and cultural resources by appropriate practices, assuring sustained production and the permanence of productivity and those practices	4) Each B.R. should be large enough to be an effective conservation unit and to accomodate different uses without conflict	4) Contain types of resource uses and practices which are appropriate and which can be demonstrated, maintained, improved and promoted	4) Stable Cultural Zone Protection and study of ongoing culture and resource use practices which are harmonious with the environment	4) Restoration Zone SAME as 3
	5) Promote appropriate, integrated development in the biome (ecosystem, ecological zone), via the study, conservation and promotion of resource use practices appropriate to that ecological region	5) Should provide opportunities for ecological research, training and education	5) Offer opportunities for promoting ecologically sound development in the region which they represent (=model)		
		6) Must have adequate long-term legal protection	6) Where possible allow for rehabilitative or restorative programs for environments totally or partially altered by inappropriate use or other phenomena		
		7) In some cases will coincide with or incorporate existing or proposed protected areas	7) Should be large enough to consitute an effective conservation unit and to accomodate the different uses without conflict		
			8) In most cases will incorporate one or more existing or proposed protected areas		

(a) Sources: MAB (1974); IUCN (1979).

FIGURE 2 : PROTECTED AREAS AS COMPONENTS OF BIOSPHERE RESERVES

CATEGORIES OF PROTECTED AREA	BIOSPHERE RESERVE ZONES			
	Complete Protection (Core)	Multiple Functions (Buffer)	Cultural	Restoration or Reclamation (Degraded)
1. Scientific Reserve/Strict Nature Reserve	X			
2. National Park (or Provincial or State)	X			
3. Natural Monument/Natural Landscape	X			
4. Managed Nature Reserve/Wildlife Sanctuary	X	X		X
5. Protected Landscape or Seascape		X	X	X
6. Resource Reserve		(X)		
7. Natural Biotic Area/Anthropological Reserve		X	X	
8. Multiple Use Management Area/Managed Resource Area	(X)	X	X	X
9. World Heritage Site	X	X	X	

X = all or part of the protected area could definitely contribute to the zone

(X)= facultative (may be possible in some cases)

THE CONCEPT OF ANALOGOUS BIOSPHERE RESERVES

By

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ABSTRACT. No matter how huge biosphere diversity is, certain characters or set of characters can be selected to distinguish similar ecosystems. The individual and the common have always been basic concepts in the perception of the world. Here we shall deal with the common that unites us as students of the biosphere.

A map of any element of nature demonstrates this unity. The smaller the scale, the smaller the difference between nature elements, and, consequently, the greater the similarity of individual territories. It is in this way tht spacemen msut perceive the Earth; geographers dealing with the general problems of their science perceive the Earth in a similar way. This macro-view of our planet provides the general concept of analogous biosphere reserves.

1. INTRODUCTION

Dr. F. di Castri has dealt with the problem of analogous sites to be used for studies involving similar research methodology within the framework of the biosphere reserve concept. His focus on this problem is readily understandable since it is Dr. di Castri who bears the heavy burden of the coordination of international research and has the best opportunity to see the common features along with distinctive ones.

What can be expected of biosphere reserves? What biosphere reserves can be considered analogous? These appear to be the questions to be accorded the first priority.

2. THE NATURE OF ANALOGOUS RESERVES

The very nature of similarity is self-evident. These are the common laws of the input of solar radiation and its re-distribution on the territory of our planet. These are the common laws of climatogenesis and the unity of the formation of the lithosphere. These are the factors which primarily determine the physico-geographical conditions and spatial pattern and their changes on different continents. From the view point of an ecologist, this unity may be defined as the commonness of the ecological space in which life on Earth has been evolving.

What are the distinguishing features which the macroview of the Earth provides? Primarily these are the patterns of tectonic processes and orogenesis determined by the peculiarities of plate drift. These determine, in their turn, the specificity of the climate and, most important, the envolutionary features of the development of ecosystems at different continents. The problem of convergence and divergence of biological systems developing under similar conditions characterized by different individual histories is the oldest problem of biology, geography and ecology. However, the problem of analogous reserves, or more precisely analogous sites, involves

primarily insight into the factors and conditions which ensure the unity. These have been defined above as the input of solar radiation, climate, and similarity of the lithogenic basis.

Using the information available it is quite easy to distinguish on different continents, sites similar with respect to these parameters. The level of similarity assumed for every parameter concerned may vary depending on particular goals, but to a first approximation is determined by the view of our planet which as been mentioned above.

The different patterns of climatic, geo-morphological and general physico-geographical features of our planet also provide, at the primary level, a sound basis for distinguishing territories analogous in parameters.

The differences in interpretation characteristic of different schools and trends are not of principal importance at this level; the methods of estimating similarity may vary but the general principle is constant. Thus, we propose as analogous sites, those areas of the land which belong to different continents but are characterized by the same type of climate and the same type of lithological and geochemical conditions. All the assumptions for distinguishing analogous sites are self-evident and do not call for further commment.

3. THE ROLE OF ANALOGOUS BIOSPHERE RESERVES

To determine the role of such analogous reserves in the framework of the MAB programme, let us state those goals which are to the greatest extent met by analogous reserves -- the objectives of monitoring.

As the similarity of climates essentially underlies the similarity of sites, the similarity of climatic situations in a certain temporal scale is very much indicative of a global trend. Similarly, when such "type responses of ecosystems" or their components to these changes are recorded, there are grounds to claim the existence of global reactions of the biosphere to climatic change. This is evident, since such changes take place despite genetic differences of the objects compared. It is noteworthy that the same changes may bring about absolutely inadequate reponses of ecosystems in different conditions. Now there are grounds to believe that the paleographic changes of ecosystems in the Pleistocene are asynchronous. Moreover, an example pertaining to an actual time scale can be supplied; for instance, the trends in the changes of the tundra southern boundary under different climatic changes may show substantially different patterns; the same global change of the climate, e.g. warming with concurrent moistening, may cause the boundary to recede southward under marine climate, while under continental climate, it would move northward. This hypothetical example makes it clear that it is very difficult to determine common features when comparing clearly dissimilar sites. However, there are reasons to believe that these estimates are still more reliable when comparing changes under similar conditions.

Thus, the initial result of comparing analogous biosphere reserves consists in an ecological estimate of global climatic change. The problems of global pollution conform to a similar pattern. Consequently, analogous sites permit solving the major -- although not all -- the problems of global monitoring.

Of still greater importance are analogous sites for research projects. There are several apsects here. The first refers to comparative ecology -- the comparability of concepts concerning the development of ecological systems

under similar conditions, the systems concerned being characterized by a different genesis. This is the only basis which permits obtaining universal constants and those general ecological properties and laws which manifest themselves irrespective of the development of biota in evolutionary time scales under similar environmental conditions. Determining these regularities for different types of conditions provides a sound basis for generalization of a material-energetic model of the biological component of the biosphere.

Another aspect is methodological. The development of an international approach to investigations into ecological laws is most effective for sites with similar conditions. It is readily understandable that the methodology and techniques of these investigations should be essentially similar for the entire biosphere. Naturally, it is easiest to converge different schools and trends for organizing studies under exactly similar conditions; subsequently, common features can be selected in any case. Still, the intercalibration of ecological views and ecological methods is best initiated at similar sites.

The third aspect applies to the problems of management integration. Evidently, methods of management of ecological objects should be extrapolated to other sites. With certain reservations associated with ecosystems properties and those of their components, broad management recommendations are most realistic for similar sites. Thus, selection of analogous reserves or analogous regions implies a first approximation to implementing scientific recommendations at an international level.

Actually, this practice is quite common. In fact, American desert specialists come here to familiarize themselves with deserts in this country. Still, the concept of desert is too wide in relation to the concept of analogous sites, otherwise its consideration would be unnecessary.

The fourth aspect is of particular interest. This is associated with the problem which could be termed "engineering ecology". Our common concern is management of natural ecosystems. We are aware of the fact that the standard of our management is relative. However, despite that, we would invariably synthesize artificial systems, e.g. agrocenoses, ranges, forests, aquasystems, etc. This inevitably involves transfer of animal and plant species. In this respect, we have accumulated a huge body of both positive and negative information. It is evident that the negative impact of such practices should be minimized. Here the problems of comparative ecology come up again, but in essence they are closely associated with the ecological niche concept. Comparative ecology of species should be studied with special reference to abiotic and abiocenotic factors. This would permit reliably predicting the possible consequences of the introduction of a species into a different evolutionary ecosystem. This most interesting problem is of both greatest theoretical and practical importance.

The fifth aspect implies a wider problem of the ecological convergence of ecosystems. One of its manifestations is the old problem of origin of similar life forms on a different genetic basis.

The above appear to be the most interesting aspects associated with the concept of analogous biosphere reserves, or, in a wider sense, analogous sites.

The problem of conservation of diversity is the biosphere reserve objective which does not rely so heavily on analogous site concepts although in some respects biosphere reserves can contribute to it in an important way.

4. CONCLUSION

To conclude, I would like to call your attention to the fact that the concept of analogous sites is traditional for the Soviet school. The huge size of this country has to a great extent promoted the elaboration of this concept. Evaluation of the country's biological resources has required the development of typological concepts that would permit the necessary precision and ease of extrapolation of results obtained at some particular site. Our experience has revealed that this practice ensures a high level of the integration of research. Also, it provides the unity and comparability of methods of a wide class of conditions. Provided a sound approach, such unification, associated with typological concepts, does not only prevent but is conducive to the development of trends, methodology and techniques reflecting the reality.

CLUSTER BIOSPHERE RESERVES

By

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ABSTRACT. Three types of cluster biosphere reserves have evolved in the USA: a conservation reserve paired with an experimental reserve(s); multiple sites containing different ecosystems administered as a single unit by a single agency; and multiple sites in a reserve using the name of a biogeographic subregion instead of an administrative unit. The development of a cluster biosphere reserve in the Southern Appalachians, of the first type, is described and analyzed. From this exerience, it is suggested that other reserves of this type should have a formal structure for administration and scientific coordination, an effective mechanism for involvement of other regional agencies and organizations, particularly with respect to the management of the buffer or manipulative zone, and a process for public involvement.

1. INTRODUCTION

This paper will trace the concept of cluster biosphere reserves as it has evolved in the USA, describe and analyze in some detail the development of a specific cluster biosphere reserve in the Southern Applachian region, and, from these experiences, attempt to provide guidelines for other areas where a simple protected area or unit is unable to fulfil all the objectives of a biosphere reserve.

2. EVOLUTION OF CONCEPT IN THE USA

During the initial process of selecting biosphere reserves in the USA, Franklin (1977) noted:

> "It was seldom possible to identify a single area that satisfied all criteria -- because of this difficulty, the US Committee on Biosphere Reserves developed the concept of multiple reserves whereby experimentally oriented tracts are matched with large preserves similar in biologic and environmental features. Together they provide a single conceptual biosphere reserve for a biotic province."

As a consequence, those areas officially designated in 1976 included paired biosphere reserves in six biogeographic provinces.

A further elaboration of the cluster biosphere reserve concept occurred in 1981, when it was expanded to include the designation of multiple sites, containing different ecosystems, as a single biosphere reserve administered by a single agency (Gregg, 1983). An example is the Big Thicket Biosphere Reserve in East Texas, which includes 12 sites and is solely administered by the US National Park Service (NPS).

A more recent development is the designation of biosphere reserves using the name of a biogeographic subregion instead of an administrative unit. An

example is the California Coast Ranges Biosphere Reserve (Gregg, 1982). Although none of these types of reserves is complete, eventually it is planned that each will have multiple sites which include all of the representative ecosystems as well as other opportunities to carry out reserve functions.

All these developments in the USA are signs of a healthy response to local, regional and national realities and needs. They are graphic illustrations of MAB as an "evolving system" (di Castri et al., 1981).

3. THE SOUTHERN APPALACHIAN MOUNTAIN BIOSPHERE RESERVE CLUSTER

One of the first cluster biosphere reserves to be proposed was a single conceptual reserve for the southeastern subdivision of the Eastern Forest Biotic Province (Franklin, 1977). This cluster, the Southern Appalachian Mountain Biosphere Reserve Cluster (SAMBRC), included a core or conservation biosphere reserve, the Great Smoky Mountains National Park (GRSM); an experimental biosphere reserve, the Coweeta Experimental Forest (Coweeta); possibly the Oak Ridge National Environmental Research Park (ORNERP); and an ill-defined partial buffer or manipulative zone (Johnson et al., 1979). Each of the units had been the site for a substantial amount of ecological research and monitoring, and it was clear that the work that had been done at one had relevance for the others. It was also felt that the designation would encourage more collaborative work and an even greater exchange of information. In recognition of this, the first regional workshop on research and monitoring in US Biosphere Reserves was held in the GRSM in November, 1976 (US MAB, 1976a). The participants prepared for Eastern US Biosphere Reserves a document which outlined needs, basic goals and objectives, scope, specific activities and priorities, and coordination of ongoing work directed toward goals and objectives; additional research and monitoring requirements were also identified (US MAB, 1976b). The workshop served as an aid and stimulus to NPS personnel to develop a research/monitoring perspective for the GRSM as a biosphere area (Herrmann and Bratton, 1977).

The regional workshop was followed two years later with an international workshop held in Washington, D.C., on long-term monitoring in biosphere reserves. The participants then visited the GRSM, the Coweeta Hydrological Laboratory and the Oak Ridge National Laboratory. At Oak Ridge they evaluated the monitoring that had been initiated as a pilot project resulting from the regional forum. A particular concern of the participants was the development of a system of pollutant monitoring. In September 1977, a pilot study had been initiated in the GRSM on the development of a pollution monitoring system for biosphere reserves. This pilot study was a mutual effort between the US Environmental Protection Agency (EPA) and the NPS. The objectives of the study were to determine the levels of trace elements and organic contaminants in physical and biological media, and to design an effective and cost-efficient pollutant monitoring system (Wiersma et al., 1978; Wiersma et al., 1979; Wiersma et al., 1980).

In an effort to improve communication between scientists working within the cluster biosphere reserve and the surrounding uplands region, the NPS in 1975 initiated an annual meeting for reports on scientific research and monitoring. These have been held in the GRSM annually since then. A review of the abstracts of these meetings shows a wide diversity of topics reflecting a substantial amount of research. It is clear that this is an important forum for communication between individual scientists working on problems of common interest.

Two specific projects utilizing the resources of the cluster have been funded as a result of proposals submitted to the MAB/Agency Research Consortium for the Study of Man's Relationship with his Global Environment. Susan Bratton and Peter White of the NPS are studying the GRSM to determine its effectiveness in preserving a sample of Southern Appalachian floristic diversity. They are evaluating various possible configurations for the Park, and are developing a strategy for an ecological survey of the changes along the Park boundary. Alan Stiven of the University of North Carolina at Chapel Hill and Richard Bruce of Western Carolina University and the Highlands Biological Station are looking at biosphere reserves as reservoirs of genetic resources, using ecological and eletrophoresis techniques to study 3 aquatic species from disturbed and undisturbed sites at GRSM and the Coweeta Hydrological Laboratory. These projects are specifically related to MAB objectives, and they will not only provide greater understanding of these two reserves, but should have relevance to other existing and proposed reserves.

The cumulative result of the work stimulated by the designation of the SAMBR and the work that preceded it, is that in relation to other areas there is a quite extensive base of knowledge. Mack et al. (1981) conducted a survey designed to assess the status of the baseline resource inventory, long-term monitoring, and long-term ecological research in 14 biosphere reserves managed by the NPS. Using an index rating for each of these activities, the GRSM was found to have high ratings in all 3 categories.

4. SOUTHERN APPALACHIAN RESEARCH/RESOURCE MANAGEMENT COOPERATIVE

At about the same time the cluster biosphere was formed in the Southern Appalachians, a group of 4 federal agencies and six leading universities with interests in the area banded together to form a unique consortium, the Southern Appalachian Research/Resource Management Cooperative (SARRMC). The initiative for the formation of this organization was not related to the new cluster biosphere reserve; rather it was a response to a growing realization that something needed to be done to bring about better communication between researchers and resource managers. The organization is a true cooperative, with no paid staff. I serve as Executive Officer and report to an Executive Committee that has a representative from each of the members. All activities are carried out using volunteer assistance and funds provided by the members or by small grants and contracts from other agencies and organizations (McCrone, 1980). These activities have included projects on stream management, wood as an energy source, natural diversity in forest ecosystems, management of mountain balds, forest insect problems, and management of wild boar populations.

In the fall of 1980, a unique opportunity arose to bring the capabilities of SARRMC together with those of MAB. The MAB Programme Coordinator for the NPS worked with SARRMC to conduct an assessment and evaluation of the information base and science activities at the GRSM. The objectives of the project were: (1) to provide a basic reference on science activities and the available information base at the reserve for use in science programme evaluation by the NPS and other authorities, and for general information for resource managers, planners, and scientists concerned with the reserve's ecosystems and the influence of human activities upon them; (2) to provide a multidisciplinary evaluation of the adequacy of existing and planned science activites; (3) to facilitate multi-institutional coordination in long-term monitoring and research, as well as in the development of management systems for ecological data; and (4) to provide a prototype for presenting information relevant to science programme formulation and evaluation in international biosphere reserves.

The project eventually involved over sixty scientists and resource managers, and resulted in the publication of two volumes, a history of scientific study at the Reserve in narrative and tabular form (McCone et al., 1982a) and a bibliography of over 500 references (McCrone et al., 1982b). In addition, a science programme assessment workshop was held in the GRSM in October 1981, attended by representatives from each of the units in the cluster reserve and scientists from universities in the region; they reviewed and discussed the evaluations and recommendations of the project participants.

5. GUIDELINES FOR OTHER SIMILAR RESERVES

During its short history, the cluster biosphere reserve in the Southern Appalachians has had considerable achievements, and all those involved have learned much. I think it is fair to say part of the recent work that has been done can be directly linked to the MAB designation and involvement. If so, how might this experience be used to enhance the future development of this particular cluster reserve, and provide guidance to others either forming or contemplating the establishment of a similar type of reserve? As Executive Officer of SARRMC and Project Director for the assessment and evaluation of GRSM as a Reserve, I have had a particular perspective, and wish to emphasize the following suggestions represent my personal views only.

One key issue for cluster biosphere reserves is the question of leadership, and administrative and scientific coordination. In the Southern Appalachians, this has been achieved primarily through a series of workshops, forums for the presentation of scientific papers, and individual initiatives on the part of the agencies involved. I do not believe this is sufficient. A formal structure such as a steering committee is needed. The members of this committee should be the administrators who have fiscal and programme responsibility for the units in the cluster and their principal scientific advisers. This committee should meet at least annually, and conduct business from a formal agenda. The continuation of other informal modes of interaction should, of course, be encouraged.

It is also imperative that a mechanism be developed to mobilize other agencies and organizations within the region to assist in the attainment of the multiple objectives of a biosphere reserve. This is particularly important with respect to activites in the so-called buffer or manipulative zone. In the Southern Appalachians many existing elements have not been well integrated into the cluster reserve. These include several national forests, the Tennessee Valley Authority, the Blue Ridge National Parkway, the Highlands Biological Station, several universities, and various industrial and private non-industrial forests. Perhaps SARRMC could play a more important role in this region, and in other regions perhaps similar organizations could be developed.

Finally, as Halffter (1981) has clearly shown with respect to the Mapimi Biosphere Reserve in Mexico, there is an urgent need to involve local populations in determining research and conservation objectives in order to guarantee their support for the reserve and its activities. This is particularly important in relating these objectives to the overall economic, social, and cultural development of the region. MAB and its programmes must be perceived as partners in the sound development of the region, and not as inimical to the goals and aspirations of the people. In the Southern Appalachians we need to do a much better job in our liaison with such citizen groups as the North Carolina Parks, Parkway and Forests Development Council, the Tennessee Park Commission, Western North Carolina Tomorrow, and the Western North Carolina Associated Communities. Any overall plan for the

management of the cluster reserve should involve groups such as these. They will also be an important resource along with educational institutions in the development of an effective environmental education programme, a key objective of MAB.

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MAN-MADE BIOSPHERE RESERVES? RE-EXAMINATION OF CRITERIA

By

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ABSTRACT. The current status of ecosystems in densely populated Central Europe seldom allows reasonable delimitation of boundaries between natural, semi-natural and man-made landscapes. Even in less-accessible wetlands and remote mountain areas, wildlife is either directly or indirectly affected by pasturing, agriculture, timber exploitation, drainage, roads, industrial pollutants, noise and introduced exotic species. National nature conservation agencies face the reality of uncontrolled material, energy and information flows between neighbouring regions and countries. Moderately man-affected areas possess a higher diversity of gene pools, and more abundant ecosystems than a landscape covered by original climax ecosystems; the fine-grained pattern of a man-made landscape offers greater choice of habitats, population niches and ecosystem functions. In Central Europe, selection and management of large-scale reserves should serve for scientific evaluation of historically successful examples of symbiosis between man and nature. Monitoring of changes and environmental education within these "man-made biosphere reserves" appear as high-priority objectives in the Unesco Man and Biosphere Programme.

1. INTRODUCTION

1.1. Natural and anthropogenic factors

In the evaluation of current biosphere reserves and while planning new large-scale reserves we should bear in mind the fairly different conditions of abiotic factors and biotic communities in various parts of the world. The current pattern of populations and ecosystems has resulted from multiple natural and/or anthropogenic factors whose particular effects are not easily distinguished. Climatic and edaphic factors develop under the impact of incessant organic evolution, migration, expansion and extinction of microbes, plants and animals. Human populations invaded various parts of the Old and New World in different periods of the Quaternary, and successively altered local biogeochemical cycles, energy flows and exchange of genetic information in all areas occupied by them.

1.2. Difference between grasslands and woodlands

Stone-Age populations, like the Acheulian hunter-gatherers in Africa or Mousterien people in Europe, increased in numbers mainly in savannas, steppes and other grasslands bordering the forest zone. Already 100,000 years ago these Stone-Age people used fire (Howell and Clark, 1964) -- a powerful "servant and master" in transformation of the landscape. In semi-arid and subtropical grasslands, burning resulted in over-representation of fire tolerant grasses and decline of woody species. Stone-Age people seldom occupied strictly arid or perhumid regions, and their favourite habitations occurred in the transitional zone between woodlands and grasslands, preferably on the margin of freshwater lakes or rivers. Archeological evidence shows that the savanna-forest ecotone was markedly altered by man several hundreds of thousands of years ago. In Central Europe, large scale accommodation of the landscape started with Neolithic industries only about five thousand years ago.

1.3. Management and mismanagement

In the current period, all countries of Central Europe feature effective agriculture, productive silviculture and ambitious industry. These aspects of human economy affect by their activities the greater part of the national territory. More locally, exploitation of mineral resources, water management (mainly drainage), dense networks of roads and habitations, and deposition of solid waste materials create numerous artificial habitats offering their bare surface to R-strategists of both plant and animal kingdoms. Disturbed ecosystems under the impact of increasing air, water and soil pollution create the conditions for unexpected population explosions, e.g. dispersal of weeds and mass occurrence of parasitic fungi or insects. Large-scale and repeated application of biocides further disturbs the homeostasis of relevant ecosystems. Aerially applied biocides easily cross the boundary between managed and preserved areas, and cause damage to the last refuges of wildlife. Repairing the disturbed balance of ecosystems requires expensive measures, but economically minded managers of farms and industry often prefer short-term profits, and omit environmental considerations in their activities, leading to long-term losses in the natural productivity of land (Moldan, Zyka and Jeník, 1979).

2. CONSERVATION CONSEQUENCES OF ANTHROPOGENIC IMPACTS

In sparsely inhabited tropical and subarctic regions, natural and man-affected landscapes can be easily delimited. In the initial stage of interference between wildlife, agriculture and forestry, the consequences of abiotic and biotic alterations are relatively easily understood. In the case of Central Europe, long-lasting and diversified arrays of environmental effects of civilization have induced an intricate network of reversible and irreversible processes whose ultimate consequence is difficult to predict. Evaluation of "positive" and "negative" trends is a matter of narrow human interest.

2.1. Questionable goals of landscape management

Paleobotany and archeology provide Central European scientists with fair evidence of the past stages in the development of the landscape. Detailed knowledge of the continual changes puts a question mark on the goals of landscape management and environmental conservation. Which stage of the past development should be represented by large nature reserves, national parks and biosphere reserves? The Ice Ages deprived Central Europe of many biota whose related or even identical species are still living in North America, many "exotic" species cultivated in European parks and gardens, such as species of Tsuga, Carya or Liriodendron, can thus be considered a re-introduction of vanished species into their original home. During the post-glacial era, the scenery of Central European landscapes has changed mainly due to successive immigration of dominant trees returning from various refuges in southern countries (Firbas, 1949 and 1952). Which of these stages should be considered as "adequate" for biosphere reserves? Also, nearly all staple crops currently cultivated in Europe, and many weedy species accompanying them, were introduced or unintentionally brought in from Asia and North America many centuries ago, though some of the naturalized species of plants and animals are difficult to identify as to the place of their origin and time of their arrival. The flow of new genetic information brought in by newly-introduced or freely-invading species will never cease.

2.2. Fine-grained pattern and migration routes

Human activities often disrupt continous distribution areas of climax (zonal) ecosystems and tend to create abrupt boundaries. The resulting fine-grained pattern of clearly-outlined patches resembles some territories affected by catastrophic ecological factors, such as floods, fires, windstorms, avalanches or herds of herbivores. Diversity and stability of the populations and ecosystems depend on the size of individual patches ("islands"), and their distance and accessibility by various means of transport. The aerial photographs of Central European landscapes show a great variety due to different size and density of man-made patches, interconnected by roads and corridors. Obviously, historical factors in the management of fields, meadows and woodlands has played a decisive role, with mountain ranges and flood plains of rivers serving as migration routes and stablization skeletons for the majority of indigenous biota. The fine-grained pattern creates a variety of habitats, environmental gradients and marginal effects, which supports the establishment of many a zonal or subclimax species. In this way the diversity of the landscape increases and extinction rate can be retarded.

2.3. Long-distance connections and international relations

The fine-grained patttern secures step-by-step dispersal and, in connection with the roads and corridors, even long-distance dispersal of indigenous and introduced biota. This makes a delimitation of any "reserve" in Central Europe a difficult task. Long-distance pollination and mating produce more uniform populations with similar gene pools, so multilateral environmental and biotic linkages exist between neighbouring regions and countries, particularly between countries divided by artificial administrative boundaries.

Two examples can illustrate these international relationships in Central Europe. In the first case (Fig. 1) a Polish mountain ecosystem with abundant relict species and biogeogrphical rarities (A) is an inseparable portion of a glacial cirque (B) belonging to the Polish Karknosze National Park (C), with numerous natural and administrative links; the same locality is strongly affected by the Mumlava Anemo-Orographic System (Jeník, 1961), an ecological and geographical unit stretching beyond the Polish territory to neighbouring Czechoslovakia (D); finally, all of the mountains are strongly affected by noxious pollutants and acid rain whose sources are situated on the territory of all neighbouring countries (E).

The other case (Fig. 2) refers to nesting grounds of rare waterfowl (A) situated in the littoral of Great Tisy Fishpond Nature Reserve (B) belonging, both from natural and administrative apsects, to Trebon Biosphere Reserve (C), a semi-natural landscape system of great diversity (Jeník et Kvet, 1981); the catchment area of the Luznice river, the main watercourse draining the flat, belongs partly to Czechoslovakia and partly Austria (D), thus depending on water management of two independent countries; moreover, all ecosystems in the regional suffer from pollutants and acid rain produced by a cluster of Central European countries (E).

3. BIOSPHERE RESERVES IN DENSELY INHABITED COUNTRIES

The above analysis suggests that in Central Europe a large reserve of the "Yellowstone model" is hardly possible. Districts with purely indigenous flora and fauna do not exist, and even the remainders of natural ecosystems are affected by human activities through moving air masses, flowing surface and ground waters and passage of dispersal units of all kinds of organisms. Sooner or later, any "boundary" outlined around a reserve proves to be unsatisfactory. Calculation of material cycles and energy flows within these imaginary boundaries is next to impossible. Under these circumstances, do biosphere reserves "make any sense"?

3.1. Large reserves established in the past

Various models of private, communal and national large-scale reserves have been established in Central Europe since the 19th century. For example, large forest areas were reserved for entertainment of kings and noblemen, and later, numerous game reserves and reserved lakes offered opportunities for hunting. The present-day Krivoklát Biosphere Reserve derives from a past royal estate where timber extraction, charcoal burning and hunting were kept at an ecologically sound level, and semi-natural broadleaved forests survived. Nominally, the first large-scale reserve was established in 1838 in order to preserve virgin forests in Nové Hrady Mountains (presently in Czechoslovak territory). A prolific era of large-scale reserves started only after World War II when all Central European countries declared numerous national parks (e.g. 13 national parks in Poland) and various kinds of sanctuaries, landscape reserves and regional reserves (e.g. "Landschaftschutzgebiet" in GDR or "Chránená Krakinná Oblast" in Czechoslovakia). Many of these large-scale reserves merely provide an administrative frame for a group of small nature reserves that cover less productive or "infertile" patches of sands, scree, rocks, summits, peatlands or lakes. A broad variety of criteria has been applied even in the establishment of the 18 biosphere reserves in the core of Central Europe (Austria 4, Czechoslovakia 3, GDR 2, Hungary 5, Poland 5). In most of these reserves, the international status raised the level of scientific research, contributed to better management of the pertinent areas, enhanced exchange of "know-how" and started many educational projects which support modern environmental conservation.

3.2. Future development of biosphere reserves

In Central Europe, the international network of biosphere reserves cannot be developed merely by transformation of certain national parks or landscape reserves. The greatest rarities in this part of the European continent are the few regions where an adjustment has been achieved between the conflicting requirements of economy and of wildlife. As in other parts of the world, these regions often display an exceptional diversity which matches, or even surpasses, that of "natural" districts, the well-known Keoladeo National Park in Bharatpur, India, possibly the richest habitat of birds in the world, is a man-made landscape. Similarly, in the Trebon Biosphere Reserve, Czechoslovakia, nearly two-thirds of the species of European avifauna find their nesting grounds around man-made fishponds and in semi-natural groves and meadows. In addition, many of these balanced landscapes contain numerous building monuments standing in witness of the old symbiosis of Man and Nature. The potential Central European biosphere reserves are situated in the close vicinity of scientific centres and universities, which makes them suitable research grounds for students and experts. Their educational value can be fully exploited by local visitors and foreign guests.

3.3. Desirable international cooperation

The network of biosphere reserves and national parks registered within IUCN make a suitable and highly desirable basis for cooperation in environmental research and environmental education in Central Europe. As explained above, neither natural nor administrative boundaries prevent unavoidable interconnections between neighbouring regions. Many large European nature reserves and national parks are lying on both sides of the same mountains that are divided by political boundaries, but none of these paired reserves has achieved a state of unified management and integration. However, industrial pollutants, eutrophic waters and biotic dispersal units are crossing the boundaries irrespective of administrative lines. All managers,

conservationists and politicians are responsible for controlling of the multilateral flows of substance, energy and genetic information, which are less spectacular but often more important than, for example, the annual migration of birds across the European continent. Biosphere reserves should make these multilateral flows more visible and understandable.

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Fig. 1. Situation of a species-rich mountain ecosystem within various natural, man-made and geopolitical boundaries: A - basalt vien ecosystem; B - Little Snow Cirque Nature Reserve; C - Polish Karkonosze National Park; D - Mumlava Creek Anemo-Orographic System; E - core of Central Europe

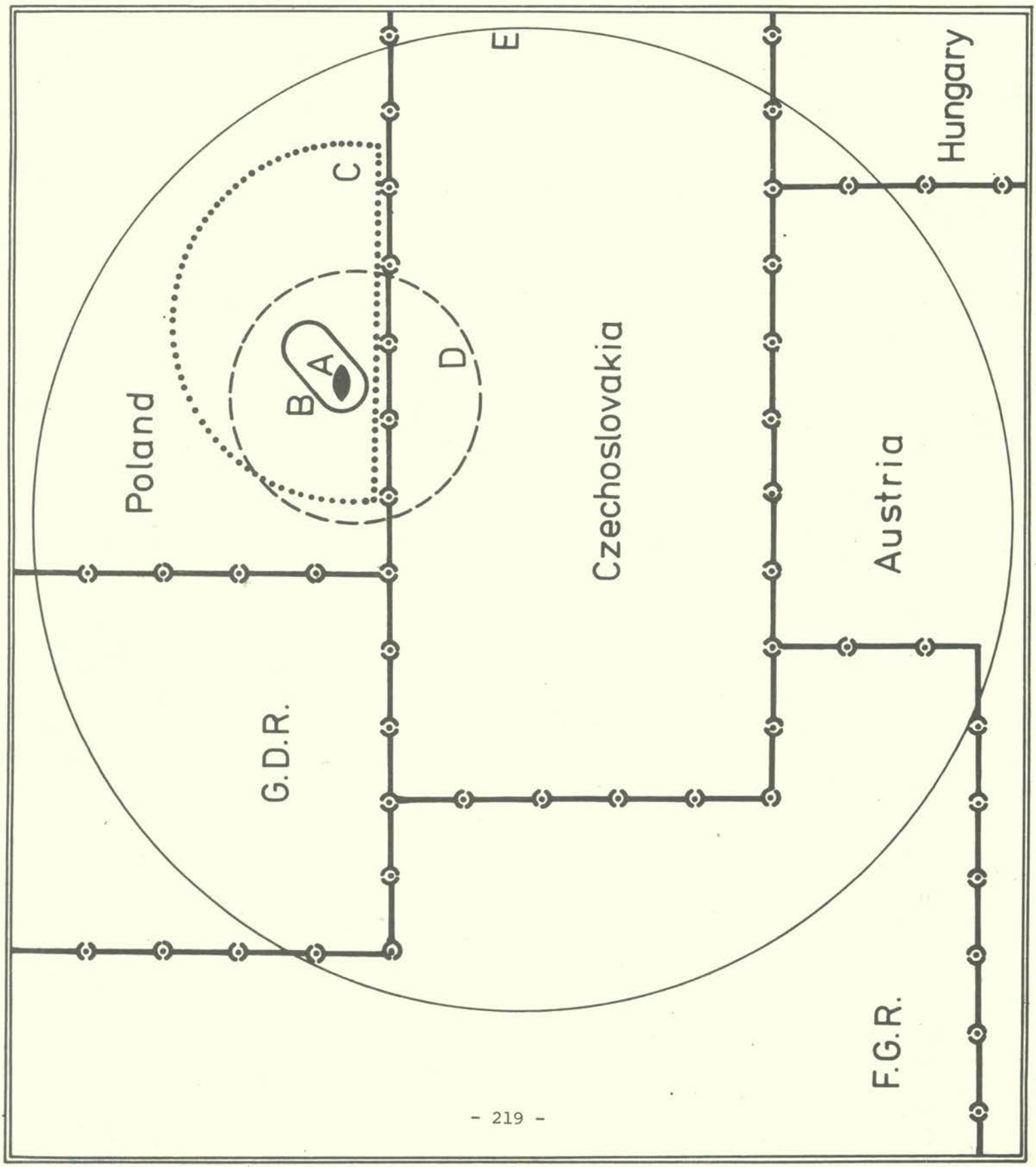
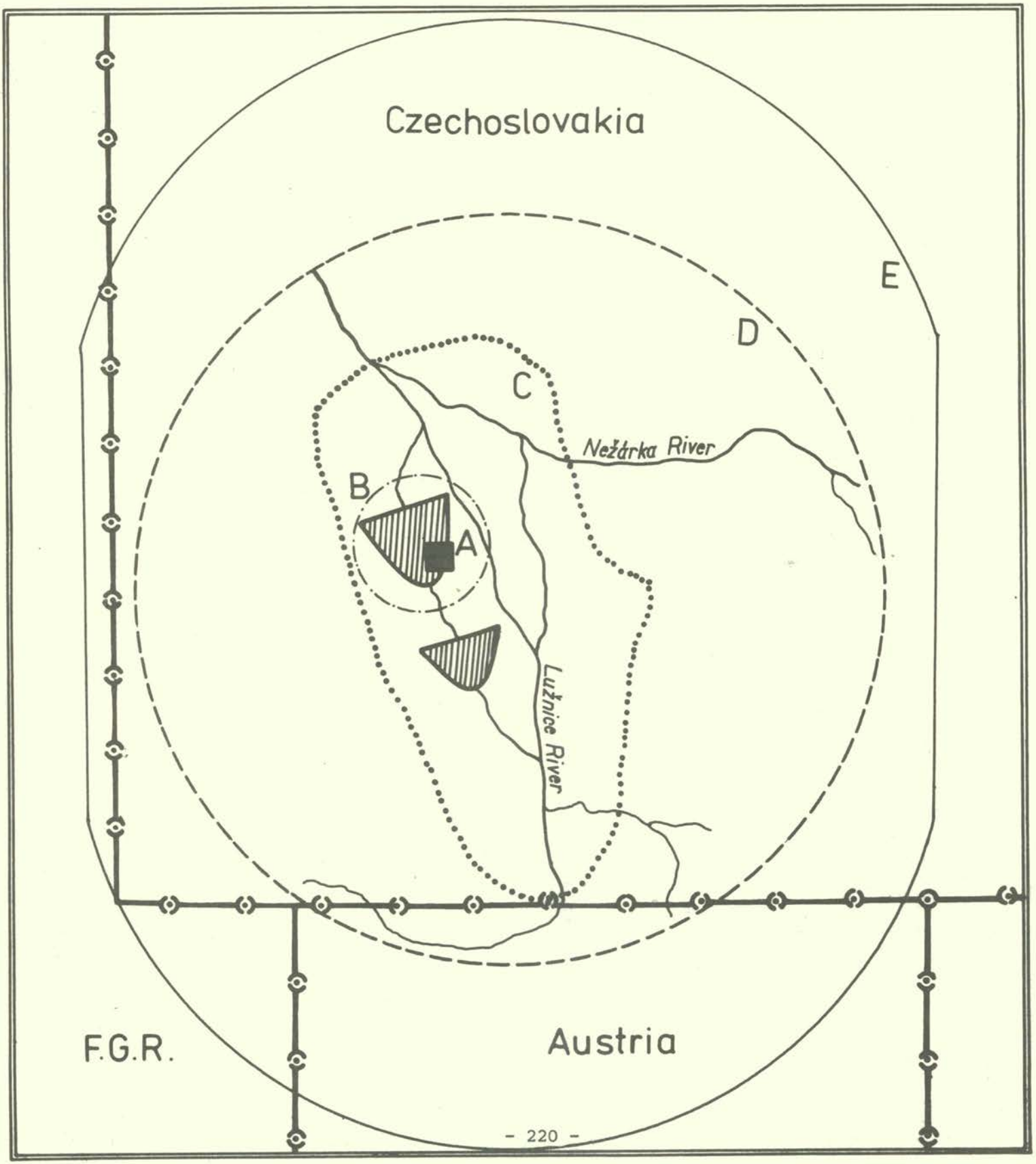


Fig. 2. Situation of species-rich nesting grounds within various natural, man-made and geopolitical boundaries: A - nesting grounds of rare waterfowl; B - Great Tisy Fishpond Nature Reserve; C - Trebon Biosphere Reserve; D - Luznice River catchment area; E - core of Central Europe.



THE SYSTEM OF NATURAL PROTECTED AREAS IN THE USSR: BIOSPHERE RESERVES AS PART OF THIS SYSTEM

By

A.M. Borodin, Yu. Isakov and V.V. Krinitsky

ABSTRACT. An analysis is provided of the system of natural protected areas in the USSR in respect to the role they play in the field of nature conservation, namely, in preserving model ecosystems and the gene pool of various organisms, reproducing renewable natural resources, maintaining a favourable ecological balance of the biosphere; optimizing the state of the environment; and providing opportunities for mass recreation and environmental education. It is proposed that the preservation of model ecosystems and provision of recreational opportunites for the people are the two spheres where greater use should be made of protected natural areas. Extensions of nature conservation activities to these ends are outlined with specific proposals for implementation indicated.

Biosphere reserves in the Soviet Union have the same basic objectives and the same legal status as state reserves. However, within biosphere reserves research is carried out in coordination with a biosphere station operating in larger areas, and the reserves actually constitute the "core" of these stations. In addition, biosphere reserves form part of a national system, as well as the global system of environmental monitoring. Studies being conducted in 140 state reserves throughout the USSR add considerably to the information obtained by biosphere reserves.

1. INTRODUCTION

Nature conservation problems are becoming increasingly important for human society. Some can be solved through administrative and organizational measures, but in most cases these problems can only be addressed within special areas designated for that purpose.

Reserves and refuges are the two forms of natural protected areas in the USSR; both terms can be found in ancient manuscripts and have been used in legal documents for more than 200 years, and are still used in up-to-date legislation. Creating reserves involves the complete and permanent withdrawal of land (forests, wetlands etc.) from economic use. Establishing a reserve implies various limitations both in volume and methods of utilizing different natural resources (forest stands, game, fish, etc.) for a definite and sometimes long period of time.

The objectives of nature conservation have evolved over time. Along with protection of natural resources, the problems of conservation of the genepool of organisms and the cenopool, environment protection and improvement on local, regional and global scales, and many other issues have come to the fore. Thus it has become imperative to differentiate between the specific objectives of the various types of natural protected areas, and to classify these areas according to nature conservation activities and the kind of protection they require.

Whereas a century or even fifty years ago in the field of environmental and resource protection in most parts of the USSR common conservation methods were employed, the situation has drastically changed today, given the rapid economic development of the country. Natural areas that have retained their structure and biologic cycle in the central and southern regions of the European sector, in industrial areas of Siberia and in rapidly developing

agricultural regions in the Kazakh SSR and the Soviet Central Asia, have shrunk to such an extent that they can no longer perform their specific ecological functions needed to reproduce renewable resources, to maintain the ecological balance of the biosphere, and to protect the environment in which people live and work. As a result, the main responsibility for implementing numerous tasks in the field of nature conservation lies on special areas earmarked for this purpose.

Yet in a number of cases, it has proved to be unrealistic to a considerably increase the amount of land designated for nature conservation. The only alternative is a considerable intensification of activities in existing protected areas. This has turned out to be rather difficult when the designated areas must perform several conservation functions simultaneously, particularly if some of the functions do not conform to each other. Thus it has been necessary to further specialize the various categories of protected areas by shortening the range of tasks assigned to each and by clearly specifying activities for each. For these reasons, the diversity of types of area designated for natural conservation has considerably increased and will increase even more in future.

Presently there are approximately 60 different types of nature conservation areas in the USSR. The situation elsewhere is similar, as can be seen from the list prepared by the International Union of Conservation of Nature and Natural Resources (IUCN).

As mentioned above, the activities of nature reserves are determined in the first place by the specific tasks to be undertaken. Multiple tasks may be grouped into seven main issues, six of which were already formulated earlier (Isakov, Krinitsky 1979, 1980). They are as follows:

1. To maintain and, in some cases, to improve the favourable ecological balance in large regions. This involves forest planting in vast areas, irrigation and water supply in semi-arid zones, interbasin transfer of river runoff and other activities.

2. To preserve model natural (and some seminatural) ecosystems and landscapes. It is necessary primarily for scientific information purposes to study their organization and dynamics and to evolve methods to control the cycle of matter and energy. The latter will help to outline ways of preserving these ecosystems in the context of growing anthropogenic pressures, to increase their biological productivity and finally, to simulate man-made ecosystems with predetemined parameters.

3. To conserve, to the fullest extent possible, the genepool of organisms. To accomplish this objective many approaches have to be taken, however, any degree of success presupposes the attainment of the preceding general goal. Conservation of the genepool is directly connected with conservation of the cenopool, i.e. of the whole diversity of natural and semi-natural communities and accordingly their ecosystems.

4. To restore, reproduce and rationally use renewable natural resource, with first emphasis on biological resources. This set of tasks includes not only conservation and propagation of endangered species, but also greater reproduction of resources which, although abundant now, do not meet growing needs of society.

5. To protect and improve the natural environment -- atmosphere, water and soil. These tasks become more vital as the pressures from economic activities increase on natural complexes. Environment protection functions are often impaired, and in some cases they need to be

compensated for by creating man-made ecological complexes and even technicogenic systems, which in their turn, become new objects for nature protection.

6. To conserve nature in order to provide recreational opportunities. Rapid urbanization has made this an urgent requirement.

7. To evolve environmental education and to introduce an ecological approach to the solution of problems related to the environment and resource protection. This has become a separate and a very important task. Naturally, educational and training institutions, starting from kindergardens up to higher educational bodies (universities and specialized institutes) should play a leading role under this task. Along with general ecological education, the inculcation of moral and ethical principles as the basis of people's approach to nature is of great importance, as well as popularization and elucidation, by means of examples, of the issues involved in nature conservation. Protected areas may be of great help in coping with this complex task, for some it may become a major objective.

In the USSR, a vast area of land and water has been designated as reserves for solving nature conservation problems. It occupies, roughly, more than 5 million sq km which is a considerable portion of the country's total territory. More than 90% of the total area is used to maintain a favourable ecological balance of the biosphere, and at least 85% is of great importance for reproducing renewable resources. By contrast, only about 5% has designated for recreation, a little more then 9% for environment protection, about 10% for conservation for the genepool, and less the 4% for preservation of model ecosystems and landscapes.

Thus, preservation of natural ecosystems and provision of facilities for mass recreation are the two spheres with less priority than the others in terms of the coverage of present protected areas. It is necessary to strengthen these weakest links in the whole system of natural protected areas, national parks that have been created recently should promote the recreational uses. At present, there are seven such parks with a total area of 430,000 ha, it is planned to increase the number of national parks threefold in the coming 20-25 years. The number of historical, cultural and natural museums-reserves is growing, as well as other recreational areas. The area of green zones around cities and towns is to be doubled. Considerable work is under way to expand and modernize health resorts, and in particular resort forests.

It is much more difficult to solve the second and more vital outstanding problem, the preservation of model ecosystems and landscapes. Although this task is being more successfully addressed by existing reserves, their number is still far from being sufficient and their distribution is uneven resulting in some biomes having no reserves. Great progress has been made recently in expanding the network of these reserves, their number amounts to 140 (October, 1982), and the total area is 13,2 million ha.

It is especially difficult to create reserves within most economically developed biomes, e.g. in steppe zones, in other words, in areas where the need for them is the greatest. It is extremely difficult to find well-preserved plots of steppe ecosystems and to get the agreement of users to withdraw these lands from economic use. Finally, it is no less difficult to preserve natural ecosystems on rather limited plots incorporated in vast areas of economically developed lands. Many such spots cannot be turned into reserves but they can be given the status of natural monuments or of other protected areas with a similar regime. It is possible to preserve natural and semi-natural ecosystems in these conditions only if the vast region requiring protection, is under special use status. The latter must stipulate a number

of necessary limitations in resources use and in management that will ensure the maintenance of favourable ecological conditions and of a high quality of the environment. In this connection, it has become urgent to evolve a legal status for the regions with special conditions for use. Such regions do not arise spontaneously but in accordance with decisions passed by responsible bodies, as may be seen in the decisions on the protection of nature and resources in the Baikal drainage basin, the coastal area of the Baltic Sea and for the quality of water in the basins of the Volga, the Don, the Dneiper rivers.

The correct siting of natural protected objects of various types and purposes is of great significance for the preservation of model ecosystems in limited areas that would ensure their favourable interaction promoting accomplishment of the main objective, e.g., preservation of model ecosystems (Isakov, 1983).

Great attention is being paid throughout the world to the creation of a network of the biosphere reserves, their main objectives being:

-- to preserve natural complexes, representative of certain biotic provinces, their usual ecosystems and the whole diversity of biota -- the gene pool of organisms;

-- to carry out systematic observations of the natural dynamics of these complexes and of changes occurring in their structure and functions under anthopogenic effects, i.e. to carry out environmental monitoring programmes;

-- to develop, on the basis of such reserves, activities in the field of environmental education and the promulgation of nature conservation ideas.

The Soviet Union has proved to be better prepared than many other countries to solve these problems. The fact is that the first two objectives long ago were identified as being basic for the whole system of USSR State reserves and were clearly formulated in the regulations for these reserves in 1981. The main purpose of setting up the reserves is the preservation of model ecosystems and the gene pool of organisms. Yet reserves, unlike most natural parks and other types of natural protected areas in other countries, serve as scientific institutions and have a permanent staff of specialists in many fields. The main objective of research in reserves is to study the organization and dynamics of natural protected complexes. A major part of these studies is carried out in accordance with the so called "Annals of Nature" -- a scientific theme conducted in all the reserves. This aspect of scientific activities corresponds considerably to our understanding of geosystem monitoring of the environment. The scope of programmes carried out in various reserves differs, and in some of them continuous observations have been underway for 35 years or more.

Finally, the third objective of biosphere reserves is environmental education, this aspect is also a part of the activities of State reserves, realized through the creation of museum exhibitions, organizing sightseeing tours, lectures, etc. Nevertheless, such activities are carried out on a much larger scale by nature conservation bodies and institutions of other types; national parks, different museum-reserves, botanical gardens, experimental and educational forestries etc. (see Table 1)

Thus, the creation of a system of biosphere reserves was not a completely new task for the USSR. Both the existing and future State reserves set up throughout the country, may provide the basis for such a system. Presently 7 biosphere reserves have been already created and a proposal to create from 12 to 15 more biosphere complexes, on the basis of the existing reserves has been developed.

Taking into consideration the above, the status of biosphere reserves in the USSR may be defined as follows:

1. They are State reserves with their basic characteristics are stipulated by regulation in 1981.

2. They differ from conventional reserves in that they are incorporated into the system of biosphere stations and participate in carrying out research projects according to programmes for background (goesystem, regional and and global) environmental monitoring. This work is carried out in coordination with the research programmes of a biosphere station in a buffer zone outside the reserve where traditional forms of land use prevail (mainly forestry and animal husbandry), as well as in testing grounds in a region with highly developed agriculture and industry.

3. Activities in biosphere reserves are carried out according to well-coordinated programmes and unified methods within systems of the national and the global network of stations for background environmental monitoring.

In addition, the widespread network of USSR State reserves (and a number of natural protected areas of other types) performs similar functions to the biosphere reserves. They preserve model ecosystems and the genepool of organisms, carry out educational work in the field of nature conservation and conduct regular comprehensive observations of the dynamics of natural complexes; and take part in monitoring of the nature environment. This can be seen to be a tangible contribution to the activities of the biosphere reserves.

A list of the main types of natural protected areas and features existing in the USSR is provided in Table 1. The table points out the main objectives to be achieved by natural protected areas of different types; XXX denotes a primary objective, XX - secondary, X - supplementary.

TABLE 1: BASIC TYPES OF NATURAL PROTECTED AREAS IN THE USSR AND THEIR PURPOSE

Basic types of protected areas grouped according to their main purpose.

Symbols: XXX=primary function;
XX =secondary function;
X =supplementary function

Type of Area	Conservation of Model Ecosystems	Conservation Gene Pool of Organisms	Restoration and Reproduction of Resources	Maintenance of Favourable Ecological Balance of a Region	Environment Protection	Provision of Opportunities for Recreation	Environ/Educ and Training
Landscape, integrated and hydrological natural monuments and refuges.	XXX	X	-	X	-	-	X
State Reserves	XXX	XXX	-	-	-	-	X
Biosphere Reserves	XXX	XXX	-	X	-	-	XX
Botanical natural features	XXX	XXX	-	-	-	-	X
Microsanctuaries	X	XXX	-	-	-	-	XX
Botanical gardens, arboretums, plantations of rare species of plants; zoo farms of rare species of animals	-	XXX	-	-	-	-	XX
Wetlands protected according to international conventions	XX	XXX	XXX	X	-	-	-
Botanical refuges including forests	XX	XXX	XXX	X	-	-	-

Type of Area	Conservation of Model Ecosystems	Conservation Gene Pool of Organisms	Restoration and Reproduction of Resources	Maintenance of Favourable Ecological Balance of a Region	Environment Protection	Provision of Opportunities for Recreation	Environ/Educ and Training
Zoological and game refuges, sea islands, seal farms, protected plots of sea shelves	X	XXX	XXX	-	-	-	-
Protected spawning water areas	X	XX	XXX	-	-	-	-
Fish producing factories with release of fry into rivers, sea-farms	-	XX	XXX	-	-	-	-
State forest-game farms	-	X	XXX	-	-	X	-
Breeding hunting farms	-	X	XXX	-	-	-	-
Siberian Cedarnut producing zones and forest-gardens	X	XX	XXX	XX	-	-	-
Reserved forests	X	X	XXX	XXX	X	-	-
Climate regulating forests	X	X	XX	XXX	XX	-	-
Pine forests in a steppe-forest zone	-	X	X	XXX	XX	-	-

Type of Area	Conservation of Model Ecosystems	Conservation Gene Pool of Organisms	Restoration and Reproduction of Resources	Maintenance of Favourable Ecological Balance of a Region	Environment Protection	Provision of Opportunities for Recreation	Environ/Educ and Training
Water protected forests along rivers, their sources; forests on watersheds	-	-	XX	XXX	XXX	-	-
Water wind and soil protecting forest plantations	-	-	X	XXX	XXX	-	-
Regions with special regimes of nature resources use	-	XX	XXX	XXX	X	-	
Railroad and highway protected forest plantations	-	-	-	X	XXX	-	-
Forest-parks and green zones around cities, health resort forests	-	-	-	X	XXX	XXX	X
Protected seashore areas	-	-	-	-	XX	XXX	XXX
National nature parks	X	X	-	X	XX	XXX	XXX
Historical-cultural and natural museum reserves	X	-	-	-	X	XXX	XXX
Parks and monuments and garden arts	X	XX	-	-	XX	XXX	XXX
Experimental, educational and school forestries	X	XX	XX	-	X	-	XXX

BIOSPHERE RESERVES IN BULGARIA AND THEIR RELATION TO OTHER PROTECTED ZONES

By

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ABSTRACT. In order to protect numerous natural ecosystems and their genetic stock, 90 natural reserves have been established in Bulgaria. Seventeen of these are recognized as biosphere reserves, covering various forest ecosystems; they are surrounded by buffer zones. Research on ecological factors has been carried out in all biosphere reserves. In some reserves, stationary ecological research into the structure and function of the ecosystems has been made, with additional research into the biosphere pollution. Biosphere reserves in Bulgaria can serve as a basis for ecological biosphere monitoring, and for training.

1. INTRODUCTION

1.1. Ecological characteristics

From time immemorial the flora and fauna of Bulgaria have been of enviable diversity. In past geological epochs some parts of the Balkan Peninsula have not been flooded; the Rila, Pirin and the Rhodopes have never been on a sea floor. The Bosporus and the Dardanelles have been bridged by land six times, enriching the Bulgarian flora and fauna with Central Asian species and forms which became differentiated with isolation by rising water levels. As a result, the Bulgarian fauna and flora are characterstically endemic and relict.

Great altitude differences have resulted in a clearly defined vertical zoning with characteristic ecosystems at each elevation. The phytogeographical belts which on a flat territory stretch for hundreds or thousands of kilometres are all present in a small territory.

The immigration of plants and animals from the east to the west, and from the north to the south has contributed to the great variety of species; more than 3000 plant species have been recorded in Bulgaria.

1.2. History of Nature Protection

For millenia there has been strong human pressure on nature in Bulgaria. It started with the formation of the ancient Thracian civilization, followed by the Old Greek and the Byzantine and five centuries of Ottoman bondage, and has continued to the present. Throughout this time, man has been actively destroying the plant and animal world. And while in the past the degradation processes had been slow on the account of poor technology, today they are accelerating. The history of nature protection began 100 years ago, with the passage of the first Forestry Bill in 1883. In 1923, on the initiative of scientists, the first Nature Conservation Union was founded. Its activities resulted in the establishment of the Silkosia Reserve in Strandja mountain in 1933, followed by the Parangalitsa Reserve in the Rila Mountains in 1934, the National Vitosha Park, and many others. In 1948, the Nature Conservation Union was transformed into the Nature Protection Conservation Committee within the Bulgarian Academy of Sciences and -- since 1972 -- into the Environmental Centre within the Academy of Sciences.

1.3. The protected natural areas in Bulgaria

According to the 1967 law on nature protection, protected areas are categorized as follows: nature reserves, national parks, natural monuments, historical places and areas including rare plant and animal species.

Nature reserves include areas containing remarkable or scientifically important plant and animal communities in danger of extinction, or communities of permanent scientific and economical value that must be protected in their natural state. Any human activities destroying the unique character of nature are forbidden.

National Parks would be areas distinguished by a variety and beauty of nature, important for science, culture and health of the population, and at the same time suitable for recreational areas. Protected areas under ecological management can be also included in the boundaries of the national parks.

Natural monuments include areas possessing scientific, cultural and aesthetic values; they include areas with unique landscape such as gorges used for tourism and recreation.

Historical places are sites where some historical event of significance occurred or where ancient settlements, monuments, etc., are found.

According to law, protected natural areas are declared by a decree issued by the president of The Committee for Conservation of the Environment in the Council of Ministers coordinated in advance with the Bulgarian Academy of Sciences. There is no material difference between the protected areas found in our country, and those considered nature reserves (Category I), National Parks (Category II), and Natural Monuments (Category III), by the International Union for Conservation of Nature and Natural Resources (IUCN).

2. BIOSPHERE RESERVES

2.1. Choice criteria

To date approximately 90 reserves have been declared in Bulgaria. Seventeen of them were established by the Bureau of the International Coordinating Council of MAB Programme in 1977 as biosphere reserves.

The following criteria have been used in selecting biosphere reserves:

-- to be part of the natural biome;
-- to be representatives of unique communities or areas containing natural elements without any human activities;
-- to represent harmonious landscapes as a result of the traditional use of territory;
-- to represent either modified or destroyed ecosystems capable of being restored on the basis of better use of nature; or
-- to have sufficient area in which unique ecosystems can be protected.

In our country because of its mountainous character the smallest area of a biosphere reserve has been accepted to be over 500 ha; most of them are much larger.

2.2. Characteristics of biosphere reserves in Bulgaria

Biosphere reserves in Bulgaria are as follows: 1) Bistrishko Branichte in Pirin National Park; 2) Steneto-Stevato National Park; 3) Tchouprene Reserve; 4) Matrchini Lakes -- Rila Mountain; 5) Parangalatza -- Rila Mountain; 6) Baiovi Dupki -- Pirin Mountain; 7) Boatin -- Balkan Mountain; 8) Dupcata -- The Rhodopes;; 9) Kupena -- The Rhodopes; 10) Chuprene -- The Balkan Mountain; 11) Zarichinall --Planina; 12) Srebarna -- near Danube river; 13) Mantaiza --The Rhodopes; 14) Usapumbudjak -- Strandja Mountain; 15) Chervenata stana -- The Rhodopes; 16) Kamchia near the Black sea coast; 17) Ali Botush -- Slavianka Mountain.

All biosphere reserves are in the Balkan Highlands biogeographic province according to the IUCN classification. But in reality, the situation is different because the above classification is rather general, while many reserves in our country extend from 1000 to 3000 m altitude including alpine and tundra zones and some of them, for instance the Kamchia reserve, are near to the Black Sea coast -- from 0 to 50 m altitude.

2.3. The relationship between biosphere reserves and other protected natural areas

The biosphere reserves in our country are part of the whole system of 90 reserves. All reserves in Bulgaria including biosphere reserves are managed under equal conditions; they all observe a strict protection regime. Some of the reserves are located in our national parks: Bistrichko Branichte biosphere reserve is located in the Vitosha national park, Baevi doupki biosphere reserve in the Pirin national park and Steneto biosphere reserve in the Steneto national park.

3. BIOSPHERE RESERVE MANAGEMENT

The biosphere reserves in Bulgaria mostly include territory from our forest estate; the only exception is Srebarna reserve which is a lake near the Danube shore. Reserve management is under control of the Ministry of Forestry and the Committee for Protection of the Environment of the Council of Ministers. The Bulgarian Academy of Sciences also takes an active part in reserve management; permission for visitation, management, and any change of the reserve boundaries must be is based on scientific advice from the Academy. Any permission for visiting must be obtained from the Forest Ministry and must be coordinated with the Committee for Protection of the Environment.

3.1. Managing methods

All Bulgarian biosphere reserves are carefully designed. The Bulgarian Academy of Sciences has produced a unified basic ecological classification that divides the country into forest plant areas, forest plant subareas and forest plant belts. The boundaries of each forest plant belt have been determined according to detailed research of the soil and geological substrate as well as the ecotopes that include the ecosystem. By this classification, 156 basic forest ecosystems have been described for Bulgaria.

Each reserve is divided into types of ecosystems depending on the dominant species; the ecosystems are further divided on the basis of age and density of the forest. The boundaries of the reserves are permanently marked, and surrounded by a buffer zone.

3.2. Scientific research

The first stage of research is represented by the setting up of the reserve's size and shape, mapped out using special methods. The second stage involves the establishment of ecological stations for research; such stations have been started in the Parangalitza, Steneto and Srebarna biosphere reserves. The third stage is represented by the Parangalitsa reserve, where more than 50 specialists have conducted a complex ecological research using special methods of work.

The Bulgarian Academy of Sciences guides the research. The dynamics of structural and functional parameters of the representative ecosystems is studied by the station research. Special appliances are present at the experimental grounds. At first meteorological appliances are set up; the initial meteorological information is taken three times a day according to the methodology established by the International Meteorological Organization. The dynamics of redistribution of rainfall on structural ecosystems units, the surface and subterranean flow, acid rain, etc., are studied as well. Research is conducted on the dynamics of the flora and the fauna, the soil, the initial productivity and energetics of the plants. There are some difficulties due to lack of fully automatic appliances at the experimental sites as well as lack of instruments for ecological lab analysis.

In Parangalitsa biosphere reserve located on Rila mountain, from 1450 to 220 m altitude, the first experiments to measure the biosphere pollution are being carried out; it is hoped that the Bulgarian biosphere reserve could be used as a basis for the development of a network of stations for world (biosphere) ecological monitoring. What is needed is full instrumentation for the complex ecological research work at the experimental grounds in the coniferous forest of biosphere reserve Parangalitsa in Rila and the beech forests of Steneto in Stara Planina.

4. USING BIOSPHERE RESERVES

Biosphere reserves are being used for scientific research and ecological education; they are visited by pupils and students who see uninfluenced and slightly influenced ecosystems. They may also be used for ecological training and educating of specialists of developing countries.

The biosphere reserves are located in the alpine areas of our country and they are not influenced by local pollution. Due to their location in the heart of the Balkan peninsula they can be used as the basis for a system of ecological monitoring stations. However, it is necessary that ecological monitoring should be made cheaper and more efficient through the use of common research methods and instruments. That implies an initiative on the part of the International Coordinating Council of the Programme Man and the Biosphere (MAB) Unesco. We suggest that the First Congress on Biosphere Reserves to propose the recommendations needed.

REFERENCE AREAS WITH REPRESENTATIVE TYPES OF NATURE IN THE NORDIC COUNTRIES: AND THE PROPOSED ECE SYSTEM OF REPRESENTATIVE ECOLOGICAL AREAS

By

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ABSTRACT. To develop adequate methods of evaluation of nature and to use biological science to support physical planning, a project has been performed by the Nordic Council of Ministers. The Nordic countries have been divided into 76 physical-geographical regions based on features of vegetation, climate and landforms. Areas reperesentative of the regions have been selected and described in a standardized manner. A method of using information on natural conditions of the regions and of the reference areas for use in physical planning has been tested.

The proposed ECE Representative Ecological Areas have been difined as areas which should reflect the variety of nature types characteristic of a natural (physical) geographical region in which the area is situated. The main objective of the areas is to be used as reference areas for all types of physical planning and the economic planning of different forms of land use within the region. The establishment of the areas will be made in a way similar to the work of reference areas in the Nordic countries.

The ECE Representative Ecological Areas are very close to the concept of the Biosphere Reserves. However, there are also differences in the scale of the regions, the frequency of the areas and in the main objective of the areas.

1. INTRODUCTION

A system of making inventories, and processing and reporting information on nature and natural resources has been developed within the project "Representative types of nature and threatened biotopes" carried out by the Nordic Council of Ministers. The work has been based on the opinion that planning using a wide resource philosophy as its starting-point implies that biological and geoscientific knowledge must be included as a fundamental part of the planning process. Knowledge on the types of nature found in the Nordic countries has been structured for use in physical planning and is presented in a number of reports. In addition, this material has been used in the development of an information system. The project has been comprised of the following parts:

-- The Nordic countries have been divided into physical-geographical regions which represent the diversity of natural conditions in the Nordic countries;

-- Vegetation types and land forms in the Nordic countries have been classified and structured for evaluation of nature in connection with planning;

-- A system for inventories, processing and reporting data concerning natural conditions has been tested in connection with material obtained on nature in the Nordic countries; and

-- Types of nature representative for the Nordic countries have been reported, and some examples are given of areas where these occur.

2. REFERENCE AREAS WITH REPRESENTATIVE TYPES OF NATURE

2.1. Division of the Nordic countries into physical-geographical regions

In a report published in 1977 from the Nordic Council of Ministers a description was given of the "Division of the Nordic countries into physical-geographical regions". Therein, Denmark, Finland, Norway and Sweden were divided into 60 physical-geographical regions with a number of sub-regions (Iceland did not participate in this work).

Since 1977 the work has now been further developed and processed; Iceland is now included and the number of regions has thus been extended to 76 (Fig. 1). The division into regions has primarily been based on vegetation using the large vegetation zones (nemoral, boreonemoral, boreal and alpine zones) as starting points. The zones have been divided according to important characteristics in the natural vegetation, e.g., dominating types of forests, but also according to features of the vegetation found in cultivated land. Consideration has been given to the extent of floristic elements in the vegetation types.

Similar divisions as regards climate, geology and land forms have been prepared, with the whole material resulting in a coordinated division of the Nordic countries into regions. The borders of the primarily delimited vegetation regions have been adjusted foremost with regard to geomorphology but also to geology, climate and even special characteristics of the vegetation; in many cases a further breakdown of the regions into sub-regions has been made. The final division largely reflects the vegetation and geomorphology of the landscape, as these are the basic parameters in the evaluation of the landscape in connection with physical planning and particularly planning involving environmental protection.

The work has been based on literature studies as well as expert knowledge, and the aim has been to provide a survey as complete as possible at the present state of knowledge. The typification used is not always strictly scientifically formulated. It is adjusted to be utilized for applied physical planning, with the aim being that the types will be understood by both scientists and practical planners. However, certain information and training is probably necessary to achieve this goal.

2.2. Reference areas and information processing

This aspect of the project has been conducted in cooperation primarily with regional authorities (amt, fylken, lan), but also central authorities concerned with environmental protection. On the basis of the division into physical-geographical regions, the number of areas considered to be representative of each region has been selected and delimited.

Each selected area is described using the lists of vegetation types and terrain configurations that have been prepared within the project. In addition, general information has been collected on geology, climate, etc., as well as protection status, threats, special faunabiotopes, and occurrence of threatened plan and animal species. The reporting has been done in such a way that the material can easily be further processed using computer techniques.

Information from the selected areas with nature representative of the Nordic countries has been coded according to the RUBIN-system and stored in a computer. Using the data programme INFOL, different processing has been carried out. In this way it has been possible to check the occurrence and extent of different landscape components (vegetation types, land forms) throughout the Nordic countries. The representativeness and rarity of the

different landscape components in relation to the physical-geographical regions has been tested. Finally, the system of evaluation of nature within an individual planning area has been developed, based on direct comparisons between landscape components within the planning area concerned, and landscape components within physical-geographical regions and representative areas of nature.

The experiences are summarized in a model for processing information on nature when planning (Fig. 2). Information on landscape components related to physical-geographical regions is continuously collected in a database. The work concerning inventories, coding and data storage has been carried out in a standardized manner. By using the same methods and routines when collecting data in connection with individual planning projects, the entire database can be used for evaluation and analysis within these projects.

2.3. Need for continued research and development

The project has contributed to structuring knowledge on nature in the Nordic countries in such a way that it can be used in different forms of land-use planning. In connection with reporting and processing, it has become clear that the material must be complemented and further developed in the future.

The classification of landscape components (vegetation types and land forms) should be taken further in some respects. Increased information on localities and biotopes for threatened plants and animals should be linked to the list of vegetation types. In addition, functional characteristics of the ecosystems indicated by vegetation types should be documented, primarily by studies of the literature.

Some landscape components have not been treated within the project. Among these are such land-use types and cultural components as relics of antiquity, buildings, etc. A project with the aim of surveying these sites has already been started by the Nordic Council of Ministers.

Finally, an inventory conducted according to the principles proposed by the project should be useful. The activity should be delegated to regional and national authorities concerned with environmental protection. Routines and processing with regard to the databases should be developed into the systems through which information can be easily transferred both to local planners and to international organizations and authorities.

3. THE ECE SYSTEM OF REPRESENTATIVE ECOLOGICAL AREAS

3.1. Definition

Based on a proposal from the Czeckoslovakian Socialist Republic and a report of the work on reference areas with representative types of nature in the Nordic countries, the Senior Advisors to ECE Governments on Environmental Problems established a Task Force on the Possible Promotion of a Network of Representative Ecological Areas. Sweden became the lead country of this Task Force.

The Task Force elaborated a definition of a "network of representative ecological areas": "A system of areas of particular importance from the ecological point of view. Such areas should reflect the variety of nature types (including areas intensively used for agriculture, forestry, etc.) characteristic of the natural geographic region in which the area is situated". A Representative Ecological Area will embrace a part of a

landscape with high diversity not only in nature types but also in different forms of land use and legislative protection. It must be possible to follow the reaction of ecosystems submitted to stress from different management and land uses within the area (Fig. 3).

3.2. The objectives of the Representative Ecological Area

The main objective of a Representative Ecological Area is to be a reference area for all types of physical planning and the economic planning of different forms of land use within the region. In this connection, documentation of the development and change of ecosystems within the area will provide experience which will facilitate the future evaluation of the biological-ecological and economic consequences of new forms of land use. These will include problems concerning long-term productivity of the biological resources, the evolution of soil fertility and the effects of pollution and climatic changes on natural systems.

In this way it is intended that the Representative Ecological Area will ensure an appropriate use of the land that takes into account the availability of its natural resources and the need to conserve and maintain the renewable character of biological resources for meeting future requirements. It will also serve the purpose of conserving and protecting representative nature types, landscapes, ecosystems and the species found in such areas, paying particular attention to those which are rare or endangered.

3.3. Method of work

The network of Representative Ecological Areas will be established in a way similar to the work of reference areas in the Nordic countries. In a preparatory stage Europe will be divided into physical (natural) geographic regions and the nature types of these regions will be classified in a standardized manner. Areas representative of the physical geographic regions will -- in an establishment phase -- be selected by each individual country and described using a standardized classification. Then these areas will be used in physical planning following the model described in Section 2.2. (Fig. 4). It is also desirable that these areas be committed to continuous documentation and scientific investigations as a part of a monitoring system.

4. RELATIONSHIPS TO THE INTERNATIONAL SYSTEM OF BIOSPHERE RESERVES

Comparing structure of areas, methods and aims of the Nordic reference areas and the ECE Representative Ecological Areas with those of the Biosphere Reserves, following the original recommendations (Unesco, 1974), there are some important differences:

	REPRESENTATIVE ECOLOGICAL AREA	BIOSPHERE RESERVES
CRITERIA	Nature types representatative of natural geographic regions; Diversity of nature types; Natural conditions classified for physical and economic planning.	Representativeness of biomes; Unique communities and unusual natural features; Man-modified landscapes.
	National physical and economic planning and associated restrictions;	Adequate long-term legal protection

STATUS	Relevant consideration to all environmental interests should be taken in using natural resources	
PURPOSE	Reference areas for physical planning; Monitoring of economically significant changes in the environment as a result of human activities; Research; Information.	Biological, archeological and historical conservation; Ecological and environmental research, education and training; Restoration; Monitoring of long-term changes in the biosphere

The biosphere reserve concept has evolved during recent years and the recommended structure for such areas is now similar to that proposed for ECE Representative Ecological Areas. Furthermore, the multiple use of these areas are stressed; for example, human activity within the reserves is accepted to a great extent. The MAB Scientific Conference in 1982 thus added the expression "representative ecological area" to the term "biosphere reserve" (Batisse, 1982).

However, the original recommendations of the characteristics and objectives of Biosphere Reserves have not been revised. The main purpose of the ECE Representative Ecological Areas to be used in a system for physical planning is not emphasized with regard to the Biosphere Reserves. The characteristic of a Biosphere Reserve as representative of a biogeographic province is on a scale that is of little direct use in regional and local planning; it is necessary to break down the provinces into smaller units, e.g., the physical geographic regions worked out in the Nordic countries. The criteria of a reference area representative of a region must be used for the selection. The reference areas must cover all the main ecosystems and they must be distributed within every physical geographic region. They must have a frequency dense enough for the demands of regional and local planning authorities. The information on natural features of the areas must be documented in a standardized way and stored in databases ready for use in practical planning of land use.

The Task Force of the ECE Representative Ecological Areas has noted that there are close links between the proposed Representative Ecological Areas and the idea of the biosphere reserve system. Each system would complement the other through information and monitoring activities. A further integration of the biosphere reserve concept and that of the ECE Representative Ecological Area will demand a further change in the characteristics and objectives of the Biosphere Reserves. Taking into consideration that it is confusing to have too many concepts of international areas for research and conservation, this integration will perhaps be a high priority of the international conservation community for the future.

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Figure 1

Physical Geographical Regions

Figure 2

Model for processing information on nature during planning

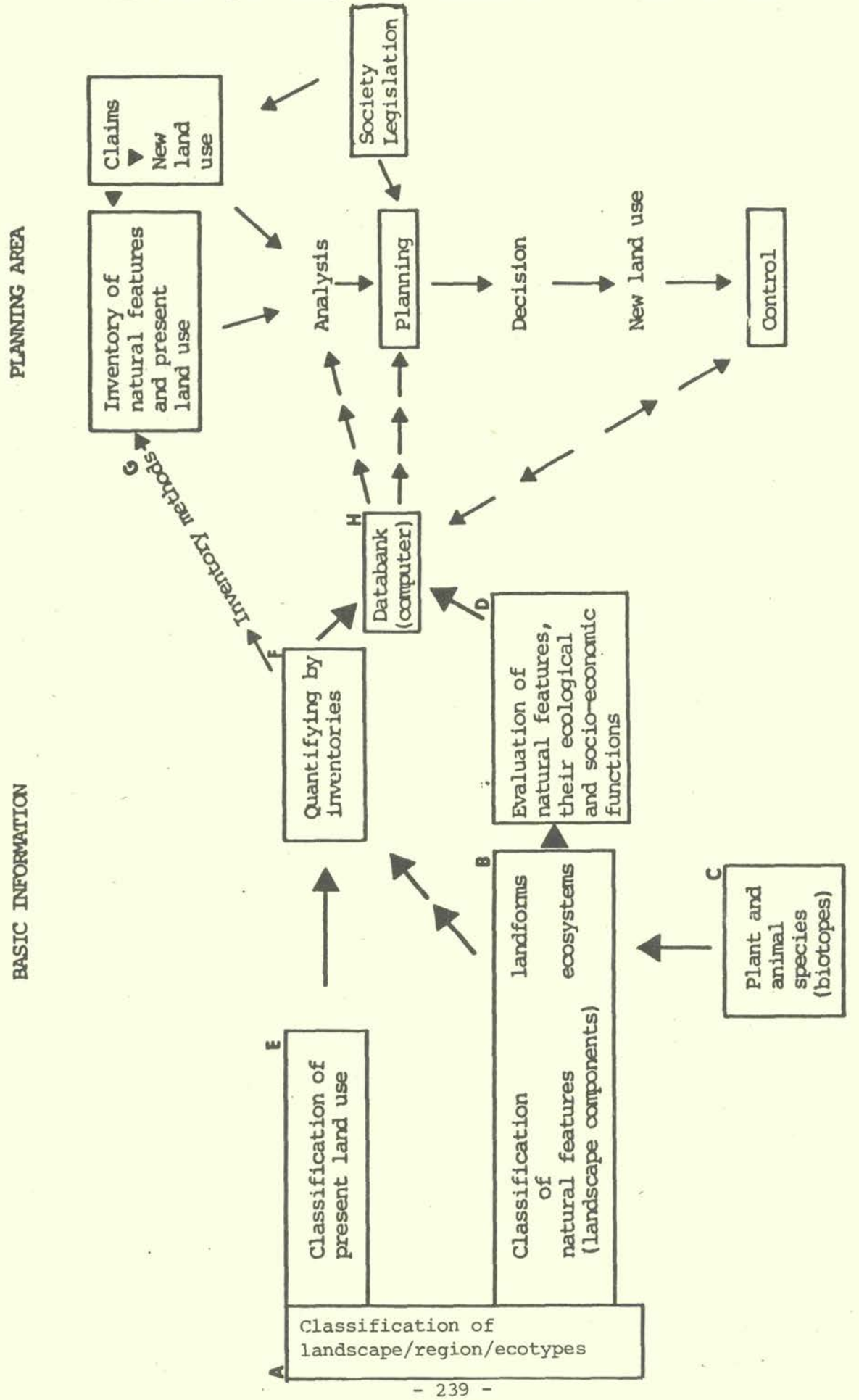
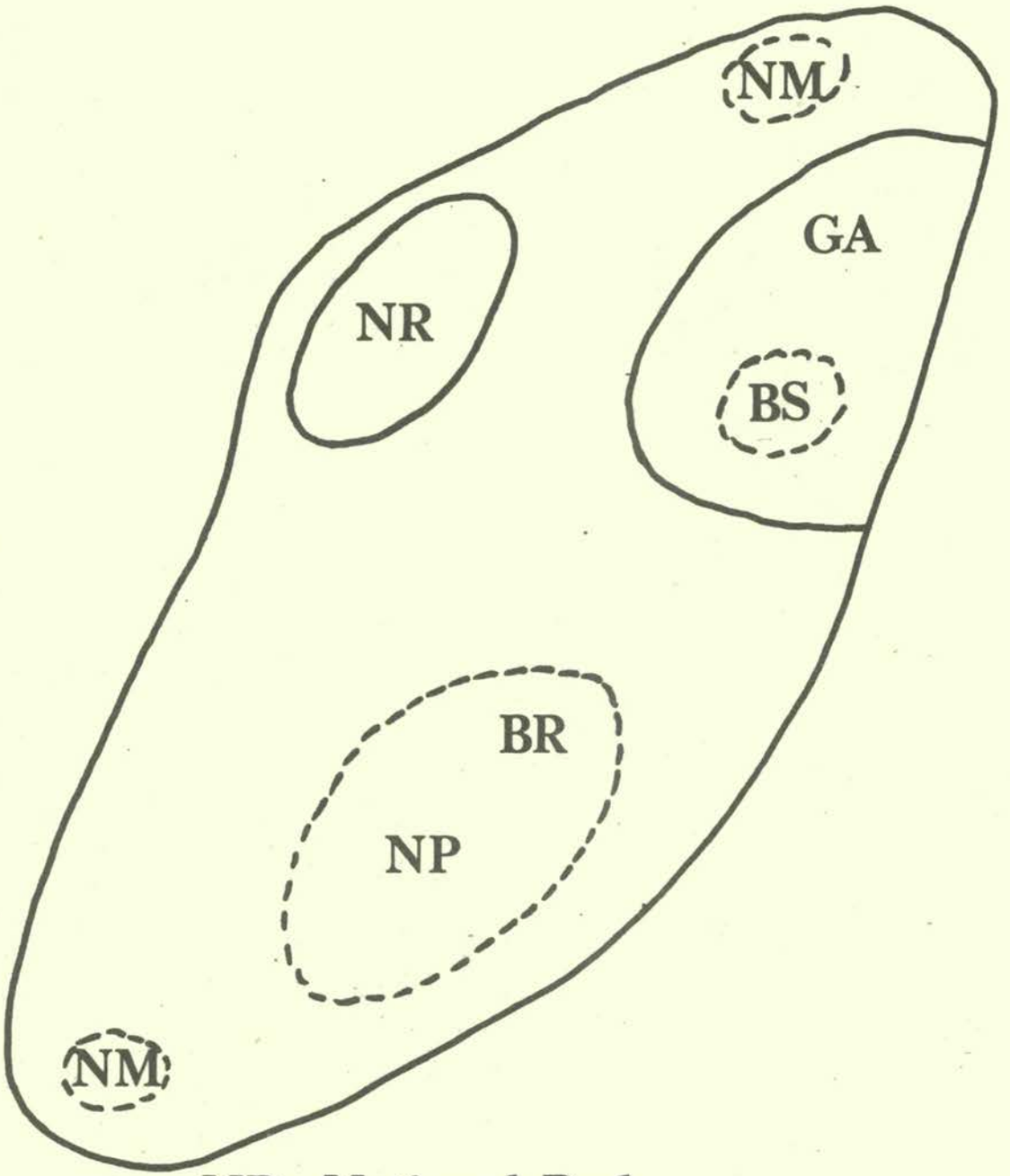


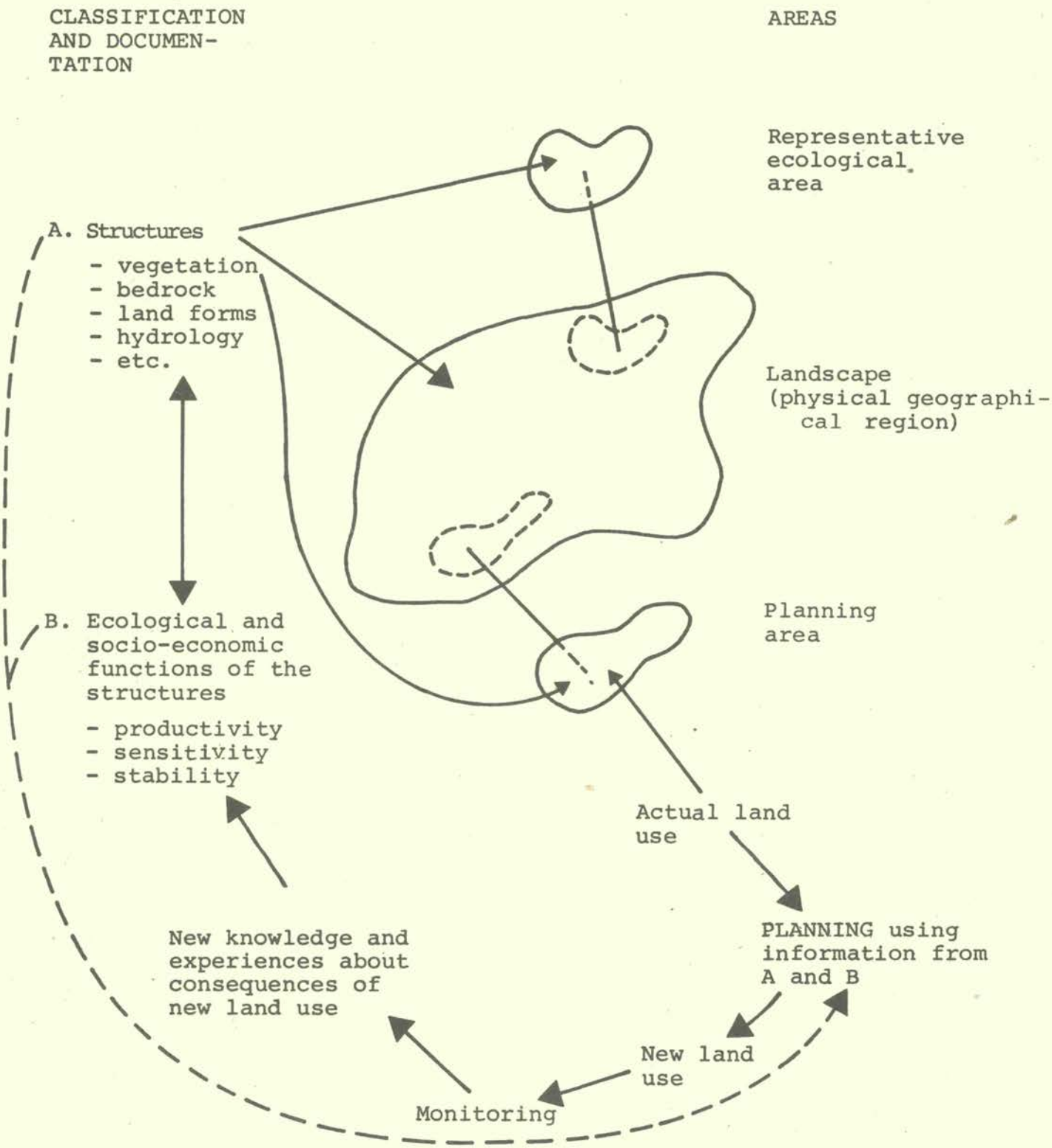
Figure 3
Status of the representative ecological area



NP = National Park
NR = Nature Reserve
NM = Nature Monument
GA = Guideline Area
(special control of landuse and exploitation)
BR = Biogenetic Reserve or Biosphere Reserve
BS = Bird Sanctuary

Figure 4

The use of natural features of representative ecological areas within physical planning



BIOSPHERE RESERVES AND WORLD HERITAGE SITES: RELATIONSHIPS AND PERSPECTIVES

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ABSTRACT. Two international conservation programmes have come of age: the International Biosphere Reserve Network of the Man and the Biosphere (MAB) Programme and the World Heritage Convention with its list of both cultural and natural properties of outstanding universal value. These two endeavours are both different and similar. The international biosphere reserve network is basically a scientific endeavour aiming at conserving a maximum of biological diversity within a worldwide network of sites which provide representative examples of the ecosystems which make up the biosphere. World Heritage properties must fulfil the criteria of uniqueness and universal value. The World Heritage Convention enhances the preservation of these properties by added legal protection and international assistance from the World Heritage Fund. One striking common point of the MAB Programme and World Heritage Convention is their co-evolution: the idea of World Heritage and of the concept of Man and Biosphere both emerged in the 1960s, frameworks for both endeavours were adopted in the 1970s and the first major operational activities took place during the late 1970s, and the wider application of both programmes can be seen as the great challenge of the 1980s.

1. INTRODUCTION

Unesco is the United Nations specialized agency for Education, Science, Culture and Communication. It offers unique possibilities for combining efforts to preserve mankind's cultural and natural heritage. In 1972, the Member States of Unesco adopted a common framework for both: the World Heritage Convention. The World Heritage Convention represents a new conservation ethic, codifying the worldwide acceptance of the World Heritage idea that there are some parts of the natural and cultural heritage which are so unique, exceptional and important to the world as a whole that their conservation and protection for present and future generations is not only a matter of concern for individual nations, but for the international community as a whole. The Secretariat for the natural part of the World Heritage Convention is provided by Unesco's Division of Ecological Sciences, which is also responsible for implementing the international network of biosphere reserves. This network forms the backbone of Unesco's intergovernmental Programme on Man and the Biosphere (MAB). The international biosphere reserve network is basically a scientific endeavour, being the part of MAB aiming at conserving *in situ* a maximum of biological diversity.

World Heritage sites and biosphere reserves are at once different and similar. Their differences and common points can be best highlighted by comparing criteria established for selecting suitable sites for each programme.

2. BIOSPHERE RESERVES AND WORLD HERITAGE PROPERTIES

2.1. Representativity versus uniqueness

In selecting biosphere reserves, emphasis is laid on samples of representative ecosystems, rather than on those that are rare or unique. A considerable degree of regional cooperation is required to ensure that the efforts of nations in proposing appropriate sites are complementary to each other and that, between them, the coverage of major ecosystems is adequate. A systematic approach is required for global ecosystem conservation which is combined with comparative ecological activities.

The World Heritage Committee will consider including a proposed natural heritage property in the World Heritage List, if it meets one or more of the following criteria:

-- constitutes an outstanding example representing the major stages of earth's evolutionary history;

-- constitutes an outstanding example representing significant ongoing geological processes, biological evolution, or man's interaction with his natural environment;

-- contains superlative natural phenomena, formations or features or areas of exceptional natural beauty; or

-- contains the most important and significant natural habitats where threatened species of animals or plants of outstanding universal value from the point of view of science or conservation still survive.

Although there is thus a considerable difference in selection criteria between World Heritage sites and biosphere reserves, this does not mean that a World Heritage site cannot also include a biosphere reserve. On the other hand some biosphere reserves may contain unique characteristics which qualify them, as World Heritage sites, 13 have been also recognized as biosphere reserves (see Table 1).

2.2. Scientific interest

Both categories, World Heritage properties and biosphere reserves, are scientifically important but in different ways. Due to their representative character, biosphere reserves lend themselves to comparative ecological research. They constitute the backbone of MAB as reference sites for research and monitoring. The scientific interest in World Heritage sites focuses on their unique, exceptional character.

2.3. Legal aspects

There is also an important difference between these two categories from the legal point of view. Both biosphere reserves and World Heritage properties require adequate long-term protection at the national level. However, the World Heritage Convention as an international legal instrument provides additional legal protection for properties included in the World Heritage List. This has been recently demonstrated in Australia, where the conservation of the Western Tasmania Wilderness area -- included in the World Heritage List in 1982 -- became a major national issue.

2.4. Development

The biosphere reserve concept brings a major focus on man, his need for development and his role as protector of genetic resources. The practical application of the biosphere reserve concept involves blending the protected representative ecological areas fully into their socio-economic environment. As such, the concept of the biosphere reserve is one of the major innovations in natural resource management in recent decades. It is a tool to relate management directly to the needs of people. This crucial part of the biosphere reserve concept should be also applied to World Heritage sites to make them locally and socially accepted. In this respect, biosphere reserves can be considered as assuming a pioneering role in developing an alternative and more lasting form of nature protection; the application of the concept to World Heritage sites is only one of many applications.

2.5. International cooperation

Both the international biosphere reserve network and the World Heritage Convention are potentially very powerful in promoting international cooperation. However, in this respect it is worthwhile to mention some of the considerable differences between those two categories.

The network idea is crucial to the biosphere reserve concept. The international character of the network is ensured by exchanges of information and personnel through the MAB national and international structure. Information and data on research, monitoring, specialist training and environmental education programmes can be exchanged between biosphere reserves which have comparable ecological conditions or environmental problems.

The strength of the World Heritage Convention lies particularly in the existence of the World Heritage Fund which was established to provide support to States Parties which are not able to fulfil their obligations under the Convention without help of the international community.

In short, MAB and biosphere reserves have been developed to promote international scientific cooperation and the World Heritage Convention to provide for world cultural and natural heritage preservation.

However, these differences do not mean that these two endeavours for international cooperation and assistance cannot be mutually supportive. Biosphere reserves attract scientists all around the world as they provide secure sites for undertaking long-term studies on the structure, processes and changes occurring in ecosystems with and without human interference. Research covers social, economic and cultural parameters, as well as environmental features. The results of those studies can also help to determine the appropriate use and management of World Heritage sites. Furthermore, the MAB Programme, with its 101 national committees, possesses a suitable structure to promote the implementation of the World Heritage Convention. Only very few States Parties to the World Heritage Convention have as yet established national heritage committees. World Heritage funds can be made available to States Parties for a variety of purposes such as training of individual specialists in conservation matters, supporting regional training centres and implementing environmental education programmes or natural heritage inventories, etc. In the case where a World Heritage site encompasses or falls within a biosphere reserve, technical cooperation can be made available, for example, to support the preparation of a management plan or purchase equipment and materials for protection, ecosystem restoration, anti-poaching measures, etc.

3. LINKS WITH THE ECOSYSTEM CONSERVATION GROUP

Last but not least, Unesco could not fully implement the MAB biosphere reserve network and World Heritage Convention without the vigorous support from UNEP, FAO, IUCN and WWF. Under the terms of the World Heritage Convention, IUCN is the advisory body to the World Heritage Committee on all questions concerning natural heritage. In an analogous way, IUCN is directly involved in the MAB Programme as it provides valuable advice and support to the development of biosphere reserves. UNEP is also promoting the development of biosphere reserves notably through a project concerning arid and semi-arid zones, training activities and a pilot scheme for ecological monitoring in biosphere reserves, jointly with GEMS and WMO. FAO recognizes the important role of biosphere reserves in *in situ* conservation of genetic resources and has organized joint activities with support from the World Heritage Fund in training conservation specialists.

4. CONCLUSION

In conclusion, we can state that biosphere reserves and World Heritage sites constitute the only two existing international categories of protected areas of significant worldwide coverage. They form two new, distinct but mutually supportive tools for international cooperation in the conservation field.

Keywords for biosphere reserves are representative ecosystem conservation, scientific network, conservation/development and for World Heritage preservation of unique cultural and natural values, enhanced legal protection and international assistance.

TABLE 1: Natural or natural/cultural World Heritage sites which are also biosphere reserves (as at September 1983).

Name of Site	Country
Mount Nimba Strict Nature Reserve	Guinea*
Rio Platano Biosphere Reserve	Honduras
Tai National Park	Ivory Coast
Darien National Park	Panama
Bialowieza National Park	Poland
Niokolo-Koba National Park	Senegal
Ichkeul National Park	Tunisia
Ngorongoro Conservation Area/ Serengeti National Park	United Republic of Tanzania
Yellowstone National Park	U.S.A.
Everglades National Park	U.S.A.
Olympic National Park	U.S.A.
Durmitor National Park	Yugoslavia

*The World Heritage site also includes the part of Mount Nimba lying in the Ivory Coast.

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